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STRATEGIC AND CRITICAL MATERIALS

by

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STRATEGIC AND CRITICAL MATERIALS

Gentlemen

I will present certain facts about strategic and critical materials and the influence of these materials upon the industrial activities of the world. The discussion will include the following related subjects

1. Certain economic considerations, resulting from the natural geographic distribution of raw materials.

2. Position of the United States as a leading industrial and agricultural country.

3. Organization of the Commodities Division.

4. Strategic and critical materials defined.

5. A discussion of strategic materials.

6. The development and use of substitutes - basic principles.

1. Certain economic considerations resulting from the natural geographic distribution of raw materials.

Six years ago Colonel House divided the nations of the world along new lines, the "Haves" and "Have Nots" - expressive words which immediately appealed to the imagination of the press and have become popularized wherever raw materials are discussed. He described the "Haves" as those nations which have all the raw materials, colonies, industries, all the essentials for peace and prosperity, and the "Have Nots" as those nations which have more population than they can feed and employ, and still maintain a decent standard of living.

Economic life has become so complex that the "Have Nots" have made far-reaching decisions in their efforts toward readjustment and their attempts to correct their deficiencies threaten the peace of the entire world.

The natural resources of the earth are unequally distributed upon its surface. Nature has deposited bounteous supplies of mineral products in certain sections of this planet, but has left other areas almost totally devoid of such treasures. Plants and animals highly useful, even vital, to human comfort and happiness, are found in profusion in some localities, but either do not exist or are available in very limited quantities elsewhere. Climatic conditions, topographic features and many other natural elements determine to a very considerable extent the profusion or scarcity of animal, vegetable, or mineral wealth. Many sections are richly endowed with some resources but lack others necessary to human comfort.

In ancient times men in different regions learned to advance their welfare by a mutually advantageous exchange of surplus supplies, out of which grew international trade.

In modern times great nations have beome more and more deperdent on foreign trade for their existence. Industrial countries usually do not grow sufficient foodstuffs for their workers and are often dependent upon outside sources for certain raw materials essential to the conduct of their industry. Each advance in civilization, each increase in the standard of living by modern inventive genius or by the development of technology has served to increase the dependence of one country on other countries for its essential requirements.

The materials which find their way into the armed forces are almost as numerous and varied as those which make up the hosts of goods used by the public in everyday life. It is practically impossible to name a raw material which has a strictly military use, and the same can be said of many manufactured articles.

2. Position of the United States as a leading industrial and agricultural country.

The United States is peculiarly favored. It is both an industrial and agricultural country. It raises practically all of the foodstuffs it requires and produces most of the raw materials essential to its needs. It is self-sustaining to a degree beyond that of any other country and well may be classed among the "Haves" nearly equalling the total of the six other great powers in the essentials of a comfortable standard of living - food, fibers, power, iron and steel, machinery, chemicals, coal, and petroleum. It is not self-sufficient, however, for either its industrial peace time needs or its war time military requirements. No modern industrial nation is self-sufficient, although the United States is unusually fortunate in its resources, its deficiencies are almost as notable.

The national wealth of the United States has been variously estimated at from three hundred and fifty to five hundred billion dollars whereas the wealth of the entire world, including the United States, has been estimated at between one thousand and fifteen hundred billion dollars. Hence, it appears that the United States, occupying less than seven per cent of the land area of the world and having six per cent of the population of the world, has between one-third and one-half of the world's wealth.

With our six per cent share of the earth's population we do approximately one-half of the world's work. I previously stated that we were peculiarly fortunate in being both an industrial and an agricultural nation. Our industrial capacity is possible because our daily output of power is approximately thirteen and one-half horse power per capita. Compare this, for example, with that of our neighbors of the Western Hemisphere - Brazil and Peru - who each have less than one horse power per capita and less than two for Chile and Argentina. Because of this horsepower aiding a workman of the United States and because of special training and skill, it has been estimated that he is equal to two French or Italian workmen, nearly two German workmen or three and one-half Russians.

The world's work is performed by the following agencies. Six per cent by animals, nine per cent by water power; seventeen per cent by petroleum, and fifty-five per cent by coal. It is obvious that in order for any nation to rank foremost industrially raw materials are of the utmost importance.

Now let us consider the contribution to our welfare by our position in agriculture. The reason we can do so much work is that only about twenty-two per cent of our people can raise the food and fibers to feed and clothe the whole nation, thus leaving seventy-eight per cent free to engage in industry. This compares with about sixty-

five per cent of the population of Italy, forty-five per cent of France, eighty per cent of Russia or forty per cent of Germany which must be raising food or whose industrial productivity must be exchanged for food and clothing.

3. Organization of the Commodities Division.

Having outlined broadly the difficulties arising because of the natural geographic distribution of raw materials, the position of the United States among the nations of the world, and the materials which are strategic and critical for the United States the logical question arises; What is the organization whose responsibility it is to make studies for the assurance of the supply of strategic and critical materials in war, what is its mission, its problem, its activities in peace, what is its composition, what are the activities of the commodity committees, what information is required in a procurement study, what about war reserves, what of problems of control and what has been done?

Because I want to devote some of the time to certain important strategic items this description will be necessarily brief.

