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IRON AND STEEL MATERIALS RESOURCES

Mr. Philip W. Chase

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

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10 November 1960

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Reporter: Ralph W. Bennett

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COL. MORGAN: General Mundy and Gentlemen: Our subject this morning deals with the iron and steel material resources of the free world, with particular emphasis on the United States position.

The effective utilization of our great wealth in these particular resources has contributed in large measure to our economic growth and our industrial leadership. In the short time allowed this morning we are going to try to cover the uses of these particular resources, their importance to our economic well-being, industrial leadership, and national security, and to give you a summary of today's supply and demand picture relative to these particular resources.

We are fortunate this morning, through the cooperation of the United States Steel Corporation, in having with us Mr. Philip W. Chase, of that corporation, who will present the subject this morning. Mr. Chase shares the responsibility for directing all of the raw materials resources aspects of the business of this giant corporation. Mr. Chase has devoted his entire lifetime to study, research, and actual operations in the field of mineral resources.

Mr. Chase, it is a pleasure to welcome you, for the first time, to the platform of the Industrial College of the Armed Forces. Mr. Chase.

MR. CHASE: Thank you very much, Colonel Morgan. You gave me a slight promotion there, and I appreciate it.

General Mundy, Gentlemen: The subject that Colonel Morgan has given me is a pretty big one and, if treated in all its aspects, it embraces a very broad field and a full discussion would fill volumes. Obviously, it is impossible to cover it in much detail in the forty-five minutes that I have this morning.

Accordingly, I plan to confine my lecture to a few of the more salient features of this subject, dealing with the future rather than the past, and presenting only such statistics as may be necessary for you to grasp the points which I hope to make. Fortunately, there are full and reliable statistics available on production, consumption, specifications, etc., as well as good descriptions of iron and steel-making techniques and the role that raw materials play therein. To anyone interested in this field, I would particularly recommend "Mineral Facts and Problems," the 1960 edition, which is published by the United States Bureau of Mines; the volume entitled "The Making, Shaping and Treating of Steel," put out by the United States Steel Corporation; and also the various publications of the American Iron and Steel Institute. These are all reliable and excellent references.

As a background for this discussion of raw materials, I would like to give first a very brief review of the various steps involved in the making of steel and the role that the raw materials play therein.

(SLIDE 1)

The first step in steel making is the reduction of iron ore, that is, the reduction of the iron oxide in the ore, to produce pig iron. This is carried out, almost universally, in the blast furnace. The raw materials consumed are principally iron ore; a flux; coke; and sundry service materials, such as water, power, natural gas, and refractories.

The second step--shown in the second column here on this slide--is to convert the pig iron, with or without the addition of scrap metal, to steel. This process, which entails the removal of excess carbon, silicon, and manganese from the pig iron by oxidation processes, is carried out, at least in the United States, largely in basic open hearth furnaces. Typically, 87 percent of the steel produced in the States is made in the open hearth furnace, 9% in the electric furnace, 2% in the Bessemer, and 2% in the basic oxygen, with a growing trend to the use of basic oxygen.

The raw materials consumed in the steelmaking furnaces, with particular reference to the open hearth, can be divided into three classes:

1. Those that are required to remove the impurities from the pig iron. These comprise iron ore and limestone of a special quality and sometimes manganese and Fluorspar.

2. The raw materials that are needed to make special types of steels. These are generally classed as ferro-alloys, and comprise manganese, nickel, chrome, tungsten, molybdenum, and various other metals.

3. Service materials, including among others oxygen.

A third step in steelmaking processes, in which raw materials play an important part, is the coating of steel products. The major coated products are galvanized steel, in which case the coating is zinc; tin plate; and aluminum-coated steel sheets.

This slide has set forth the variety of raw materials required by the iron and steel industry. Now let's take a look at the quantity of materials that the industry consumes.

(SLIDE 2a)

This slide, and the two that follow, give a rough approximation of the quantity and value of the principal raw materials consumed. Here are listed the so-called "major" raw materials; that is to say, iron ore, limestone, coke, scrap, and manganese ore. The tonnages given are the amounts of material that the industry would theoretically consume in a year when ingot steel production was 100 million tons;

that is to say, when the industry would be operating at about 68 percent of its present capacity.

(SLIDE 2b)

This slide lists the so-called "minor" raw materials, most of which go into the ferro-alloys and in coating materials. The quantities shown here represent the actual consumption in 1959, when the industry was operating at about 63 percent of capacity.

Both sets of figures, in this slide and the previous slide, would have to be increased some 50 percent to give the quantities that would be consumed when the industry was operating at rated capacity.

The values on these slides are on a delivered-to-furnace basis, and have been calculated using the 1959 consumption figures as reported by the American Iron and Steel Institute, and 1959 prices as reported by the Bureau of Mines and other sources. These figures, while admittedly only rough approximations, do, I think, serve to convey an idea of the magnitude of the annual raw material requirements of the iron and steel industry--over 333 million tons of material when operating at capacity, valued at over 7 billion dollars.

