NATIONAL STOCKPILE AND UNITED STATES STRATEGY

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NATIONAL STOCKPILE AND UNITED STATES STRATEGY

8 October 1957

CAPTAIN OWEN: Our Government has been stockpiling the strategic and critical materials effectively for about 11 years. The present stockpile is composed of 75 materials. It includes 2.5 million tons of materials, stored in 223 locations, and is worth more than $6 billion at current prices.

The national strategic concept and the strive for economy in Government spending is causing a broad reappraisal of the program.

Our speaker this morning was actively engaged in the stockpile program from 1948 until about 1956, when he left Government service to go into his own private business. He has kept in touch with the stockpile program and is exceptionally well qualified to talk to us this morning on the subject, "National Stockpile and United States Strategy."

It gives me great pleasure to welcome back to the College for his fifth lecture here and to present to you Dr. John D. Morgan, Jr.

DR. MORGAN: General Hollis, Guests, Members of the College: It is a real pleasure to come here to Fort McNair again to talk about strategic materials and national strategy. I am sure you didn't expect a civilian to come here to tell you about our present military strategy. But I will discuss current strategic materials problems and how they may influence our strategy, as well as how our strategy in turn may influence what is being done in the field of strategic materials. I will also make some recommendations as to what should be done in the future.

As Captain Owen indicated, stockpiling has been going on for a number of years. The preamble to the basic act--The Strategic and Critical Materials Stockpiling Act of 1946--sets forth the policy clearly as follows:

> "That the natural resources of the United States in certain strategic and critical materials being deficient or insufficiently developed to supply the industrial, military, and naval needs of the country for common defense, it is the policy of the Congress and the purpose and intent of this Act to provide for the acquistion and retention of stocks of these materials and to encourage the conservation and development of sources of these materials

within the United States, and thereby decrease and prevent wherever possible a dangerous and costly dependence of the United States upon foreign nations for supplies of these materials in times of national emergency."

I should like to pick out a few words from that preamble and discuss the implications contained in them. First, the act speaks of "natural resources," so it is basically concerned with metals, minerals, and agricultural products, rather than with manufactured articles. The Congress noted that in certain strategic and critical materials United States resources are either "deficient" or "insufficiently developed." Consequently, although there may be enough of a material here in a low-grade form in the ground, but not sufficiently developed to call upon readily, there is an implied need for stockpiling. Further the Congress was interested in supplying the "industrial, military, and naval needs of the country." "Industrial" is included because they were very much concerned with the whole economy of the Nation in time of war. They mentioned "military" and "naval," but not "Air Force," because this act was passed in 1946, when we had only the Army and Navy and they still hadn't come to the 1947 reorganization of the Department of Defense. I am sure that if they were to rewrite the act today they would also include the Air Force.

The act covers "needs of the country for common defense." These then are defense needs, not peacetime needs. The act also notes the need for developing sources of materials within the country. One major phrase subject to a lot of interpretation is: "decrease and prevent wherever possible." It is one thing to "decrease" dependence, and another thing to "prevent it wherever possible." Likewise "dangerous and costly dependence" can be subject to widely varying interpretations.

The operations under the 1946 Act have been underway for 11 years now. In the years immediately following World War II there wasn't really too great a stockpiling activity, because procurement of new materials was limited by funds and it was also necessary to avoid interfering with industrial uses of materials. I might say that, while this is the 1946 Act, the concern of Congress and of the Government with assuring adequate supplies of material for the defense of the country goes much further back than that. Some of the early acts shortly after the Revolutionary War were intended to protect industries in this country that were essential for defense purposes.

In the raw materials field I recall reading some hearings held in the 1880's when the Congress was concerned with the question of whether

we should have a steel Navy to take the place of our wooden Navy. Among the questions considered were: Do we have an adequate supply of iron ore and coal and manganese and chrome to make the steel for the steel Navy? They were forward-looking in those days.

Then we find in the early 1900's, when much of the Navy was still fueled by coal, that the naval petroleum reserves in California were established. About the same time special reserves of high-quality coal in Alaska were set aside primarily for the use of the Navy. So again we see that timely provision was made to meet future defense needs.

The need for stockpiles of strategic materials was recognized in World War I. In its final report the War Industries Board recommended stockpiles of strategic materials to prevent dependence on foreign countries. Little was done, however, until 1939 when the first Stockpile Act was passed, but appropriations were very small, totalling only about $70 million. When World War II started there was little on hand in the strategic stockpile.

So, profiting from this whole experience, the 1946 Act was passed. However, in the period from 1946 through 1950, when materials were available and prices were fairly low, sufficient funds were not available to adequately build up the stockpile.

The Korean War started in June of 1950, and at that time there was only $1.6 billion worth of material on hand in the stockpile. Today, as Captain Owen indicated, the materials on hand in the stockpile are worth about $6.2 billion and there are additional materials in Government inventories worth about $1 billion more. That's a real improvement.

Let me describe the process by which stockpile objectives are determined. This is done by the Office of Defense Mobilization, with the aid of a number of interagency commodity committees, composed of experts from several major Government Departments, including Interior, Commerce, Agriculture, Defense, and State. The work of the commodity committees is then reviewed by the ODM's Interdepartmental Materials Advisory Committee. Finally, the Director of ODM has the ultimate responsibility for determining the quantities and qualities of materials to be stockpiled.

Two major steps are involved in the determination of the quantities of materials to be stockpiled under the provisions of the Stockpiling Act.

These are (1) estimating requirements in a future defense emergency and (2) estimating supplies that can be relied upon during an emergency.

Up to now, attempts have been made to compute requirements in a defense emergency for five major sectors of the economy. These sectors are:

a. Military--including the Army, Navy, Air Force, and Marine Corps.

b. Atomic energy programs.

c. Essential industrial--including the needs of major defense-supporting industries, such as the railroads, electric power generation, and shipping.

d. Essential civilian--including the needs of individuals for food, clothing, shelter, and heat.

e. Essential exports--for example, where the United States is a major supplier of essential raw materials to other nations of the free world as in the case of natural sulphur and molybdenum.