The purpose of the Commodities Division is to establish a procedure for coordinating those activities of the War Department concerned with securing a supply of essential materials for the production of items required by the War Department and for rationing those materials in case of a shortage. In the execution of this mission the Commodities Division's activities are directed along the following lines

(1) Analysis of plans for procurement of strategic commodities.

(2) Preparation and evaluation of studies relating to procurement of critical commodities.

(3) Development of control measures for commodities.

(4) Collection of information showing requirements for specific commodities, together with data on sources, stocks, substitutes and trends.

<u>The Problem - National in Character.</u> It is evident that in planning for the many problems associated with war the first thing to be considered is the military and civilian requirements of raw materials and other commodities. The requirements for strategic materials are estimated by each supply arm and service by experts in regard to their respective materials with the help of information obtained from industry based on the requirements of the finished product. The consolidated requirements based on a maximum industrial effort are balanced against production and shortages determined.

Studies by the commodity committees are based on this information and include considerations such as, where curtailments can be effected, how the commodities may be obtained, and production increased when indicated, also the possible increase of available supply by substitution, reclamation, conservation or suitable war reserves. In brief a plan or study is a storehouse containing all information and all control measures necessary to enable an intelligent man to apply the information furnished and put the plan into execution in any emergency that may arise.

In general, the normal peace-time stocks of strategic materials maintained within the United States are adequate for purely military war needs, should they be used in a national emergency exclusively for such. The War Department realizes that the requirements of industry to meet essential civilian needs in war must be given equal consideration with those for the armed forces.

Classification of Commodities.

a. Mineral and Metallic Raw Materials Section.
b. Chemical Section.
c. Animal and Vegetable Raw Materials Section.
d. Manufactured Products Section.

Operation of Commodities Division. The Commodities Division constitutes one of the divisions of the Planning Branch, Office of The Assistant Secretary of War. It operates directly under the Director of that branch. The Commodities Division comprises forty-three commodity committees, nineteen of which are now active and have personnel assigned to them for active work. The active commodity committee is composed of members from the several supply arms or services of the Army, having as a chairman an officer from the supply arm or service which has the major interest in the respective commodity under consideration. These commodity committees are consequently under the supervision of The Assistant Secretary of War and all membership is authorized by him after individual designation by the Chief of the supply arm or service.

Activities of Commodity Committees. The activities of the committees are not restricted to any set form but are adjusted to the particular needs of their special problem These activities may be briefly summarized, as follows

a. The determination of all military (Army and Navy) and civilian requirements

b. The study of all sources of supply.

c. The comparison of requirements with available supply.

d. The preparation of plans to meet resultant deficiencies, including the development of suggested control measures in the event of an emergency

Representation by means of the Commodity Committees' Chairmen on the next higher agency now in existence, the Army and Navy Munitions Board, and coordination effected with the Navy is absolutely essential in order to plan for total military requirements. The commodity committee may be described as a mutual information bureau where there is free exchange of ideas and information. Coordination in military matters is vital and the commodity committees make this possible. That part of the War Department problem represented by requirements for strategic materials must be available for coordination with the needs of other war-making agencies and with the production capacity of industry. This necessitates the determination and consolidation of the requirements of the different supply arms and services. Another duty of a commodity committee is the constant study of the industries concerned in the manufacture of its respective commodity or material and to obtain definite and reliable information with regard to the capacity developing the possibilities for expansion or conversion when necessary. Knowing the sources, capacity requirements and other pertinent data, the Committee has the proper basis on which to determine the extent of its problem. Should its study indicate a shortage or the probability of a shortage, it is then necessary to develop the most reasonable solution possible. The study and consideration of the problem must be sufficiently continuous to produce results that are current. Constant coordination must be maintained between the different procurement agencies in the proposed use of materials and continuous consideration given to availability and capacity of sources of supply. A copy of the directive under which the plans are prepared is included in the appendix.

The peace-time existence of the Commodities Division is available for representation on any corresponding division of any proposed superagency authorized in event of war. This procedure facilitates the coordination of planning, and affords the assurance of adequate supply in war which is the responsibility of The Assistant Secretary of War as given under Section 5a National Defense Act.

What of stock pile reserves?

Every nation has its list of strategic materials. That of the United States is relatively small in comparison with those of most other great powers. This, coupled with our favorable geographical location, perhaps accounts for the very small part the Government has played in solving our problems of strategic materials.

The governments of other leading nations, notably France, Germany and Japan, have always been keenly awake to this problem and have established and carried out policies leading to its solution.

Before the War, the German Government actively assisted the newly created nitrogen fixation industry and it is said that the World War would not have happened in 1914 had not the German Nitrogen Industry developed at that time to a position in which it was able to supply the entire nitrogen requirements of Germany in war. It is reported that the French have now sufficient manganese in France to fight a major war of four years duration. This supply is said to have been accumulated through the assistance of the Government. The Japanese now are coining pure nickel coins which will assure an ample supply of nickel for the Japanese in time of war.

The attitude of the British Government toward Britain's strategic materials has been similar to that of our own, but for entirely different reasons. There are so many vital materials for which Britain depends upon outside sources that she could not hope to accumulate large supplies during peace nor to subsidize uneconomical domestic producers, but must rather depend upon her ability to keep her sea lanes open in war time.