(SLIDE 2c)

Not included in these totals are the various service materials, such as water, liquid and gaseous fuels, electric power, oxygen, and others.

So much for the total requirements of raw materials. I would now like to discuss briefly the considerations that govern the choice of raw materials; that is to say, what influences the industry to select and use raw material from one source as opposed to another source. In this discussion I will use iron ore as an example, but the overall economic principles involved apply to the other raw materials as well.

When a furnace operator goes shopping for iron ore, he is looking for that particular ore which will give him the most value per dollar. In other words, he is looking for an ore that will give him the best price-quality relationship in his blast furnace. This is a pretty elementary concept--one that every housewife adheres to when she goes to the local grocery store--but, for some reason or other, in the steel industry it seems to have been overlooked at times. But it is important and is at the bottom of both the domestic and international iron ore trade.

If we analyze this price-quality relationship, we find that the two principal items that determine the price end of this relationship are, first, mine costs--that is, the cost of producing the material at the mine or plant--and, secondly, transportation costs--that is, the cost of moving it from the mine or plant to the consuming furnace. The relative importance of these two cost factors varies widely from case to case. In the case of low-cost bulk materials, such as limestone or

iron ore, the transportation costs are often predominant. In the case of the higher-priced materials, such as tin, tungsten, and nickel, it's a minor consideration.

On the quality side of the relationship, a number of factors, both chemical and physical, must be considered. In the case of iron ore, the more important factors determining quality are the iron content of the ore, the relationship of the acid to basic gangue constituents--the term "gangue" referring to the constituents of the ore other than iron oxide--the absence of harmful impurities, the ease with which the iron oxide of the ore can be reduced, and the size consist and structure of the ore particles. Of course, different factors enter into the quality of coke, scrap, and ferro-alloys; but the foregoing illustration, I think, points out that there are a number of factors entering into a determination of quality.

From this concept of price-quality relationship--and by "price" I refer here to the price that the furnace operator pays for his raw material, in other words, the cost to him--it follows that steel producers in one area will prefer raw materials from certain sources, while steel producers in another area will select materials from entirely different sources; and this applies equally to different plants within the same area and even to different furnaces in the same plant. The iron and steel industry is becoming very selective indeed in its

purchases of raw materials; and its becoming even more so as competition from substitute materials or from imported steel products forces the steelmaker to operate his plant at its highest possible economic efficiency.

We now have a picture of the variety and amounts of raw materials required by the iron and steel industry, as well as the economic principles which govern the choice of these raw materials, and hence determine the demand or market for such raw materials as are available. Turning now to the individual materials, I will deal first with iron ore, as it is by far the most important of the primary raw materials, both as to tonnage and value.

Fortunately for our civilization, iron ore is one of the most abundant and widely distributed elements, constituting about 4 percent of the total earth's crust. In almost all regions of the world its supply is practically limitless. To be sure, most of this iron is not in a form that can be used in our current iron and steelmaking practices; nor is it located in the earth's crust in a manner that is easily available. That part of this total iron content that is available to industry, or could be made available to industry, is commonly designated as iron ore reserve.

There has been much discussion from time to time as to the sufficiency of our iron ore reserves to meet the future requirements of the iron and steel industry, both in the United States and in the world as a whole. A major problem in estimating reserves is one of definition, because, as we have just seen, for economic reasons what is satisfactory ore for one furnace operator in one area may not be acceptable to others. As a specific example, ores now being used in eastern France contain less than 25 percent iron. Such material would not be considered suitable for the blast furnace in other sections of the world. However, in Alsace and the Saar, the spatial proximity of this ore to sources of coking coal and to an important steel market area, as well as its adaptability to the furnace practices developed in that area, give it a favorable price-quality relationship. Much the same situation exists in Birmingham, where ores with as low as 37 percent iron are being used successfully.

Obviously, ore reserve estimates are meaningless and may be misleading unless the term "ore" is defined realistically in relation to its potential commercial usage. The most logical definition of "ore," in a purely commercial sense, is "iron-bearing material that could be economically mined and used at a particular place under current cost and market price conditions."

Using this definition, and using as a unit the iron content of the ore, rather than the ore itself, the world reserve of iron ore has been estimated at 68 billion tons of iron-in-ore.

(SLIDE 3)

This total, as can be seen in this slide, is distributed throughout the world, the U.S.S.R. containing almost 15 billion of the 68 billion total, followed by Brazil and India with about 10 billion each, the United States with about 7 billion, and the European Economic Community, Red China, and Canada with about 5 billion each.

(SLIDE 4)

In total, this reserve is more than ample to meet the projected demands of the iron and steel industry, which are forecast at 9 billion tons of iron-in-ore over the next 30 years. Obviously, there is an adequate world-wide supply of iron ore, even without taking into account the immense tonnages of iron-bearing material such as laterites, itabirites, and fine-grained, non-magnetic taconites, whose existence is proven but for which no adequate metallurgical treatment has yet been developed. In fact, there is such an abundance of potential iron ore supply that competition for the available markets is bound to be keen.