For many materials it is difficult to make accurate requirements estimates for each segment of the economy. Consequently, for many materials recourse has been had to estimating future requirements by basing the estimates on normal industrial consumption patterns, modified for conservation and substitution practices that would be feasible in a defense emergency. The Defense Department normally has computed requirements for a 3-year period, and the ODM then extrapolates such data to cover the basic 5-year period used in making stockpile calculations.

In estimating supplies that can be relied upon in time of emergency, the ODM generally bases its estimates on existing productive capacity and known resources in the United States and elsewhere in the free world. However, offshore sources, which are clearly indicated by the Joint Chiefs of Staff to be considered inaccessible in time of war, are not relied upon at all. Then, based on advice from the Department of State and other informed agencies, certain safety factors, or "discounts," are applied to normal overseas peacetime supplies to the United States to make provision for political and economic instability in foreign countries, the possibilities of sabotage, and possible shipping losses on overseas

supply lanes. Safety factors are also applied to normal sources of supply in the United States itself when these are particularly vulnerable to attack, sabotage, fires, floods, or other disasters, or when there are particularly dangerous concentrations of production.

Minimum Stockpile Objectives for a 5-year war are generally established to equal the deficits between 5-year requirements and the reliable supplies computed as described above.

This was the system that was in operation until about 1953 when President Eisenhower and the new Administration took another look at the stockpile system. I don't need to tell you that the President, being a military man, was particularly aware of some of these strategic material problems. In fact I believe that in the course of some of the early studies of the War Department General Staff prior to World War II he had worked on strategic materials problems. Having attended the College here, he undoubtedly had quite a background in the subject.

The question was: "Have we fully carried out the mandate of the act to prevent wherever possible dangerous and costly dependence on foreign sources?" The Minimum Stockpile Objectives clearly decreased dependence, but still they assumed some reliance on foreign sources. Accordingly, following recommendations of the President's Cabinet Committee on Minerals Policy, a second set of stockpile objectives known as Long-Term Stockpile Objectives, was established for the nonperishable metals and minerals. In estimating available supplies in this second calculation, all the distant and dangerous sources are discounted fully, and only nearby sources in the North American area are relied upon. Because the Minimum Stockpile Objectives represent the quantities most urgently needed for defense purposes, they were to be acquired as quickly as possible, paying above-market prices if need be, or expanding the supply by other incentives. Once having reached the Minimum Objectives, and recognizing that the Long-Term Objectives represent a greater degree of security, they were to be acquired only when it could be done at reasonable prices and without interfering with normal industrial needs.

Where do we stand at the present time? The figures as of 30 June 1957, which are the most recent ones that have been published show that the Minimum Stockpile Objectives for all the 75 materials are valued at about $6.2 billion.

These 75 materials include abaca and sisal, which are cordage fibers, and opium, which is a crude drug, as well as most of the metals and minerals that anyone could name, such as copper, lead, zinc, tin, antimony, chrome, and manganese. Table 1, page 7, is the complete current list. On hand toward the Minimum Objectives were materials valued at $5 billion, and for 47 of the strategic materials the Minimum Objectives had been reached.

As for the Long-Term Objectives, the long-term increment added about $3.8 billion to the total. Long-Term Objectives are established only for the metals and minerals--not for the small number of agricultural items, because the agricultural items and the drugs generally are subject to deterioration, they require much more costly storage, and many of them require rotation. So the Long-Term Objectives exist only for the metals and minerals, which are relatively inert, cheap to store, and don't deteriorate.

The total value of the stockpile, including Minimum and Long-Term Objectives, comes to about $10 billion. As Captain Owen indicated, materials valued at $6.2 billions are now physically on hand in the strategic stockpile, while materials valued at about an additional $1 billion are in the Defense Production Act inventory and in the Supplemental Stockpile.

The stockpiles include over 25.5 million tons of strategic materials. So that would be equivalent to over 2,550 10,000-ton vessel loads that would not have to be imported in wartime.

So far I have described the situation as it was until recently. Recently saving money has become very important. Saving money has always been important, and it is very important now, too. In looking at the stockpile, people wondered whether the Government was still doing the right thing. The stockpile had been based on a 5-year war. Now many people think we may not have a 5-year war. We spent a lot of money and have over $7 billion worth of material on hand and more coming in. Consequently, until the situation could be thoroughly evaluated, ODM limited new procurement to what they call the Procurement Priority Level.

The Procurement Priority Level is the deficit that would exist in the first three years of an emergency, assuming reasonable reliance on all accessible foreign sources. In other words, it is a minimum stockpile objective based on three years instead of five years.

Table 1

CURRENT LIST OF STRATEGIC AND CRITICAL MATERIALS FOR STOCKPILING

December 2, 1957

GROUP I MATERIALS

The following list constitutes Group I of the materials in the strategic stockpile. These materials have been or may be acquired through purchase pursuant to Section 3(a), and by transfer of Government-owned surpluses pursuant to Section 6(a) of Public Law 520, 79th Congress. All materials purchased must conform to stockpile specifications. Some of these materials are not under active procurement.