No domestic industries producing strategic materials have been subsidized by the Government in recent years nor has the Government actively assisted in the accumulation of stocks of the materials in this country for use in war time other than the appropriation for the Navy by the Seventy-fifth Congress, and the acceptance of the Faddis Bill H. 1608 by the committee, which provides reserves in manganese, chromium, tungsten and tin

It is not intended to criticize the Government because of its failure to subsidize domestic producers or to accumulate or assist in the accumulation of stocks, but rather to point out the absence of a more or less definite national policy on strategic materials approved by Congress. Such a policy would indicate the kind of peace time action which must be taken in respect to each strategic material and would guide the expenditures of such governmental funds as might be found necessary to carry out the policy It would further form the bases for cooperation between the industries handling these materials and the Government

It is dangerous to presume that in time of war if the sea lanes of one ocean are closed all strategic materials required can be brought into the country via the ocean whose lanes are open. It is, no doubt, true that varying amounts of these materials will come in but the actual quantities will be far below the requirements and will develop economic hardships, if not actual military handicaps.

The following methods can be used in peace time for assuring a supply of strategic materials for war time use

a. The accumulation of stocks either by the Government or by private enterprise under government supervision and assistance.

b. The encouraging of proven domestic production by means of subsidies through price concessions or by tariffs.

c. The encouraging of the use of substitutes by assisting in their development and the sanctioning of those found satisfactory in all governmental work.

What are control measures?

A discussion of this question alone would occupy more than the allotted time. Control measures must be certain to produce results, sufficiently flexible for adaptation to the varying degrees necessary when applied to a large variety of commodities, simple enough to avoid time losses and just in application to assure civilian, as well as military, requirements in a future war. Control measures differ with the varied problems and comprise a section of each plan. The measures suitable for the control of a given item to meet any and all conditions at an unknown time are unpredictable. Past experience leads us to a consideration of the following methods divided as to procedure into before and after M-day activities

a. Methods Prior to M-day. The specific methods used in the Commodities Division will depend upon circumstances. During the period when war is imminent, prior to M-day and before the final development of the Army and Navy Munitions Board, the division will act vigorously to bring the situation, in regard to commodities, to the best possible status by

(1) Taking steps to stimulate imports of strategic commodities by closer contact with organizations representing importers and industry.

(2) Bringing to the attention of the proper agency the importance of building up War Department stocks of certain designated commodities.

(3) Bringing to the attention of exporters and industry the desirability of curtailing exports of certain designated commodities.

(4) Taking measures to mobilize the personnel of the Commodities Division and to expedite the accumulation of up-to-date data in regard to important commodities.

(5) Bringing to the attention of the proper agency the measures which will assist in the economic strangulation of the enemy.

(6) In general, coordinating the War Department commodities program so as to be of maximum assistance to the superagency directly concerned.

During this transition from peace to war, the Commodities Division of the Planning Branch has strengthened its representation on the Army and Navy Munitions Board. As now organized there is a committee made up of representatives of the interested supply arms and services for each commodity or commodity group. This augmented staff, let us say, has been supplemented with reserve personnel. If we admit that this background fairly represents existing conditions at the end of the transition period, we are now in a position to extend the analysis of procurement planning to the period of operation under a War Resources Administration.

b. Methods After M-day. It is proposed when strict control is necessary at the beginning of war to issue warrants from the Commodities Division of the highest control agency then in existence which will state the amount of a given commodity set aside for each department (Army and Navy) issuing "commodity credits" from existing stocks and make this amount immediately available to the supply arm or service (or Bureau) for use in its manufacturing problems. This does not assign a definite amount of a strategic raw material for a given project, but places at the disposal of the Chief of the Supply Arm or Service, as nearly as possible, his first three months requirement. The Chief of the Supply Arm or Service in turn issues subwarrants against his allotment to each manufacturer interested, each warrant listing the location and amount of the commodity under consideration. This method affords the desired flexibility to the Chief of the Supply Arm or Service, permitting him to shift stocks wherever needed, avoids competition and promotes efficiency.

After creation of a superagency the mission of the Commodities Division of the Office of The Assistant Secretary of War is to supervise and coordinate the activities of the supply arms and services with regard to commodities. That Division also serves as the contact agency between the War Department and the Commodities Division of the Army and Navy Munitions Board or War Resources Administration. This work will be carried out in general by the following methods

(1) Furnishing to the superagency a complete set of all commodity plans and studies on file in the Commodities Division.

(2) Contacting industry by means of the War Service Committees.

(3) Apportioning controlled materials to the various supply arms and services, in accordance with established priorities, by credits or warrants approved by a higher authority. In order that procurement will not be delayed, an initial quota of three months supply of controlled materials, based on peace-time planning, should be made to each supply arm and service concerned.

(4) Keeping informed of any changes in the needs for commodities of the supply arms and services and present these to the superagency.

(5) Initiation or continuation of measures for the application of developments in satisfactory substitutes for those materials and commodities in which a shortage is likely to occur.

(6) Enforcing the substitution of suitable materials in which a shortage does not exist for those in which a shortage does exist.

(7) Keeping informed through intimate contact with the Procurement Progress Division as to status of procurement of items requiring important materials.

(8) Assigning to a particular supply arm or service the procurement of a commodity for which direct purchase by the War Department has been directed by the superagency, and supervising the distribution of the material to the other using arms or services when purchased.