(SLIDE 5)

However, examining this slide, it will be noted that the nations which consume the most ore are not always those that possess the largest reserves of ore. The result is that nearly all of the principal steel-producing nations, either from necessity or from economic choice, import substantial quantities of their ore, as illustrated on the next slide.

(SLIDE 6)

This situation has resulted in the establishment of an international trade in iron ore, which in recent years has grown tremendously as furnace operators have begun to recognize the economic importance of the price-quality relationship.

(SLIDE 7)

This slide and the succeeding one show the major movements and the volume of this international iron ore trade in 1956. Unfortunately, I do not have more recent data on the movement. But if I did, they would show a much larger tonnage of material moving over essentially these same routes.

Leaving the world now and considering specific nations, in the United States we find a domestic situation which is quite similar to the world-wide situation which I have just described. The domestic iron ore reserve of approximately 7 billion tons of iron-in-ore--remember, that is iron units in ore; not iron ore--is ample to meet

the anticipated requirements of the domestic iron and steel industry for many years, even without drawing on the huge deposits of fine-grained, non-magnetic taconites which are known to exist in the Lake Superior area. However, these reserves are not spread around the country in keeping with the steel-making centers. For example, the blast furnaces in the Lower Lakes and Missouri areas, with about 50 percent of the nation's capacity, have easy access to the Lake Superior iron ores, which comprise 80 percent of the nation's total. On the other hand, the remaining 50 percent of blast furnace capacity must depend on local reserves totaling only 20 percent of the nation's total, or must pay high transportation costs to obtain ore from the more distant sources. Particularly deficient in local ore are the northeastern steel mills.

A second important factor in evaluating our domestic iron ore situation concerns the quality of the ores. Almost 70 percent of our total reserves is in the form of Lake Superior taconite. Perhaps I should explain that the term "taconite" represents an unoxidized iron formation with an iron content generally running from 20 to 30 or 35 percent; and this must be subjected to very complicated and costly grinding, concentration, and agglomeration before it can be used in the blast furnace. There is 70 percent in taconite. Another 8 percent is in the form of high-silica oxidized ores that require some treatment

such as screening, washing, or concentrating before they can be used; and a further 6 percent occurs as Alabama "red" ore, which, because of its high phosphorus content, cannot be economically upgraded to make an optimum quality feed for modern blast furnace practices. That leaves only about 16 percent of the total which can be considered as direct shipping ores--ores that can be used without any particular processes. And even this 16 percent is rather low grade compared to many of the imported ores.

It is true that most of the low-grade United States ores, particularly the taconite ores, can be beneficiated to make a desirable product. However, the plant investment required is tremendous--$30 to $45 per annual ton of capacity. Compare that with some $15 to $20 per annual ton of capacity for developing an ore source in foreign countries, and you recognize the advantages of sometimes going to the foreign source.

As a consequence of these two conditions--one, the location of important segments of our domestic steel industry far from adequate domestic sources of iron ore; and, two, the general lack of high-grade ores in the United States (or, alternately, the huge capital investment required to make a desirable product from taconite)--a growing demand has developed in certain sections of the United States for high-grade foreign ores. Thus we have the apparent anomaly of a

nation possessing one of the world's largest reserves of iron ore being at the same time the world's largest importer of iron ore.

(SLIDE 8)

I'm sorry. The slides got mixed up. This slide should have been shown together with that containing the map of the world. It illustrates the international trade in iron ore. You see that the trade between Canada and the U.S.A. is by far the largest, followed by Sweden to the Community, Venezuela to the U.S.A., and so forth.

(SLIDE 9)

This slide shows the growth of iron ore imports into the United States. The rapid increase since 1953 reflects the expansion of the steel industry during this same period. More particularly, it reflects the growing realization by the furnace operator that inflation has caused depreciation allowances to become entirely inadequate to replace worn-out or obsolete furnaces, and has so raised the cost of new furnace construction that investment in plant expansion has become rather unattractive. Hence, faced with growing competition from foreign steel imports and domestic substitutes for steel, the steel operator is forced to get the most from his existing plant. One way of doing this is to use higher-quality raw materials. In searching for higher-quality iron ores, some operators have found it more economical to import high-grade foreign ores than to upgrade and pay high transportation costs on our domestic low-grade ores.

I have dwelt at some length on iron ore, first, because it is the principal raw material used in steel making; and, secondly, because many of the considerations applicable to iron ore are also applicable to a greater or less extent to the other major raw materials.

Let us consider next the fluxes. Fluxes are used both in the blast furnace and in the open hearth. Their function is to make the gangue more easily fusible and at the same time to combine with impurities in the ore and prevent their entering the iron. The chemical reaction is that of an acid combining with a base to form a stable salt. Thus, if the ore gangue is acid, a basic flux should be added, or vice versa. The resultant salt generally has a lower melting point than either of its components; but if not, a neutral, low-melting flux is added.