1. Abrasives, Crude Aluminum Oxide
2. Agar
3. Aluminum
4. Antimony
5. Asbestos, Amosite
6. Asbestos, Chrysotile
7. Asbestos, Crocidolite
8. Bauxite, Metal Grade, Jamaica Type
9. Bauxite, Metal Grade, Surinam Type
10. Bauxite, Refractory Grade
11. Beryl
12. Bismuth
13. Cadmium
14. Castor Oil
15. Celestite
16. Chromite, Chemical Grade
17. Chromite, Metallurgical Grade
18. Chromite, Refractory Grade
19. Cobalt
20. Coconut Oil
21. Columbite
22. Copper
23. Cordage Fibers, Abaca
24. Cordage Fibers, Sisal
25. Diamond Dies, Small
26. Diamonds, Industrial, Bort
27. Diamonds, Industrial, Stones
28. Feathers and Down, Waterfowl
29. Fluorspar, Acid Grade
30. Fluorspar, Metallurgical Grade
31. Graphite, Ceylon-Crystalline & Amorphous
32. Graphite, Madagascar-Crystalline Flake & Fines
33. Graphite, other than Ceylon & Madagascar-Crystalline
34. Hyoscine
35. Iodine
36. Jewel Bearings
37. Lead
38. Magnesium
39. Manganese, Battery Grade, Natural Ore
40. Manganese, Battery Grade, Synthetic Dioxide
41. Manganese, Chemical Grade, Type A Ore
42. Manganese, Chemical Grade, Type B Ore
43. Manganese Ore, Metallurgical Grade
44. Mercury
45. Mica, Muscovite Block, Stained A/B and Better
46. Mica, Muscovite Film, First and Second Qualities
47. Mica, Muscovite Splittings
48. Mica, Phlogopite Splittings
49. Molybdenum
50. Nickel
51. Opium
52. Palm Oil
53. Platinum Group Metals, Iridium
54. Platinum Group Metals, Palladium
55. Platinum Group Metals, Platinum
56. Pyrethrum
57. Quartz Crystals
58. Quinidine
59. Rare Earths
60. Rubber, Crude Natural
61. Selenium
62. Shellac
63. Silicon Carbide, Crude
64. Silk, Raw
65. Silk Waste and Noils
66. Sperm Oil
67. Talc, Steatite, Block
68. Tantalite
69. Tin
70. Tungsten
71. Vanadium
72. Vegetable Tannin Extract, Chestnut
73. Vegetable Tannin Extract, Quebracho
74. Vegetable Tannin Extract, Wattle
75. Zinc

GROUP II MATERIALS

The following list constitutes Group II of the materials in the strategic stockpile. These materials have been acquired principally through transfer of Government-owned surpluses pursuant to Section 6(a) of Public Law 520, 79th Congress. None is under procurement.

1. Bauxite, Abrasive
2. Corundum
3. Cryolite, Natural
4. Diamond Dies, other than small
5. Mica, Muscovite Block, Stained B and Lower
6. Mica, Phlogopite Block
7. Rutile
8. Sapphire and Ruby
9. Talc, Steatite, Ground
10. Titanium Sponge *
11. Wool

* As of June 30, titanium sponge was on the Group I list; it was transferred to Group II on September 11, 1957.

The value of the Procurement Priority Levels for the 75 materials is $3.4 billion, and materials on hand toward these limited levels are valued at $3.1 billion. Of the 75 strategic and critical materials, 63 have reached the Procurement Priority Levels.

The conclusion that we come to, then, is that new procurement for the strategic stockpile is pretty much over, although the Government will continue to take delivery on a substantial number of old contracts that were made several years ago, and some few materials are still far from being stockpiled in adequate quantity.

I should like to describe some of those old contracts very briefly. When the Government believes that reliable supplies are less than future requirements, there are a variety of ways in which that deficit can be met. Stockpiling is not the only solution. There may be better ways, cheaper ways in the long run, and more satisfactory ways of meeting the national deficit.

This was recognized by the Government and the Congress in 1950, shortly after the start of the Korean War, when the Congress passed the Defense Production Act, by amendment to the Internal Revenue Code, also permitted accelerated amortization of the cost of new defense facilities. Where there is adequate domestic production, there is less need or none at all for a stockpile.

The preferred way of meeting any shortage in this country is to have a going domestic industry.

Our steel industry had a rated capacity of about 100 million tons at the time the Korean War started. It is now at somewhat over 140 million tons. Much of the increase from 1950 to 1953 came about through assistance provided by accelerated tax amortization. We do not stockpile steel because we have generally an adequate domestic industry, although certain shapes and forms could be critical in a future emergency.

In the case of aluminum and copper, the problem was a little more complex. Accelerated tax amortization alone was not enough of an incentive for the domestic industry to expand its production. If they did not expand, very large stockpiles would have been needed. So a decision was made to try to strike some reasonable balance between expanding the domestic production somewhat and buying some for the stockpile, on the theory that the very contracts that were made for the stockpile would serve as the incentive to expand the production.

Let me give you an illustration of a typical copper contract of the type made to stimulate domestic mine expansion. At the time the contract was made in 1951 the United States ceiling price was 24.5 cents a pound. The Government guaranteed to buy the entire output for a certain number of years at 24.5 cents a pound (with escalation for certain costs) if it couldn't be sold elsewhere. This contract was made under the Defense Production Act. As long as the demand for copper was good--and part of that demand was occasioned by military and other defense programs in the time of the Korean War--that copper moved to the consuming industry; the Government did not take title to it at all. But the mine went ahead and expanded because they knew they had a home for their output if they couldn't sell it to private industry.

Some individual contracts of this type involved over $100 million under the Defense Production Act. Since the mine owners didn't have enough money of their own, even with the contract guaranteeing a market, the RFC, which was in existence then, made major loans involving many millions of dollars. Then, because the higher the percentage of accelerated amortization allowed, the lower the unit price, these operations also were allowed about 75 percent accelerated tax amortization.

So they had a combination of three incentives--accelerated tax amortization, a Government loan, and a guaranteed market. Under a variety of contracts of the type described, over 250,000 tons of annual copper production were added to this country's domestic production.