The projection of plans and control measures for raw materials in too great detail is not only inadvisable but dangerous. The purpose of any study in peace time is to present in detail all pertinent data in regard to the material or commodity under discussion. It should suggest control measures and be of such a character that it can be utilized in any situation by intelligent individuals familiar with the problem. The War Resources Administration will have all such data furnished through the Commodities Division of the Army and Navy Munitions Board. All questions involving allocation, priorities, etc. should be settled by that Board and presented, after coordination, to the War Resources Administration. The Commodities Divisions of the War and the Navy Departments will coordinate their own activities through the commodity committees of their respective departments. It is believed that the organizations described have ample authority under the methods indicated to perform their functions to the best advantage and accomplish the mission of The Assistant Secretary of War under the National Defense Act

Permit me to call your attention to a statement made in a previous lecture before this group that the War Department is planning to receive from Congress necessary legal authority to impose, where desirable, the following industrial controls

a. Price fixing
b. Priorities.
c. Compulsory orders.
d. Commandeering of materials and plants.
e. Licensing.
f. Apportioning commodities and raw materials.

What has been done?

There are now studies on all strategic and critical materials. A precedent was established last year in holding commodity committee meetings on the nineteen active commodity groups. Twenty-seven plans were accepted by the Army and Navy Munitions Board as a result of this work, eighteen strategic and nine critical Additional work on the revision of plans is being done and as completed, plans will be presented to the Army and Navy Munitions Board for approval. Originally, requirements were not computed with but few exceptions on critical materials, and right here I am going to anticipate a question on aluminum. Its position is temporarily justified on the strategic list in order to obtain proper consideration of requirements. The strategic and critical lists are not considered permanent but are subject to change. When sufficient study has been devoted to an item to establish clearly the extent of the problem involved, it is placed where it belongs.

There have been twenty-seven commodity surveys revised on critical items, following the same directive that is used for strategic items. This work must be continuous and exhaustive.

4. Strategic and critical materials defined.

Broadly speaking, the strategic materials of any nation are those materials of commerce which are essential to a nation at war and which are not produced in peace time within the boundaries of the Nation in sufficient quantities to satisfy even the normal peace time requirements Moreover, if the raw material itself is available and a problem involving procurement is anticipated regardless of whether it is a shortage of raw materials, or facilities to produce the finished items of which the raw material forms a part or any condition rendering control measures imperative in time of war, such a problem must be given unusual attention. Plans must be made in peace time with a proper consideration of all phases of the problem I would like to especially emphasize this thought and will again refer to it after reading the definition of strategic and critical items, authorized by the Army and Navy Munitions Board, which follow

Strategic materials are those materials essential to the national defense for the supply of which in war dependence must be placed in whole, or in large part, on sources outside the continental limits of the United States, and for which strict conservation and distribution control measures will be necessary.

Critical materials are those materials essential to the national defense, the procurement problems of which in war, while difficult, are less serious than those of strategic materials due to greater resources or to a lesser degree of essentiality, and for which conservation and distribution control measures will probably be necessary.

The two classes of items involve basic problems of procurement of materials essential to the national defense, strategic items afford greater problems than critical, because of lesser resources or greater essentiality and strategic materials will require strict control measures whereas critical materials may require such measures.

The lists of strategic and critical materials are included in the appendix.

5. A discussion of Strategic Materials.

It is obviously impossible in the short space of time allotted to more than briefly enumerate a few of the many important factors in this short consideration of strategic materials. For convenience in following, they will be considered alphabetically without regard to group relationships.

ALUMINUM. The Army and Navy Munitions Board has been increasingly conscious of the importance of aluminum in war. Some of the reasons for placing this metal on the list of strategic materials are as follows

a. In order to obtain exact requirements of both raw materials and study facilities for production for the purpose of developing the extent of the procurement problem involved. This material is an example of a group of strategic and critical materials where allocations play an important part.

b. The military and civilian requirements for aluminum are increasing at a tremendous rate, particularly in relation to aircraft and heavy transportation

c. Over fifty per cent of bauxite ores for aluminum production is imported, the controlling factors being price and high quality of foreign ores.

d. Military requirements for uniform, high strength non-corrosive alloys are only produced from primary metals.

e. The fabricating equipment for producing high tensile strength alloys is limited.

f. A shortage is also indicated as a result of limited fabrication facilities for special shaping, electric furnace and power facilities.

g. The choke point is not a problem in raw material but in power for electrolytic processes and in facilities for the manufacture of high tensile strength non-corrosive alloys.

ANTIMONY is used in type metal, in anti-friction bearings for machinery, Britannia metal, antimonial lead, enameling metal ware, glass making, vulcanizing rubber, as a mordant in dyeing cloth, in safety match tips, in the building and paper trades, in making wood preservatives, to line chambers in the manufacture of sulfuric acid, in solder and in battery plates. It is used in the military service in shrapnel, bullets, primers, cable covering, and to produce a white smoke for range finding. The world production of antimony is approximately 27,000 tons (1935) of which sixty-five per cent came from China, fourteen per cent from Mexico, six per cent from Bolivia and six per cent from Czechoslovakia. We use about one-half of the world production, mining a relatively small quantity within our borders and securing the remainder largely from China and Mexico. We have an average stock on hand of about sixteen hundred tons and our production could probably be stimulated to about three thousand tons. To this should be added about twenty thousand tons which could be recovered in a two year period from old metal. By restrictions in uses and substitutions this quantity would probably be sufficient in time of war, even with increased military consumption. Extensive experiments are being conducted which indicate that fairly satisfactory substitutes may be produced from Frary metal, copper, calcium, barium, and bismuth, so that it appears that the supply of antimony required in an emergency may present less of a problem than that of several other items on our list.