The selection of the proper flux is a purely chemical problem. The usual basic fluxes are limestone, that is, calcium carbonate, or dolomite (calcium-magnesium carbonate). These two fluxes are pretty much interchangeable, and the choice between them depends largely on economic considerations. In general, high-calcium limestone is favored when it is desired to keep slag volume low, remove large amounts of sulphur, or produce slag for cement making. Dolomite is favored when the slag is to be used for ballast or construction aggregate.

The usual acid fluxes are sand, gravel, or quartz. However, inasmuch as most iron ores are siliceous, particularly in this country, acid fluxes are seldom used except to increase slag volume when this would otherwise be insufficient to remove all of the impurities.

The other common flux, fluorspar, is used as a neutral flux, generally in open hearth practice, to increase the fluidity of slag without changing its basicity. Average consumption is small--only about 5 pounds per ingot ton.

Limestone and dolomites suitable to meet specifications are plentiful and widely distributed throughout the United States and throughout the world. The principal concern is to develop quarries close to points of consumption with a minimum of overburden so as to maintain low costs. The only treatment usually required is crushing and screening to accurate size specifications.

In the case of fluorspar, however, the maintenance of a suitable source of material for the iron and steel industry is becoming somewhat of a problem. With a few exceptions, fluorspar is found in small, irregular bodies that do not lend themselves to large-scale mechanized mining. Most of the ore must be upgraded in one way or another. Although world reserves of fluorspar appear adequate, very keen competition is offered by the aluminum and chemical industries for the product of the better mines; and as the price for the so-called

"acid grade spar" used by the aforementioned industries is considerably higher than for the "metallurgical grade spar" sought by the iron and steel industry, most fluorspar producers aim to convert as much of their production as possible into the former grade. As a consequence of this competition, domestic production of metallurgical grade fluorspar is limited; and the bulk of the iron and steel industry requirements, that is, about 80 percent, is now imported, principally from Mexico, Spain, and Italy.

Looking into the future, the domestic reserves of fluorspar are high cost and inadequate to supply the growing demands from the aluminum, chemical, and steel industries. It appears that the United States will become more and more dependent on foreign sources of fluorspar. Serious consideration should, therefore, be given to reducing or removing entirely the present excessive tariff barrier as one way of encouraging the development of foreign sources.

Turning now to coal: Coal, of course, is used primarily in steel operations for the making of coke and, to a minor extent, for the generation of power. About three-fourths of a ton of prepared coal is required for each ton of ingot steel.

The same price-quality relationship which I mentioned in the case of iron ore applies equally well to coal. And, likewise, just as the furnace operator is demanding higher-quality iron ore, so is he

demanding a higher and more uniform quality of coke. This in turn requires a higher-quality coal, attained principally by a more careful cleaning of the coal as it comes from the mine in order to remove the ash and the sulphur.

Domestic reserves of coking coal total, in the aggregate, some 1.8 billion tons, and are adequate to supply the foreseeable requirements of the iron and steel industry. However, as the mines get deeper, and as the thicker seams become exhausted, the operator must resort to more mechanization to keep his costs down, and to increasingly elaborate treatment processes to meet the quality demand of the furnace operators, and at the same time to compete with such other reductants as fuel oil, natural gas, oxygen, and "form-coke", all of which are receiving growing attention.

Manganese ore, the last of the major raw materials required by the iron and steel industry, serves two purposes. Added to the blast furnace charge in small quantities, it acts as a desulphurizer. Converted into ferro-manganese, it is the most important of the numerous ferro-alloys used to impart special properties to steel.

The United States possesses only limited reserves of commercial manganese ore, and these are of very low grade and are not amenable to economical upgrading. Consequently, industry requirements for metallurgical-grade manganese ore, amounting to about 1,700,000 tons annually, are filled almost entirely from foreign sources.

The major future sources of manganese ore are Brazil, India, South Africa, the Gabon Republic, and possibly the U.S.S.R.

As concerns the other ferro-alloy metals--nickel, chrome, tungsten, and molybdenum--the United States is dependent on imports for all of these except molybdenum and about half of its tungsten requirements. Nickel is imported principally from Canada and until recently from Cuba; chrome from Turkey, Rhodesia, South Africa, and the Philippines; tungsten from Brazil, Peru, Bolivia, and Australia.

Now, getting on to the steel-coating raw materials, the industry consumes nearly 60 percent of the total domestic consumption of primary tin; and all of these requirements must be imported, principally from Malaya, although Bolivia, Indonesia, the Congo, Thailand, and Nigeria are also important sources of tin concentrate.

Zinc is the other major coating material, with about 40 percent of total domestic consumption used for the galvanizing of steel products. Domestic sources of supply are available for zinc.