Under a group of contracts of very similar nature, though not generally including RFC loans, the United States aluminum industry, which had about 850,000 tons annual capacity at the start of the Korean War, expanded to 1.75 million tons. That is more than 100 percent expansion. In the case of aluminum the major incentives were 85 percent accelerated amortization and 5-year guaranteed procurement contracts. With one exception those contracts have just about run out. But the capacity will be there, and in case of a war we can call upon it.

Additionally, the aluminum industry, without any Government incentive, is now putting in additional plants for several hundreds of thousands of tons of additional capacity. With this great domestic aluminum productive capacity, the need for a Government stockpile should be smaller.

It is very hard to hit an exact balance between expansion and stockpiling. Sometimes over-expansion results. I might say that in the

early days when I had something to do with these programs, in 1950 and 1951, if anyone could have guaranteed that we could not have had an all-out war through 1957 or 1958, some of the expansion might have gone ahead a little more slowly. However, the great expansion of materials production served as a significant deterrent to war, and to interference with peripheral countries that are important materials suppliers. We are now strategic-materials-wise, in excellent shape for any type of war--general, limited, or economic.

This gets into the question of what kind of war we are likely to have to fight. As I indicated, all stockpile calculations were based on a 5-year war, and it was a 5-year war of, roughly, the World War II type. There were big requirements in for the Army, for such things as ammunition, trucks, vehicles, and tanks. There were big requirements for the Navy, for new vessel construction and other programs. There were also big requirements for the Air Force, for airplanes, and so forth. Now we hear that this may not be--some people are brash enough to say it is not--the type of war that we are going to fight. I am not that brash. I say it may not be.

Admiral Radford, at the commissioning of the USS RANGER on 10 August 1957, said a few words on our strategy. He should be in a position to know what it is. He said:

> "As a consequence of rapid progress in technological developments and in the power of modern weapons, certain fundamental changes have occurred in national and military thinking and planning.
>
> "One of the great lessons of the past decade is that no longer will the United States be afforded an opportunity to mobilize and rearm after the outbreak of a general war.
>
> "Stemming from this basic fact the United States has adopted as national policy the placing of primary reliance, in event of general war, on a strong retaliatory capability.
>
> "It is obvious that certain requirements must be met if our overall retaliatory capability is to be meaningful. It must be adequate, it must be ready for immediate application, and it must be able to avoid being neutralized by enemy action at the outset of general emergency.

"Under conditions short of general war, our forces must be able to handle adequately situations varying from cold war to limited aggressions. With consideration for budgetary limitations, our planning, therefore, should be such that the forces which we have for general war contain within them the elements and the flexibility to handle situations short of general war."

Now, I hate to pick to pieces a very carefully worded statement like that is, without the Admiral present. However, I shall refer to a few words here and there. In the first place, he talks about a "general war." This is a polite word, I suppose, for "all-out nuclear war." He says that we will not be afforded an opportunity to mobilize and rearm after the outbreak of a general war. If he had said "all-out nuclear war," I'd agree with him. However, the term "general war" might imply to some people a World War II type war or some other type.

He says that the United States places primary reliance on a strong retaliatory capability. And then, very carefully, in his statement for public consumption, he says, "It is obvious that certain requirements must be met if our overall retaliatory capability is to be meaningful." Must be met--future tense--means that something more must be done. In other words, we apparently are not yet fully squared away, as I read this. He said our retaliatory capability must be adequate, it must be ready for immediate application, and it must be able to avoid being neutralized by enemy action. Apparently we have some more things to do yet, before we can sit back.

Then he goes on to say--and I think this is very important (and that's why I want to develop this theme a little further) "Under conditions short of general war, our forces must be able to handle adequately situations varying from cold war to limited aggressions." Then comes a real, qualifying phrase--"With consideration for budgetary limitations." That phrase means that there is much more to be done. "Our planning, therefore, should be such that the forces which we have for general war contain within them the elements and the flexibility to handle situations short of general war." This latter concept has some very serious implications that I shall discuss further.

I want to talk about the influence on strategy of the United States strategic materials position, and vice versa. In the first place, we've got to be prepared, in my opinion, for a variety of wars and Admiral Radford recognizes that. We have to be prepared for an all-out nuclear

war. It is a possibility, and we have to be ready for it. And I don't think we are ready in several important areas. Also, we have to be prepared for limited wars, peripheral wars, in a lot of places. Lastly, we have to be prepared for something that the Defense Department may not even feel much responsibility for, and that is long-range, cold, economic war, involving political, economic, and psychological factors.

All of these wars will require materials in one way or another. If we have an all-out nuclear war and a major part of our resources are blasted to pieces, materials on hand and manpower will be essential for reconstruction. If we are going to have an all-out nuclear war and lose it, we might as well not think about it. But if we are going to have it and attempt to reestablish some sort of living in this country again, it will take materials to do it.

In the old stockpile calculations, based on a 5-year war of the World War II type, there is no specific consideration of the needs for reconstruction after a massive atomic attack. Just think of cities like New York, Philadelphia, Chicago, and San Francisco, and the millions of tons of copper, and lead, and zinc, and aluminum, and other materials, that are now in those cities in the form of piping and communication systems, and so forth, that in some very minor degree would have to be replaced, even in some other locations, to bring a minimum standard of living to the surviving people. Requirements for strategic materials have never been calculated on this basis.

Further, how much more difficult would it be to produce such strategic materials after an atomic attack? For example: What about power? Refining of copper and aluminum is dependent on power; pumping in mines is dependent on power. Power would be disrupted; manpower would be disrupted. So I say let us not be complacent just because the 3-year PPL on the old basis may be on hand in the stockpile. Until we make some specific calculations of the needs for materials in rehabilitation and reconstruction after an atomic war, we can't say that we have finished with the strategic materials job.