CHROMIUM is of prime military importance as a raw material and its use is constantly increasing, since it is used as the essential ingredient in rust resisting and the so-called stainless steels. The chief military uses are chrome steel alloys, armor plate, projectiles, high speed cutting tools, automobile axles, springs, etc. Chromite bricks are also an important refractory material in metallurgical industries. Chromium is also an important ingredient in tanning leather, furnishes colors for paints, and is used in electroplating and dyeing. Chromium has the property of resisting corrosion. It has a wide use in so-called stainless steel. About fifty per cent of the United States' consumption is in alloy steel and forty per cent in the manufacture of refractories. Chromite, from which we obtain chromium, is found in low-grade ore in California, Montana, and Oregon. However, these deposits are not extensively worked because of high production costs

Under the stimulus of war-prices, domestic production in 1918 was approximately 82,000 long tons which came principally from California and Oregon. In 1929 it had dwindled to 269 long tons. The world's production of chromite in 1935 was approximately 800,000 tons. Of this amount U S.S R. (Russia) produced twenty-two per cent, Turkey in Asia, nineteen per cent and Southern Rhodesia, thirteen per cent. The Union of South Africa also produced eleven per cent of the above total and the remainder was produced in New Caledonia, Yugoslavia, Cuba, British India, Japan and Greece in quantities varying from seven to four per cent, respectively The United States is the world's larg-

est consumer. The importance of this material and our limited supply emphasizes the necessity for an adequate reserve.

COCONUT SHELLS are included in the strategic raw materials, because this material produces the best charcoal for use in gas masks. This purely defensive equipment may be required in the next war for the civilian as well as the military population. The world sources for coconut shells are Ceylon, India, the Philippine Islands and tropical countries generally where the coconut tree grows. Water transportation over long sea lanes is necessary to bring this material to our shores.

There is no domestic production. Certain other nuts and fruit pits can be used as a source of gas mask charcoal, but such material is not entirely satisfactory for use in canisters.

COFFEE AND SUGAR. Coffee is now on the strategic list, and sugar is a critical material. We have the largest per capita consumption of coffee of any country in the world (coffee 13.84 pounds yearly and sugar 108 pounds) and the people might resent a marked curtailment. The world's annual consumption of coffee is one and a half billion pounds - one-half of which is consumed in the United States. While there are other beverages which people consume, namely, cocoa, tea and domestic cereal products, there is no substitute for coffee acceptable to the consumer class.

HIDES are the raw materials for the production of leather. From a viewpoint of world sources the United States has more cattle than any other country in the Western Hemisphere and it should be kept clearly in mind that in an emergency our dependence in large part must be placed on the Western Hemisphere to meet our shortage. In 1932 there were in the United States 62,400,000 cattle of all kinds with 12,800,000 slaughtered. In addition approximately one-third of our cattle hides is imported, usually the heaviest hides. The United States tans about twenty-five per cent of the world's output of leather, amounting to approximately 135 million hides and skins in normal times. This figure has dropped during the depression. The use of substitutes for leather is growing rapidly and the industry is about seventy-five years old. Recently there has been developed among other substitutes one made of a cotton fabric treated with a waterproof coat of cellulose nitrate. In 1929 some 45,000,000 square yards of artificial leather were made and 1931 about 65,000,000 square yards.

IODINE is one of the most important drugs for field use and no satisfactory substitute has been developed. Normal domestic production is now estimated as about fifty per cent of our consumption and could be increased to meet all the war-time needs of the Nation. There is normally a large quantity in storage in the United States.

Our progress in the production of strategic materials is illustrated by our progress in the manufacture of iodine. Formerly sixty per cent of the world's annual production of iodine was pro-

duced in Chile and twenty per cent in Scotland. Relatively small amounts were produced in Japan, France and Java. World production and trade of iodine have undergone significant changes in recent years with the United States, formerly dependent upon a foreign monopoly for its supplies, emerging as the world's second largest producer, and capable of obtaining its entire requirements from domestic sources. The old method of obtaining this important item was from kelp, it is now produced in this country from salt water oil wells. In 1930, prior to the utilization of domestic resources, the price of iodine was approximately $5.00 per pound. Since that time the price has gradually declined to approximately ninety cents per pound. This item, however, is being maintained on the strategic list because of its high degree of essentiality and because the industry is new and it is felt that some difficulty may be encountered in maintaining domestic production in the face of decreased price, the result of foreign imports without any protective tariff. There are no satisfactory substitutes for this item for field use.

JUTE is a vegetable fiber used principally in the manufacture of burlap and hessian cloth. This material is used in the military service in the manufacture of horse covers, surcingles and webbing, also sand, forage and feed bags. In addition burlap is used for baling and packing. Jute fiber has no inherent advantage over other fibers, except its cheapness and ease of manufacture. The domestic fibers - cotton, flax and hemp - are considerably more expensive. There is no domestic production of jute in the United States. The United Kingdom has a complete monopoly of jute and a partial monopoly of burlap. There are ample facilities in the United States for the manufacture of jute into such items as burlap, hessian cloth, carpet and linoleum bases, etc All of the jute imported is raised in India Annual imports are approximately six hundred million pounds. Jute is used in great quantities in the United States and it is desirable to maintain a supply in an emergency. However, if it can not be secured, cotton can be satisfactorily substituted. The position of jute on the strategic list is not justified.