Aluminum, which has been used historically as a deoxidizer and more recently as a coating material, offers no problem, since usage in the steel industry is relatively insignificant and domestic supply is ample.

Before closing this discussion of raw materials, I'd like to make mention of steel scrap, because although this is not really a primary raw material, it does nevertheless constitute a very important part of the charge to the furnaces. A small amount of scrap is charged to the blast furnaces; but the great bulk of the tonnage--more than 50 million tons in a normal year--is consumed in the steelmaking furnaces.

Of the total scrap supply, somewhat more than 50 percent is so-called "revert scrap"--that is, scrap developed in the steel mill itself. The balance, referred to as "purchased scrap," comes in part from the operations of steel fabricators and in part is collected as junk.

Many furnaces, particularly in non-integrated steel operations, are operated entirely on scrap, while furnaces forming part of integrated operations use scrap more or less interchangeably with pig iron or hot metal. The extent to which scrap is used in these latter furnaces varies considerably from time to time and depends largely upon the relative prices of scrap and iron. Scrap prices characteristically fluctuate widely. When they are high, the tendency is to minimize scrap usage and operate as far as possible on iron. On the other hand, when they are low, the tendency is to increase the use of scrap so as to maximize furnace production.

The price, and hence the domestic consumption, of scrap is related to the foreign demand; so that not only consumption but likewise exports vary rather violently. However, in spite of all the commercial influences on the domestic scrap market, the United States is normally self-sufficient as regards scrap and will in all probability continue to be so.

Lastly, as was shown on Slides 1 and 2, there are a number of raw materials that I have lumped together under the heading "service materials." Chief among these are refractories, electric power, water, fuel oil, natural gas, oxygen, as well as other products developed in the coke plants often associated with integrated operations. There is not time to discuss these in detail. Suffice it to say that, in spite of the large quantities involved, they do not, except in very special cases, present any important supply problems.

So far, my discussion of raw materials has been based on the usual steelmaking techniques as they are practiced today. However, during the last ten years a number of new steelmaking techniques have been receiving attention. Some of these have been or are being adopted; others are still in the experimental stage. Among these are several processes for the direct reduction of iron ore to semi-steel, without going through the pig iron stage; the use of natural gas in the blast furnace as a partial substitute for coke; the use of self-fluxing iron

ore agglomerates, in which the necessary flux is mixed with the iron ore particles in a sinter or pellet so that the charge becomes self-fluxing and the addition of further fluxes in the furnace charge is eliminated; the use of oxygen in both blast furnace and open hearth; the so-called basic oxygen process of steelmaking, which takes the place of the open hearth or Bessemer converter and blows oxygen on the surface of molten pig iron in an open-topped vessel to produce steel; and the use of "form-coke," derived from non-coking bituminous coal, as a substitute for coke.

The effect of these new techniques on raw material requirements differs from case to case, but in general they tend to reduce the amount of solid fuels and raw materials consumed, while at the same time increasing the furnace productivity. As a rule, their adoption would reduce somewhat the amounts of coal, fluxstone, and open-hearth-quality iron ore per ton of ingot steel; and, in the case of the direct-reduction processes, it might make possible the use of off-grade iron ores. At the same time, these new techniques will tend to increase the consumption of natural gas, oxygen, and electric power.

In summary, as concerns basic raw materials for the iron and steel industry, the United States can be essentially self-sufficient with respect to coal, limestone, molybdenum, zinc, aluminum, and

scrap. It could, given three to five years for plant construction, become self-sufficient in iron ore, although the added cost of using only domestic ores would severely handicap its competitive situation. The industry is, and in all probability will continue to be, in part or entirely dependent on imports for its requirements of fluorspar, manganese, chrome, nickel, tungsten, and tin.

Now, turning next to the European Economic Community: The Community ranks second to the United States as a producer of steel, with a capacity of over 70 million tons. As an entity, it is in very much the same situation as is the United States. It likewise has ample reserves of iron ore; but as these are generally low grade, it has been found commercially advisable to complement the use of domestic ores with high-grade imports, largely from Sweden, North Africa, Venezuela, and Canada.

Although possessing very substantial reserves of coking coal, the Community has in the past few years imported coking coal in quantity from the United States because of the latter's superior coking quality; and it will probably prove economical for many of the Community steel mills to continue to import coal from Poland or North America. As regards scrap, the Community has on balance been an importer, albeit on a rather small scale in recent years. Presumably it will approach self-sufficiency in this respect in the near future. It

is also self-sufficient in limestone and fluorspar. But, like the United States, it must depend to a very large extent on imports for its ferro-alloy and coating materials.