Next let's take the limited war, the peripheral war. We now have a pretty good pile of strategic materials on hand. But, in a peripheral war, you cannot reduce the economy of the country very far. We found that out in the Korean War. You can't cut back the civilian consumption very much. The only way that you can superimpose military programs of any size on a going civilian economy is through the use of additional raw materials. In a limited war there would be a need to replenish

military inventories, as well as for other programs to better prepare the Nation for the increased probability of attack. This would require increased supplies of materials.

The present stockpile calculations, based on World War II, assume that the industrial sector of the economy will be limited to minimum essential needs. However, our stockpiles on hand are large enough in many instances to make reasonable provision for limited or peripheral wars.

Lastly, if we don't have any shooting war, but if we have many years of economic warfare, raw materials--which in turn assure the ability of any nation to build up its economy and to deliver the goods that make people happy--to give them more electric power, more pots and pans to cook in, more roofs over their heads, more automobiles, and so forth--are the key to success. There are only two countries that have within their own borders right now anywhere near enough supplies of raw materials to engage in substantial economic warfare--the United States and the USSR.

However, the present stockpile calculations make no specific provision for the possible needs of extended economic warfare, although our stockpiles on hand add greatly to our overall strength if we engage in lengthy cold wars.

Now, I have an additional point that I should like to make.

Table 2, page 14, lists the melting points of all elements that have a higher melting point than iron, as well as selected materials below iron. Table 2 also lists several compounds, together with their melting points. The melting point is not the only significant characteristic of an element or a metal, but it is one of the most important characteristics. You all know that the efficiency of a steam engine increases in relation to the change of temperature that takes place within it. You know that the better rocket fuels, the better aircraft fuels, are the ones that can burn at higher temperatures; because of the greater release of energy. However, not only are high-temperature fuels needed, but the burning must be accomplished in a container that will adequately withstand the temperatures generated. The World War II type stockpile calculations result in a reasonable evaluation of the needs for the common, familiar, materials, such as steel, bronze, brass, tin, lead, zinc, aluminum, and copper, because we have had enough experience with those materials in several wars to have some pretty good ideas of potential uses.

Table 2

Melting points of all elements above iron (and selected ones below)	
Carbon - graphite	6692 °F
Tungsten	6143
Rhenium	5738
Protactinium	5432
Tantalum	5425
Osmium	4892
Molybdenum	4752
Ruthenium	4532
Iridium	4449
Columbium (niobium)	4379
Hafnium	3866
Boron	3632-4172
Rhodium	3571
Chromium	3434
Zirconium	3353
Ytterbium	3272
Platinum	3223
Vanadium	3110
Throium	3074
Titanium	3074
Actinium	2912
Palladium	2829
Iron	2802
Cobalt	2723
Yttrium	2687
Nickel	2651
Silicon	2606
Beryllium	2332
Copper	1981
Aluminum	1220
Zinc	786
Lead	621
Tin	448

Melting points of certain refractory compounds	
Hafnium carbide	7029 °F
Tantalum carbide	7011
Zirconium carbide	6404
Columbium carbide	6332
Fused thoria (ThO_2)	5972
Titanium carbide	5684
Zirconium boride	5540
Boron nitride	5432
Titanium boride	5252
Tungsten carbide	5193
Vanadium carbide	5126
Fused zirconia	4892
Molybdenum carbide	4874
Fused magnesia	4752
Beryllia	4622
Boron carbide	4442
Silicon carbide	4172
Alundum (Al_2O_3)	3632

Note: These tables are based on the AEC "Reactor Handbook" and other recent sources. Different sources vary somewhat, however.

However, let's look at the higher temperatures and see what sort of materials we get into. Above the melting point of iron, we find a number of materials ranging up to carbon, which has the highest melting point of the elements. Tungsten has the highest known melting point of the metals. Rhenium is a very scarce material, so far found only in traces in association with molybdenum. Tungsten, tantalum, molybdenum, and columbium are relatively in greater supply than other materials in their temperature ranges. Further note that the compounds in Table 2 are composed of many of the elements that possess high-temperature properties.

The point I want to make in connection with Table 2 is this: It is too late, in my opinion, to wait for one of the services of the Defense Department to assign a research project down the line to some laboratory, which will then come up with some sort of widgit, which then gets involved in Research and Development, and then in turn in Applications Engineering to be standardized. Then it goes over to Supply and Logistics, where they analyze it and integrate it into their other requirements calculations--always checking back with the services in the process. Finally the widgit may become part of a requirements estimate years later, after which ODM will hear of it officially.

This process is too long and too late for new applications of the newer, less familiar, materials. It works all right in the case of copper, lead, and zinc, and so forth, because the possibilities of making a mistake there are not too great. But, for the newer materials with high temperature or other special properties, the time to get them is when you first think there is a possibility that they may be used. Once you go through all the industrial testing and application and standardizing, and calling committees, and so forth, not only the people in this country but the people throughout the world are alerted to the likelihood of new uses. Then, when you finally want to get enough of it to carry out your production program, the price is 10 or 15 times as high as it could have been if you had started out a few years earlier; and, worse, the availability may not be assured. Deposits of the material may be located in some other country and the Communists may have denied them to the free world by then.

So, the modification that I would like to see in our stockpile policy is that an entirely different approach be taken in the case of the high-temperature and other special-property materials, an approach not based on the normal, statistical, adding and subtracting of supply and requirements data. Instead, if there is any special material that we

think we may need for the defense of the country, it would be far better to go out immediately to get an adequate supply, and the chances are that we will always find some significant uses for it. If we never fight a major war, we will use it in our own industrial economy eventually.

In the very limited time available I shall try to cover one additional point, but there is much that I haven't covered that I hope your questions will bring out any special problems on your minds. The United States now has on hand over $5 billion worth of agricultural surpluses. They are not in the strategic stockpile, but rather in the hands of the Agriculture Department as a result of the farm price support programs. As such much of the material would be just as useful in time of war as if it were in the strategic stockpile. The Government has it and it is here.