MANGANESE ferrograde ore, for use in making steel, is normally imported. Our country can produce low grade and chemical ores but has no large deposits of the richer types. All of the high grade manganese deposits of any quantity are located in remote countries - Russia, India, Africa and Brazil, with the exception of Cuban resources. In the absence of an adequate domestic or readily accessible foreign supply, a shortage of ships or a blockade by an enemy fleet could seriously curtail or completely shut off our supply of imported manganese.

For the twelve months of 1936 during which the new one-half cent a pound tariff was in operation, a total of 846,648 long tons was imported of which Russia furnished 289,867 long tons, the Gold Coast 241,594 long tons; British India 126,913 long tons, Brazil 110,018 long tons, Cuba 37,912 long tons and all others 40,344 long

tons. In 1935 before the effect of the tariff was felt, Cuba furnished 43,955 long tons and Brazil 29,528 long tons.

MANILA FIBER There is no manila fiber produced in the United States. It is a tropical product. The necessity for cheap labor alone would prevent its development here, unless machine methods were developed. The commercial source is the Philippine Islands in the southern provinces of Luzon, and in Davao and Leyte. There are about fifty acres planted in Pahama but labor difficulties have prevented its exploitation. It may be grown elsewhere in the tropics but the Philippine supply is ample and cheap. Practically all is shipped from Manila, the amount in storage at that port varied from 172,000 bales in 1929 to 23 853 bales in 1931. The three year average (1929-31) of the stocks in Manila and the United States was 59,964,000 pounds. In an emergency it is important to secure immediately the stocks in Manila and if possible maintain its continued importation.

MICA is a crystal which is unique among minerals in the number of useful properties it contains. The automobile, airplane and radio industries find this material practically indispensable for insulation.

All grades of mica occur throughout the world but the principal commercial sources of sheet mica are India, Madagascar and the United States which produced respectively - eighty-two per cent, six per cent and five per cent of the estimated world's production of 19,300,000 pounds in 1935.

Roughly speaking, commercial mica may be classed in four groups, namely ground, punch, sheet, and splittings. It is chiefly with sheet mica that we are concerned, as the domestic production of the other grades is sufficient to cover the demand except for splittings, which are imported not because of lack of material but because Oriental material can be imported at a lower price than our high price domestic labor would make necessary.

NICKEL is necessary to toughen steel, and the armor plate of the world is made of nickel steel. Many alloys are made of this valuable metal with copper and other metals. The greatest world's source is in Canada, with whom we have always been on excellent terms, but our domestic supply is practically nil. In 1935, eighty-three per cent of the world's nickel came from the Sudbury district in the province of Ontario in Canada. Most of the remainder came from New Caledonia, with small quantities from Russia, India, and Norway. The world's annual production of nickel was approximately 75,000 tons, of which the United States imported about 38,000 tons (1935), all from Canada. Normal stockage of nickel in the United States is about 11,000 tons. To this should be added a possible local production of 2,000 tons and secondary production and recovery from scrap of 4,000 tons, making a total available supply of nearly 17,000 tons. About thirty-seven per cent of the nickel is used in

steel alloys and thirty-three per cent in anodes. The remainder is used largely for plating and in non-ferrous alloys, such as monel metal. Its chief military uses are in armor plate and projectiles. Nickel increases the strength and resistance of steel and tends to make it non-magnetic and to increase its co-efficient of heat expansion There is a possibility that experiments now under way will indicate that molybdenum may be substituted to a considerable extent for nickel as a ferro-alloy. In making heat-resisting steels and many of the electric heating units, nickel is indispensable. Even our soap industry finds nickel desirable in hardening its fats and oils. It would be difficult to cut us off from the Canadian source, although the British Empire at war might require the greater part of the Canadian production.

OPIUM Crude opium is prepared in irregular lumps or cakes of dark brown color. There are twenty alkaloids of which morphine and cocaine are the most important. Morphine has been classed as the most important drug in medicine for relieving pain The drug is permanent and does not deteriorate, but finished preparations become unusable. The content of alkaloidal salts however, can be recovered with only the losses incident to processing.

There is no domestic production. The principal world sources are British India, Turkey in Asia and Yugoslavia. Importation is controlled by the narcotic division of the Treasury Department by allotting specific quotas to recognized importers It is estimated that 11,037 pounds (crude) are normally in storage in ports at all times and a similar amount en route. Shipping routes are via the Mediterranean and Atlantic sea lanes. Two-thirds of the imports are made in United States bottoms. In 1925 authority was granted the Surgeon General of the Army to accept and store in reserve stocks of opium or preparations thereof suitable for medicinal use which have been seized and confiscated by the authorities The amounts received in this manner are sufficient for all military uses in a national emergency Because of the unusual importance of this drug in medicine and the necessity for its use for civilian needs it is believed that the present policy of acquisition and storage should be continued until both military and civilian requirements can be satisfied in a national emergency.