The Soviet Union, with the world's third largest steelmaking capacity, is almost entirely self-contained as concerns raw materials, and with Red China may be considered to be completely so. This is due in part to political considerations, which have led to the use of domestic materials even though foreign materials might have been more economical. More important, however, Russia's self-containment has been forced on her as the consequence of the geographical location of its major steel plants, which are so far removed from ocean ports as to rule out the use of any but local raw material. Nevertheless, although Russia may never enter the international trade as the importer of the major raw materials, there is every indication that she will eventually become an important exporter of certain raw materials. Russia is historically an exporter of manganese ore from its extensive reserves in the Caucasus and Black Sea areas. Red China, likewise, has historically been an exporter of iron ore and coal to Japan, and of tungsten to the world. It is also well endowed with reserves of manganese and tin ores.

The remaining major steel-producing nations--the United Kingdom, Eastern Europe, and Japan--are dependent to a large extent on

imported raw materials, although the first two have substantial reserves of coal and some low-grade iron ore. Eastern Europe has made up its raw material deficiencies in the past largely from what is now the Soviet Union, but increasingly it is drawing on other countries. Japan is almost entirely dependent on imports, largely from Southeast Asia and the Pacific, although it also reaches across the Pacific to South America and Canada.

However, comparing nations on the basis of self-sufficiency in raw materials could be misleading. From the strictly commercial point of view, national self-sufficiency is no longer an important factor. As I have tried to explain, a furnace operator in any country, wherever located, in order to be competitive, must strive to obtain raw materials with the best price-quality relationship regardless of their origin. To the extent he neglects to utilize advantages offered by imports, he correspondingly weakens his competitive position both at home and abroad.

International trade in iron and steelmaking raw materials is here to stay. It received its major impetus with the realization that ocean transport costs could be greatly reduced by the utilization of larger and specially designed vessels, combined with improved port facilities for handling bulk material. There is still much that can be done along

these lines, and it can be expected that as a consequence, raw materials will be in a position to move between nations even more freely in the future than they are at present. As already noted, no major steel-making nation, except Russia and Red China, either can or would wish to rely solely on domestic raw materials. The economic necessity of using at least some imported materials in order to remain competitive in both domestic and international steel markets is so compelling that it seems unlikely that any of the major steel-producing nations will restrict the free flow of raw materials by such artificial barriers as quotas or tariffs, to the extent of economically handicapping their own industries. To the contrary, steel-producing nations should facilitate, through their international relations, their commercial laws, and their port facilities, the free movement of raw materials into their steel plants.

Although self-sufficiency may not be of major importance during peacetime, the vulnerability of sources and of supply routes in time of war may be of concern. If for any reason the steel industry in the United States should be forced by circumstances to operate for several years without benefit of transport on the high seas, it could do so.

As we have already seen, the United States is in a position to supply its requirements, including wartime requirements, of coal,

limestone, and scrap; and by drawing on Canada and Mexico, it could also satisfy its fluorspar requirements.

During World War II, domestic iron mines were able to meet the unusual demands made upon them; and they could do so again, even without the additional ores now available from Canada via the Great Lakes and the St. Lawrence Seaway. However, using only iron units from the relatively low-grade ores available on the North American continent to meet expanded wartime requirements would adversely affect blast furnace productivity. This situation could be remedied, should it ever arise, by constructing plants to beneficiate our low-grade ore. But this would take time.

Manganese ore might provide the greatest problem. There is no lack of manganese units in the United States in the form of open hearth slags; manganiferous iron ores in the Cuyuna Range in Minnesota; the iron silicates of Aroostook County, Maine; the carbonates in the Butte, Montana, area; and some of the low-grade ores in Arizona. Furthermore, processes have been developed to recover these manganese units in commercially acceptable forms, although the cost is so high that under peacetime conditions they are not competitive with imported ores. However, there are no plants presently available for recovering these domestic manganese units. Accordingly, enough high-grade ore or ferro-manganese would have to be stockpiled to tide the industry

over the period of plant adaptation or new plant construction. To supplement such stockpiles, small tonnages of acceptable ore could be produced and imported from Mexico. The supply routes for the current sources of high-grade ore--namely, Brazil, India, South Africa, and West Africa--are unquestionably long and exposed.

In summary, therefore, it is concluded that with adequate stockpiles of the ferro-alloys and of tin, and a two- to three-year supply of manganese ore or ferro-manganese, the iron and steel industry requirements of raw materials could be met for a considerable period of time without recourse to overseas supplies. However, under these conditions, blast furnace productivity might suffer until such time as facilities could be constructed to transform our low-grade domestic sources of iron into effective furnace feed.

The question might be asked: What steps should the Government of the United States take to meet present and future raw materials requirements of the iron and steel industry in the United States and in the rest of the free world?

On the domestic front, the Government should encourage the establishment of new iron ore and coal productive facilities by providing adequate depletion allowances to take care of the increasing exploration and preproduction costs of developing new mines to replace those that are being exhausted; by providing realistic depreciation

allowances to permit modernization or replacement of obsolete or worn-out plants; and by granting more liberal tax deductions for exploration expenditures.