However, there is a real belief that we have too much and that these surpluses are inhibiting agricultural progress. A couple of years ago it was suggested that these agricultural surpluses might be exchanged for strategic materials. It was pointed out that the strategic stockpile had come pretty much toward the end of its program, that the objectives were more or less achieved, and that there would not be too much room for barter. So Congress authorized what they called the Supplemental Stockpile--a quantity that could be above and beyond the needs of the strategic stockpile--to be acquired in exchange for surplus agricultural commodities.

Now, if I were an alchemist and could take all that we know about nuclear energy and chemistry and metallurgy to devise some process whereby we could put agricultural materials in one end and transmute them into tungsten, or rhenium, or tantalum, or columbium, or some other high temperature or special-property material that I think we will have real use for in the future, that would be something to work on. Well we've got the process right now. We can grow the wheat and corn and other farm products in this country and trade them to other peoples for some of these other things where our resources are deficient and that we are sure are likely to be needed in increased quantity in the future. We should trade our agricultural surpluses to the hungry people of the world now while they can eat them up and while we can get our hands on valuable metals and minerals--particularly before others find need for the latter. This would be a process of modern alchemy whereby we can transmute perishable agricultural materials into valuable strategic metals.

The barter program was going ahead pretty well until the agricultural people decided that it was interfering with normal cash sales of agricultural products. The program was then severely cut back by adopting tight regulations; and little has happened in recent months. I believe this program could well be stimulated.

Perhaps you are interested in where the strategic materials are stored. They are stockpiled all around the country as near as possible to the points of ultimate consumption. They are, however, outside of the immediate danger area around major target centers. The old adage, "don't put all your eggs in one basket," has been followed. That way, ton-miles are also stockpiled.

I should like to point out just one contrast and then I'll conclude for the question period. We have about $7 billion worth of strategic materials on hand, piled up. We have 170 million people. If you divide that out it comes out to roughly $41 per man, woman, and child in the country. It's not an awful lot, but it is a significant amount. However, when we come to products that would be needed in the event of nuclear attack, we find at the present time, in the Civil Defense stockpile, medical and engineering supplies, valued at only about $200 million. If you divide that by the approximately 170 million people here, it comes to only about $1 per man, woman, and child in the country. You can just imagine how much good, in the event of any major attack upon the country, survival and relief supplies of the value of $1 per man, woman, and child would do. If it makes sense to spend $41 per man, woman, and child on raw materials like copper, lead, tin, zinc, and rubber, I think, if we have any sense at all, we should be making a proportionate effort--proportionate to the danger and the numbers of people involved, and everything else--in the civil defense area.

That is not the mission of the Stockpiling Act, because I pointed out in the beginning that it was intended to make up for deficiencies in natural resources. But I think that the Government should get the survival area squared away and should make a proportionate effort there. There is no point having all these strategic materials on hand for a 5-year war, and not have available adequate pain-killing drugs and not have an ample supply of bandages, and not have a way of getting an uncomtaminated drink of water for a survivor the first night of an attack.

I don't think that the answer to that is to sell the stockpile of strategic materials, although that has been proposed in some quarters. I don't think that is the answer. I think the answer is to keep our stockpile

of strategic materials for use in defense programs, but to get rid of those materials that are deteriorating and that require rotation, and so forth, and to retain the bulk of them; and at the same time go ahead to make a proportionate effort in the civil-defense field.

As an engineer, I think that if we ever had a major attack upon the country we would be faced with far worse problems than the Army Corps of Engineers had in countries we went into after the war or that the Navy Seabees had in restoring ports. In such cases the machinery and the equipment and the supplies that you can put your hands on immediately are the things that spell the difference between success and failure.

In World War II we had the homeland to draw upon; but, if we ever have this attack upon our own country, the homeland will be pretty well fouled up. We need reserves in being. I don't have to tell that to military people; you know it. But somebody has to tell it to the Government and the Congress. It is the reserves in being that give you the ability to cope with desperate situations, and we are only beginning to visualize some of the horrors of atomic attack on the Nation.

I think I have probably said enough.

CAPTAIN OWEN: Dr. Morgan is ready for your questions.

QUESTION: Dr. Morgan, I think there are two sides to this problem of the stockpile. I would like to ask this question: What if the requirements for these metals are drastically reduced because of a change in the strategy and in the types of materials needed for a particular type of warfare? Wouldn't we have a series of management problems on our hands in disposing of these materials? Wouldn't they become surplus?

DR. MORGAN: I'll be glad to take that one. Right now we have a population in this country of 170 million people; in contrast, the population of the world is about 2.7 billion. Right now, of all the materials being produced in the world, we use about half. In other words, the per capita use in this country is many times greater than the per capita use in the rest of the world. I am willing to admit that in any commodity market there are minor ups and downs and temporary periods where it looks like there is a real shortage, and temporary periods of surplus. But I think that, over any extended period of time, the main problem that this country will have will be to obtain adequate supplies of raw materials to meet not only our defense needs but also our industrial and civilian needs.

If we are successful in our desire of averting war, by being prepared for it and being strong, and if we are successful in our desire to raise the standard of living of these other 2.7 billion people in the world, in a very few years we may be wondering where many of our common raw materials are going to come from. I don't have a fearful or an alarmist attitude about it, but I do believe that over a 5- or a 10-year period into the future there is no such thing as a surplus of a metal or a mineral, the quantity of which is fixed in the ground where the grade of ore is declining every year and where the discoveries--because you have to go deeper and deeper into the earth--are more difficult to make.