OPTICAL GLASS The optical glass industry has not been greatly developed in the United States perhaps because its manufacture does not lend itself to methods of mass production. Our manufacturers are unable to compete successfully with foreign producers who have a source of cheap skilled labor. Dependence for our supply prior to the World war was placed on foreign sources and upon the outbreak of the war we were thrown upon our own resources with little help from our overburdened allies. As a result ample capacity for producing this material was available by the conclusion of the war Since that time several of the optical glass plants have been dismantled, but Bausch and Lomb, the largest and most efficient plant, still remains in operation. The National Bureau of Standards is also aiding in keeping

the industry alive by producing a small amount of high grade material for the Navy.

Military requirements will be undoubtedly greater than the industry can meet, especially in the early months of a national emergency. The shortage of production capacity will be felt most severely in such complicated instruments as range finders and other telescopic instruments. Delay in production will be inevitable until facilities are developed and workmen trained. The greatest choke point in production of optical glass is the aging and curing of kaolin pots for the melted glass, which requires eight months. The optical glass industry is supplying fifty per cent of the present peace-time needs. In the other fifty per cent is included such material as camera lenses, some of which is processed here.

QUICKSILVER is a metal of many uses. It is a drug and a chemical necessary in many of our industrial activities, from the production of gold to the disinfection of seeds. In the military art, it is an ingredient of certain explosives and a minute quantity serves to start on their way many of our projectiles. The greatest world's sources are Italy and Spain. Our own production has been decreasing in recent years and our capacity to produce is being retarded by flooded mines and stagnation of manufacturing capacity If we become entirely dependent upon foreign sources for mercury, we may expect serious difficulties if conflicts abroad deny us access to world markets.

QUININE is a specific in the treatment of malaria and is also employed as a tonic, an antispasmodic, an antiperiodic and a diaphoretic. Quinine is usually extracted from the bark with sulfuric acid and therefore the product obtained is in the form of the sulfate. There are but two companies engaged in the importation and manufacture of quinine, namely, the New York Quinine and Chemical Works, Inc. and Werck and Company, Inc.

There is no domestic production. Netherland India produces ninety per cent of the world's cinchona. World production in 1932 was 11,000 metric tons An average of 2,270,113 pounds of bark was imported annually in the past ten years Adding to this the yearly imports of quinine sulfate, a total of 3,352,915 ounces of the sulfate, or its equivalent, was imported. The production and manufacture of quinine are controlled by the Kina Bureau and the Quinine Convention. The Kina Bureau is an organization of planters and certain manufacturers, while the Quinine Convention is an association of international manufacturers. In 1928 the so-called Quinine Trust was formed in New York and brought under government control the activities of the importers of quinine. Total world production of cinchona bark in 1929 was 1,959,891 pounds. Shipment of quinine from the Netherlands and its possessions is made in Dutch ships and from Germany in German ships. Japan is reported as now producing quinine and within three years expects to be producing 900,000 ounces of sulfate annually.

There are no substitutes for quinine but two synthetic compounds, namely, atabrine and plasmochin have been developed by the Winthrop Chemical Works to complement the use of quinine in the treatment of malaria The essential chemicals in these two drugs are imported from Germany

RUBBER is a vegetable material, which grows in the tropics, and we are dependent upon outside sources for our supply We use over one-half the world's production which comes from the Malay States, the Dutch East Indies and Ceylon

None of our strategic commodities is worthy of more serious consideration than is rubber. Our principal use of rubber is, of course, in automobile tires. It also serves a number of other important purposes, as for example, its use in medical and electrical equipment. Ninety-four percent of all rubber now used comes from the East Indies. Great Britain controls approximately sixty-five percent of production in the East, the Dutch twenty percent, and the Belgians, French and Japanese the remainder. We import and consume annually over one billion pounds, or about seventy percent of the world's consumption. Our stockage is equal to about six months consumption. There is no satisfactory substitute. Guayule rubber is being experimentally produced in California in small quantities. It may be substituted for imported rubber in some cases and used with it in others. Under stress of war conditions a greater amount of reclaimed and reworked rubber would undoubtedly be used. It has been estimated that 525,000 long tons can be made available.

SILK is a material usually regarded as a luxury, but it has many uses in industry. The insulation of wires and cables is an example, and in warfare it is used for the powder bags for our big guns and for parachutes for our air services. There is no domestic production of raw silk

The total annual production is in excess of 100,000,000 pounds, of which Japan produces seventy percent, China twenty percent and Italy nearly ten percent. Our raw silk imports reach a total of about 75,000,000 pounds, seventy-five percent of which are from Japan, which in turn represent thirty-five percent of Japan's production for foreign trade. In a major war with our imports stopped practically all civil requirements might very well be reduced, as other fabrics, particularly rayon, could be substituted for silk. Experimental work is being done with a view to substituting cotton for silk for some of the military uses.

SISAL and henequen are similar fibers. Sisal is the softer, stronger and more flexible. Both are used for the same purpose and one substitutes for the other. The domestic production of sisal, henequen and similar tropical plant fibers is negligible

Military uses are sand bags, heavy and light package twines and packing fibers.