In the foreign field, accepting the thesis that a free flow of raw materials between nations will be beneficial to both domestic and foreign industry and hence to their national economies in general, the Government of the United States should take measures that would encourage the development of international trade. Tariffs on steelmaking raw materials should be removed entirely or at least reduced in keeping with reciprocal treatment by other nations; and conditions should be made conducive to investment by United States nationals in foreign sources of raw materials that could be made available to American industry.

Such conditions could be achieved--

1. by the United States Government agreeing that the profits earned in foreign operations should not be taxed twice--once by the foreign country and again by the United States when they are repatriated;

2. by the United States Government broadening insurance protection against expropriation by foreign governments; and

3. by maintaining harbors and rivers capable of handling the large, deep-draft vessels used in international ore trade.

As I mentioned at the beginning of this lecture, the subject of iron and steel materials resources has many ramifications and could be expanded into volumes. This morning it has been possible only to touch on a few of the salient facts. However, I hope that with an understanding of these facts as a framework, you will be able to place in their proper position the more technical details available from publications, and so round out the picture as a whole.

The principal points that I have wished to make, and which are essential to a full understanding of the problem, are--

First: Raw material requirements of the iron and steel industry are many and form an important part of our total national product. Directly or indirectly, they touch thousands of people and scores of related activities.

Second: In the world as a whole, there are sufficient reserves of all of the raw materials to meet the foreseeable requirements of the industry. However, these are not necessarily distributed in keeping with national needs.

Third: In order to meet competition and get the most production out of his furnaces, the furnace operator selects his raw materials not on the basis of price alone, nor on the basis of quality alone, but, rather, on the basis of economic considerations--specifically, on a

combination of price and quality that gives him the best price-quality relationship.

Fourth: In certain locations the most favorable price-quality relationship can be obtained with imported material. Thus, international trade in raw materials is economically desirable and should be encouraged.

Fifth: As a nation, the United States enjoys as favorable a position with respect to raw materials as any of the other major steelmaking nations. With abundant domestic reserves of most of the major raw materials, and with unrestricted access to supplementary foreign materials, it can obtain its overall requirements at a cost as low as or lower than any other nation.

Sixth: The United States Government can assure an adequate continuing supply of raw materials for the domestic steel industry by taking certain recommended measures, other than subsidies, tariffs, or quotas, that will encourage private enterprise to engage in the development of raw material production both at home and abroad.

Thank you very much.

COL. MORGAN: Mr. Chase is ready for your questions, gentlemen.

QUESTION: In 1945 the aluminum industry served notice upon the steel industry and the copper industry that they were going to

compete for their market. Can you tell us to what extent the aluminum industry has taken over any part of the steel market?

MR. CHASE: It has certainly found markets which were formerly serviced entirely by the steel industry, in the tin can field, for example; and some of the automobile parts have been taken over by the aluminum industry. I would say that tonnagewise the encroachment has been very small.

QUESTION: My question concerns the iron ore deposits in Labrador. I am interested in knowing what percentage of our imports from foreign countries come from Labrador, what the quality of the iron ore in that area is in comparison with other foreign imports, and how our percentage of imports would be affected if our overseas supply was cut off.

MR. CHASE: I would say that somewhere between a third and a half of our total imports come from Canada--most of that from Labrador.

The Labrador ore which is now being shipped is very similar to our Lake Superior ore. It will run about 52 1/2 percent iron, and has not too good a physical structure.

However, there are potentialities in Labrador, just as there are in the Lake Superior region, for the concentration of low-grade taconites. There is one plant that will start production this coming spring, and there are two or three others that are in the pilot-plant stage.

The Labrador deposits are particularly well situated geographically to serve both the east coast of the United States and the European market, as well as entering the Great Lakes through the St. Lawrence Seaway. Strategically they are in a much better position, therefore, than the Lake Superior deposits, which have only the lower lakes area as their natural marketing ground.

QUESTION: I noticed from one of your charts that only two percent of the iron ore is converted from iron to steel by means of the oxygen process. My European friends tell me that there is no comparison so far as efficiency is concerned of this process with blast furnaces and other means of conversion. Why is the steel industry using this process so little? Is it because of the cost of oxygen, or why?

MR. CHASE: No. I think that the industry recognizes that efficiencies can be realized through the use of the basic oxygen process. However, they have a tremendous investment in open hearth furnaces, which they cannot just walk off and abandon. As new capacity is being installed, or as worn-out open hearth furnaces are being replaced, the tendency is toward replacing them with the basic oxygen furnaces.

Also, as I understand, the basic oxygen furnaces now in use over in Europe are comparatively small--a hundred tons or something like that. The ones that are being installed over here are of larger capacity. I believe that the Kaiser furnace is rated at about three hundred tons

a day, and is actually producing more than that, and that Great Lakes Steel Company is planning one for eight hundred tons a day. It takes a little time to technically iron out all the wrinkles when you increase the size of the furnace that much. And that also, I think, is one reason for the delay.