There will be ups and downs on a year-to-year basis, depending on the commercial cycle and the consequent demand for metals and minerals, but, if you analyze over the last many years the pattern of use of these materials, you will find that very few of them ever drop down. For example: New materials come along such as plastics. Aluminum use increases, but the curve of steel use doesn't go down very much. Steel holds level; indeed, it goes up. Aluminum goes up. Right now consumption curves for lead and zinc and copper and tin are relatively horizontal. But in practically no case of a metal or a mineral--as distinct from something that you can grow on an annual basis, like wheat or corn--do I foresee any real surplus in the long run. Accordingly our stockpiles should be held, unless needed for national security programs, and in the future they will generally be much more valuable.

QUESTION: Dr. Morgan, I question how realistic our tariff program is in the light of what you said this morning. We have tariffs on many of these critical resources, the justification being to build up domestic production so we are less dependent on foreign sources. The more domestic production we build up, the less we have to stockpile, but, in the event of war, the more essential it is that we keep our own resource-gathering industries busy. It requires manpower to do that, and manpower is just as critical in time of war as many of these items that you have here. Why wouldn't it be better for us to eliminate the tariffs, stockpile the material, and, when technology has increased and improved it, then build up the domestic production so that we get the materials cheaper in the long run?

DR. MORGAN: One should go into that in the way the President's Cabinet Committee on Minerals Policy went into it. Their report, which I commend to you to read, was dated 30 November 1954. They say you have to go into it on a case-by-case basis. Now, I think that, as I said earlier, the wise thing is to have some balance between stockpiling and

a going domestic industry. I would hate to rely wholly on a stockpile, because our ability to foresee the future never is too good. If we relied wholly on the stockpile and had no going domestic industry, we could very easily make a major miscalculation and not have enough.

On the other hand, in the case of some materials, such as lead and zinc, an extreme position in which we produced 100 percent of our own needs exclusively from our own mines, which would require high tariff protection or quotas, might also be self-defeating. I think that you have to look at the relative availability of supplies, and so forth, and try to strike what is a proper balance.

Personally, I would like to see us, even in those cases where our reserves in this country right now appear to be quite small, have an active going domestic industry working on the problem. Let me cite you an example. In the case of tungsten, prior to the start of the Korean War, we were dependent in large measure on tungsten from China, Korea, and Bolivia. You know what happened to China--it has been in the hands of the Communists for some years. The tungsten mine in Korea was a few miles from the battlelines along the 38th parallel, and it could just as easily be in enemy hands. Even sources in Latin American may not be wholly reliable.

I have a lot of faith in my friends, the geologists, but they must look at the price structure, and so forth in estimating reserves. But people don't go and look for these things unless they have a reason to look, the main reason being that they hope to make some money. When the Korean War came along we didn't have enough tungsten in the stockpile. The Munitions Board, which had been in charge of the stockpile, knew about the high-velocity armor-piercing shell program that required four pounds of tungsten carbide for a single armor-piercing shell, but there wasn't enough tungsten in the stockpile. The reasons were shortage of money, and so forth, but they just didn't have it.

We were desperate in 1950 and 1951 for tungsten. We said to the domestic miner, "We'll buy all that anybody can produce at $63 a unit up to a total of 3 million units, if you can't sell it elsewhere." In a few years this country was consuming about 9 million pounds of tungsten, and the domestic mines alone were producing about 16 million pounds. People who had been going around wailing that we were dependent on Korea and on China were wrong. Given the proper incentive, we found plenty of it in this country.

People have to go out first to look for a material and then find ways of recovering it and using it. So I would like to see us have a balance, depending on the material, between the stockpile and a going domestic industry.

QUESTION: Doctor, a few years ago there was a lot of concern about the availability and the production of titanium. I believe that the Malone Report estimated that we were going to need something like 150,000 tons a year. As I understand it, right now titanium is almost a drug on the market, we are using such a small percentage. What has happened to the demand and the production in that case?

DR. MORGAN: (Referring to Table 2, page 14.) Here is titanium on our melting-point table. It shows that its melting point is a little higher than iron, nickel, and cobalt, and a little lower than chrome. Most of our stainless steels are iron, nickel, and chrome, and maybe some cobalt. Here is titanium with a melting point much higher than aluminum. But the melting point is not the only characteristic. It has quite an affinity for other gases, particularly as the temperature goes up. So it isn't good for anywhere near to its melting point. Most metals are good only up to about 40 percent of their melting points, at which time they run into a recrystalization phase that changes the strength characteristics.

Certainly titanium looked better than aluminum for some uses in view of its higher melting point and strength-weight ratio. For a time people thought that airplanes would use a lot of titanium. But then they found that, by design, such as honeycomb structures, the corrosion-resistant properties of stainless steel and the way of designing it and using it gave it some advantages over titanium in some applications.

At the moment there is an excessive supply of titanium. There's no doubt about it. But titanium at the lower-temperature ranges has amazing corrosion-resistant properties, better than many stainless steels and far better than many other metals. So, as quantities become available, before too much longer I think there will be a great increase in the use of titanium in the lower-temperature, corrosion-resistant applications.

This takes time. It took 30 or 40 years to develop aluminum to the point where it is today. It took 3,000 or 4,000 years to develop bronze and brass and copper to the point where they are today. Titanium was a laboratory curiosity just a few years ago, and only a rush Government

accelerated program got it into quantity production. Under those circumstances, every little shop and fabricator and subcontractor doesn't know how to use titanium. I don't need to tell you that there is an art to handling any metal that develops only with practice in the shops. Even skilled metallurgists can't predict all the problems that arise in actual usage.

When using stainless steel, a bidder on a contract can figure his bid fairly accurately. If he had to use titanium, he wouldn't know how to bid on it. The Defense Department for a while tried to subsidize the gaining of experience in the use of titanium by paying special bonuses for its use. As part of the economy program, they backed off from much of that. They have refused to allow the additional expense of designing titanium into many applications. Therefore--and because of other reasons, such as the cutback in the aircraft program--titanium is in a slump.