Sixty-one per cent of our supply of sisal or henequen comes from Mexico. Other sources are Cuba, the Dutch East Indies, and Africa. There is no domestic production in continental United States. The average imports (1927-36) were about 266,000,000 pounds. Our normal stockage in the hands of manufacturers and importers is about one-third of this amount. Substitutes may be developed by the cordage industry, but the situation in harvesting crops during a war a few years hence may be so changed by the increased use of the combine that our need for binder twine will be greatly lessened

TIN is one of the minerals which nature left out of our soil. It has become indispensable in the preservation of food, since it furnishes a protective coating on the steel from which our so-called tin cans are made. We use it in the manufacture of automobiles, for the making of bearings, solders, bronzes and gun metals. It can be rolled into foil and has many uses as a chemical.

The United States uses more than thirty billion tin cans each year. No satisfactory substitute exists for the use of tin plate in the preparation of food in convenient containers. We produce no tin at all. The world's production of tin in 1936 was 180,000 long tons of which we consumed 79,000 tons. Nearly thirty-seven per cent of the world's tin was produced in the Malay States, eighteen per cent in Netherland East Indies and thirteen per cent in Bolivia. Smaller quantities were also mined in Siam, China and Nigeria to the extent of seven, six and five per cent, respectively.

TUNGSTEN. Probably no other metal produced in such small quantity has any greater industrial importance and has such an influence on the comfort of the people at large as tungsten. Tungsten is used as a ferro-alloy and also in incandescent lamps. It is an essential element in certain tool steels for forming metals. For production during an emergency, when speed is essential, it is hard to see how we could keep the pace required without this valuable metal. Smaller quantities of this material are used in steel which has to stand excessive heat. We use annually approximately four thousand tons, of which we produce one thousand, principally in the states of Colorado, Nevada, and California. The world production (1936) of tungsten was over 22,000 tons. Of this amount thirty-eight per cent was produced in China, twenty per cent in India and ten per cent in the United States. Bolivia and Burma each account for about ten per cent of the world production. Malay States, Bolivia and Portugal each account for about eight, seven and five per cent of the world's production, respectively. We have on hand a current stock of about 1,500 tons, so in the event of war we would have with our domestic production about one-half of our annual requirements. Recent experiments with molybdenum, found in considerable quantities in the United States, indicate that it may prove to serve in part as a substitute for this material, but we would have difficulty in meeting our

needs for the rapid production of war materials without tungsten. Large low-grade deposits in the West might make it possible for us to secure our requirements by paying a high price for them but perhaps with a delay that could be fatal to our national security.

WOOL is the most important animal fiber, and the health and well-being of both the civilian population and the armed forces depend to a considerable extent upon the supply of this material. In normal times we import a considerable supply from the countries of Europe and from Argentina, Uruguay, Australia, South Africa and Canada. In time of war, both our Army and Navy are clothed in wool. Without imports there would be serious shortages of this material. The principal military uses of wool are in the manufacture of clothing, blankets, felt, horse equipment, bunting and flannel.

The estimated world's production of wool, in 1936 (exclusive of Russia) was in excess of three and one-half billion pounds. Many countries do not publish statistics as to wool produced and estimates covering such countries as Russia and China, where much of the wool is used locally are apt to be inaccurate. The United States produces about 435,000,000 pounds of virgin wool each year, about two-thirds of its consumption. In addition, wool reclamation amounts to 160,000,000 pounds. There is a normal stockage of about 300,000,000 pounds, or two-thirds of one year's peace requirements. It must be remembered that our requirements for a large army and navy would greatly increase the consumption as the life of clothing and blankets under combat condition is relatively short. The United States depends upon imports for about one-fourth to one-half of its normal consumption.

6. Basic principles in the development and use of substitutes.

In order that a substitute may be used for the purpose of planning and the ultimate reduction of raw material requirements, it must not only be acceptable to industry but must be commercial practice While this statement is axiomatic it should not be taken as an argument against planned research directed toward the development of substitutes, on the contrary, it merely serves to emphasize the tremendous distance between the development of a product in the laboratory and its use by industry In the final analysis whether or not a departure from present commercial practice, at any given time, by the adoption of a substitute is likely to occur, depends directly on the cost of using the substitute compared with the cost of using the original material. If the substitute is less costly and of equal value in use, it will be accepted. If it costs an equivalent amount and is of greater utility or simplifies production, the substitute item will sell itself. Such factors create demand. Many industries owe their existence to these principles - the most outstanding of which is the aluminum industry. Finished products made of aluminum are largely items used in lieu of something that existed previously.

Substitutes, however worthy of consideration, now in the laboratory stage can not be used in tomorrow's wars because of the delay in changing existing commercial practice. All research and development programs are, therefore, necessarily considered from a long range viewpoint. This is an argument for planned, closely coordinated and carefully controlled research directed toward lessening the load of industry in those items where careful study shows requirements can not be met either by reason of a lack of raw materials or facilities.

Present Methods. Development and research are now being directed, as is perfectly proper, by the several branches but without any such thought of coordination as above expressed. Once each year the progress made is reported directly to the Commodities Division for record. The primary interest of that division in these reports is to keep informed as to the possibility of reducing requirements of strategic and critical commodities by reason of substitution, and also the application of funds for the procurement of such items as blanks of optical glass where problems involved are other than those of raw materials. Existing plans for raw materials utilize substitutes for reducing requirements to the greatest possible extent.

In conclusion, I feel that definite progress has been made in the studies of raw materials. The work of the division is necessarily continuous in character. You will individually form your own conclusions with regard to the best methods of solving such problems and from your background of experience will do much to aid in their solution.