QUESTION: Mr. Chase, reference is made to your water requirements, indicated on the chart, I think, in 1959 as about 3100 trillion gallons. The question is in two parts. How much of this total represents a new water requirement, and how much is recirculated or recaptured water? The second part is, What is the current status of the steel industry in reference to available water supply?

MR. CHASE: Let me answer the second one first.

The steel industry, except in particular cases, such as Kaiser's plant in Fontana, has no great problem as regards water supply. The steel industry does not necessarily have to have pure water. They can use polluted water quite satisfactorily for most processes. And they do not have at the moment, and do not foresee in the immediate future, any problem with regard to water supply.

The present average consumption of the steel industry is about 31,000 gallons per ingot ton. I may have these figures wrong; but I understand that, if necessary, by recirculating and recovering as much of the water as possible, that figure could be reduced very

much--possibly to less than 2,000 gallons per ingot ton. On the other hand, if there is no recirculation, no recovery, it may run as high as 65,000 gallons per ingot ton. So you've got a very large field in which you can economize if you have to.

QUESTION: I noticed that Brazil is one of the great sources of ore. Could you give us a run-down on that area as to national attitude, the percent of development, locations, transportation, and so forth?

MR. CHASE: Yes. Brazil is one of the major iron ore reserves in the world. Most of the ore is concentrated in the State of Minas Gerais, which is, I would say, about 250 rail miles from a shipping port near Rio de Janiero.

In the past they have exported only the open hearth lump ore. Exportations have run as high as two or three or four million tons a year--all of this premium-quality ore. They are only now contemplating the possibility of exporting a blast furnace product, for which the market would be very much greater.

Brazil itself has a national steel plant, the Volta Redonda plant, which consumes a little ore. It is planning another plant near Sao Paulo. And there are other small users of iron ore throughout the nation. But certainly the domestic requirements are very much below the potential of the ore deposits. You may have heard that the Hanna Iron and Ore Corporation has recently made an effort to acquire some

reserves down there with the thought of exporting them. This is going to require probably a new railroad or possibly the retracking of the present railroad, and a new ore port.

Brazil is very definitely a potential exporter of iron ore on a much larger scale than it has been in the past.

There are also other iron ore deposits in the State of Mato Grosso which could conceivably be used for a steel industry in that section or even down in the Argentine.

QUESTION: You mentioned the fact that there are certain tariffs or quotas on the importation of raw materials. Would you tell us some more about that--for example, who is behind these tariffs, or how much they affect the price of steel in dollars and cents, and what can U.S. Steel, for example, or the steel industry do about it?

MR. CHASE: The principal tariffs on steel-making raw materials are on nickel and fluorspar. There has been a certain amount of propaganda to put a tariff or increase the tariff on zinc.

Actually, these tariffs do not increase the cost of a ton of steel very much. While the tariffs themselves are high on an ad valorem basis, the amounts used in a ton of steel are so small that it has very little effect.

What would be most damaging to the steel industry would be a tariff on the major raw materials, such as particularly iron ore, and to a lesser extent, manganese.

You asked what the steel industry can do about them. I don't know that it, as such, can do very much except to try to explain why the nation as a whole would benefit if these tariffs were reduced.

QUESTION: Mr. Chase, you advocated Government encouragement of the iron and steel industry--encouragement which would not take the form necessarily of subsidies or quotas and tariffs. The question then is, In what way can the Government really contribute? Through a tax advantage? Through a proper attitude on labor negotiations perhaps?

MR. CHASE: Well, specifically the ones I mentioned--the more adequate depletion allowances, the more adequate depreciation allowances; some realization that in foreign operations the profits shouldn't be taxed twice. They have some insurance now against possible expropriation by foreign governments, but that could be expanded somewhat. That is the type of assistance that would help very much.

QUESTION: So far most of the development of raw materials abroad has been carried out by the larger American steel companies, either working independently or in a small consortium. I wonder where this leaves some of the smaller American steel companies in the raw materials problem. Do the larger companies or these consortiums sell any of their excess iron ore to the smaller producers? Or ultimately might these smaller producers find themselves squeezed?

MR. CHASE: Well, that is true--that the major developments in raw materials production facilities in the foreign field have been made by the larger companies, partly because of the very large capital requirements. But more and more I think there is a tendency for a number of small companies to combine in a consortium.

Now, this is evidenced up in Labrador. Some of the projects up there have as many as four, five, six, or seven, or even eight companies combined.

And the smaller companies themselves seem to be directing their efforts toward becoming self-sufficient as regards iron ore supplies--whether it be in small properties which they acquire alone up in the Lake Superior district, or whether it be in some of the larger foreign sources of ore, in which they participate as one of a group. But I do not think that there need be a squeeze on the small producers.

COL. MORGAN: Mr. Chase, this has been a very comprehensive picture of this very complicated industry. We appreciate your coming here this morning. On behalf of the Commandant, I want to thank you for a very fine presentation. Thank you.

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