Of course the titanium people knew this was a possibility. However, construction of most of their plants was almost entirely underwritten by the Government through guaranteed contracts. Now they're got to do the educational work to teach people how to use it, and I think that in a few years there will be quite a market.

COMMENT: Doctor, I don't have a question, but a comment. You referred to the medical stockpiles of the Federal Civil Defense Administration and their smallness. I would like to say that that smallness is not due to lack of interest and desire on the part of the Civil Defense Administration, but perhaps is due to lack of ability to convince Congress. This year the stockpile budgetary request was treated rather drastically by Congress. It was reduced to zero percent. If any question should arise, it would be on what to do about that. I am sure that is rather difficult to answer.

DR. MORGAN: Well, I'll say this, based on 10 years of personal experience with stockpiling. It wasn't easy getting the billions of dollars to build up the strategic stockpile. The Munitions Board did a good job in the early days when they were responsible. They had a good staff. They had to develop arguments for the 70 materials as to why each was on the list and how much they needed. They had to brief the Administration and the Congress. There are several people here in the audience who played a big part in that.

It was first a coordinated Government effort. We had general agreement with all concerned. Oh, everybody can pick at a program, a little

piece here and there, but generally we had coordinated agreement with Defense, Agriculture, Commerce, Interior, State Department, and ODM (or its predecessor, NSRB) as to the program. Civil Defense doesn't have that, as far as I know. We had active effort on the part of all these agencies. And I will say, as I cited in the beginning, we had the experience of World War I, when we were short of materials; World War II, when again we were short of materials; and the Korean War, when we were again short of materials. And with those experiences, when we went up to talk to the Congressmen and Senators about tin and rubber and copper and materials like them they each had a stack of letters from constituents who were also short of tin, rubber and copper, and they understood what we were talking about.

I would hope that we don't have to experience several atomic attacks in order to convince the Government of the need for planning for survival. Perhaps a real educational campaign, which would have to start at FCDA and ODM, is needed. I think the American people are smart enough that, if they understood how little has been set aside to prepare for nuclear attack, they would want something done about it. I know I, personally, feel very unhappy about the present situation.

QUESTION: Dr. Morgan, could you estimate for us, roughly, what the carrying charges for the present strategic stockpile are per year?

DR. MORGAN: It depends on the question of interest. As I said, there are about $7 billion worth of strategic materials on hand. If you want to figure that the Government has to pay 3 percent interest, or it is costing the taxpayer interest on the total investment, you can figure that out each year--the interest charge. The actual storage charges are relatively small, because the bulk of the materials, being metals and minerals they are stored on military reservations or in open storage. Administration and handling charges run around $40 million a year much of which is attributable to the perishable items.

QUESTION: Sir, the computation of the industrial reserves would appear to have some relation to projected distribution or allocation controls. Could you comment on what effect it might have in terms of the World War II restrictions of chromium for toasters and items like that on the economy?

DR. MORGAN: That's a very good question. Generally, where the Long-Term Objectives are on hand, there would be very little need for end-use controls of the quantitative type that were used in World War II

and the Korean War. Where only the Minimum Objective is on hand, that implies that there might have to be some reduction in normal industrial and civilian use in an emergency.

Your question brings to my mind an additional point that is very important. We have been told that one reason for a lot our defense planning--and this gets to the area of strategy--is to protect the sea lanes, and that we must be friendly with various countries because they are major sources of raw materials. I think that more important than not having a need for domestic controls on some of these materials is the fact that, by not having to patrol supply lanes, purely for the purpose of bringing in raw materials, as was done in World War II, large stockpiles have a major influence on our strategy, in that the military can now concentrate on fighting the enemy.

That isn't, of course, 100 percent true across the board. For example we don't stockpile petroleum and we might have to protect the supply lane to Venezuela. But generally stockpiling reduces both our need for the allocations which you were talking about, and our need for protecting vulnerable supply lanes.

QUESTION: Doctor, you indicated that about 60 of the 74 materials have reached procurement level on the basis of the 3-year war. Would you comment on what are some of the 14 materials that have not reached procurement levels and what are some of the problems with respect to reaching procurement level, particularly whether or not our present Government policy is interfering with reaching the procurement level?

DR. MORGAN: I would say that in my opinion probably the most critical ones that have not reached the Procurement Priority Levels are two materials--muscovite mica block and muscovite mica film. Mica has very specialized dielectric properties. It is somewhat temperature resistant and fairly flexible also, so it can be used in specialized electrical condensers and other electrical applications such as radio tubes, and spacers. Up to now, despite a fair amount of research, they have not found too good a substitute. Mica is needed where you have shock, a number of g's, as in a missile, or in a projectile. If you want to design some electrical equipment that will be stationary, you can do it pretty well, but, where it has a lot of shock or acceleration it needs strategic mica.

Mica is produced largely in India and Brazil in these particular grades. There is a little bit in this country. We have had a program

in this country whereby we pay many times the normal price, and it hasn't brought much out. Mica mining is essentially a hand job where a miner goes down a little hole and picks it out by hand. He brings it home and his wife and little boys sit around and pick it apart and sort it by hand and then carry it on to a broker who assembles material from a number of miners and packs it for shipment.

It you pay them more in some foreign countries they often work less. So paying higher prices doesn't always work. The Government tried to send technical teams to foreign sources. They sent engineers down who talked about using bulldozers and such, but mica doesn't generally occur in a way where you can use much heavy equipment. I think that ultimately what we need is a really good research program directed toward synthesizing of the material.

The Bureau of Mines has done some good work along that line and the long-run solution is that the United States must come up with a synthetic material.

The other materials in short status in the stockpile are generally of not too great importance.

CAPTAIN OWEN: Dr. Morgan, in behalf of all of us we want to thank you for your usual excellent performance.

DR. MORGAN: It is a pleasure to be here.

(14 Mar 1958--4,100)O/sgh:ljt