IRON AND STEEL MATERIALS RESOURCES

16 October 1958

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

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Dr. Grover J. Holt, Assistant to the President, Cleveland-Cliffs Iron Company, was born in Northwood, North Dakota, 30 July 1894. He received his B. S. in Mining Engineering from the University of North Dakota in 1916, a graduate degree in Mining Engineering from the University of Utah in 1917, the degree of Mining Engineer from the University of North Dakota in 1942, and an honorary degree of Doctor of Engineering from the Michigan College of Mining and Technology in 1956. He served as lieutenant in the Corps of Engineers during and until the end of World War I. He served in professional capacities with the Basin Metal Mining Corporation and the Bunker Hill and Sullivan Mining and Smelting Company until 1920. He then joined the United States Steel Corporation as a mining engineer, until 1923; the Manganiferous Iron Company as chief engineer and superintendent until 1930; and Butler Brothers as assistant to the vice president until 1942. He then joined Cleveland-Cliffs Iron Company and is now Assistant to the President. Dr. Holt is a member of the Board of Directors and past president of the American Mining, Metallurgical and Petroleum Engineers, and is a member of the Mining and Metallurgical Club of America, Kitchi Gammi Club of Duluth, Sigma Chi, Sigma Psi and various other orgainzations. This is Dr. Holt's first lecture at the Industrial College.

IRON AND STEEL MATERIALS RESOURCES

16 October 1958

COLONEL FLYNN: This morning we move to another area in our current unit of study, that of "Iron and Steel Materials Resources." A discussion of the raw material outlook for steel and iron is of particular interest to us, for certainly iron and steel are the very backbone of industry in every economy, both in peacetime and in wartime.

We can ill afford an interruption in the steady flow of iron ore, coal, and the essential alloys required for the production of high-strength and high-temperature steel, not only to meet the needs of our expanding economy but for our national security as well.

I believe that no one is as well equipped as our speaker to bring this story to us this morning. You have his biography, but, to be very brief, let me say that he was a lieutenant in the United States Army Corps of Engineers during World War I, and since then he has dedicated his long and full professional career to facing up to and solving the problem of developing and improving our resource position for iron and steel.

It is a pleasure to introduce to you Dr. Grover J. Holt, the Assistant to the President of one of the world's largest producers of iron ore, the Cleveland-Cliffs Iron Company. Dr. Holt.

DR. HOLT: General Mundy, Admiral Clark, Gentlemen: I consider it an honor, a pleasure, and a privilege to be with you here today to discuss very briefly and to give you a few facts concerning a vital segment of our natural resource program.

This paper is primarily intended to cover the natural resources used in the making of iron and steel. I feel it essential to give you a background, in a brief way, of our steel capacity and our steel production, which has a very direct bearing on our reserves, as well as production of these natural resources. The primary materials I am going to discuss are those of interest in the making of pig iron and eventually steel. They are: number one, iron ore; number two, coking coal; number three, limestone; number four, manganese; and number five, briefly, alloying elements.

While some of you may be familiar with the great strides made in the expansion of the steel industry over the last 20 years or more, I hope that you will bear with me while I give those less familiar a little of the background of this industry which is so vital to our national progress.

Chart 1, page 3. --This chart gives you a true picture of the steel tonnage output by years, from 1900 through 1957, represented by the lower line. The steel productive capacity is indicated by the more regular line above. I would like to call your attention to several salient points indicated by this chart, as follows:

1. The upper line, indicating steel productive capacity, follows a relatively steady trend, as you will note, with the exception of the years representing the depression of the thirties, when there was little increase in capacity for about four years.

2. Back in 1900 our productive capacity was about 22 million tons per year, and by the beginning of World War I it had approximately doubled this amount. By the start of World War II, it had reached 90 million tons, and today it stands at 140 million tons.

3. While the steel productive capacity climbed steadily, the actual output of steel, represented by the lower line, has been extremely erratic, with a series of peaks and valleys. This might be called the "ups and downs" of the steel industry. I think it demonstrates very well the conditions faced by a supplier of raw materials to that industry, since his output must be geared to that of steel and he must necessarily be equipped to meet the peaks of output to make his raw materials available to the steel producers at their beck and call.

4. Figures on this chart reveal an annual increase of 4 percent per year between the years 1945 and 1957. These increases in capacity for steel production reflect optimism on the part of our steelmakers in the future of our Nation. I would like to give you a few facts which may have been the basis for this optimism.

You may have heard President Eisenhower, in a recent television program, make the statement that the population of the United States is increasing each year equal to the population of the entire State of Kentucky. And the statistics prove that, between 1950 and 1955, our population showed an increase of 14 million, or about 1.8 percent per year. Now, these facts would hardly justify an increase of 4 percent per year in steel output.

CHART 1

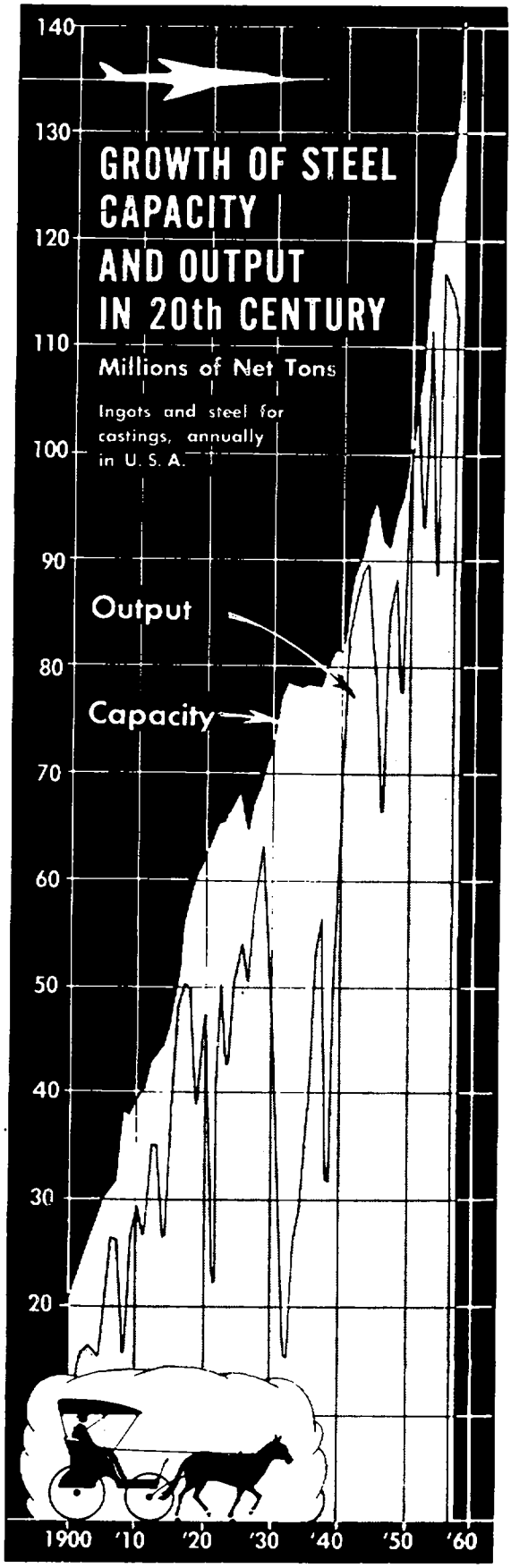
GROWTH OF STEEL CAPACITY AND OUTPUT IN 20th CENTURY
Millions of Net Tons
Ingots and steel for castings, annually in U. S. A.
Output
Capacity
140
130
120
110
100
90
80
70
60
50
40
30
20
1900
'10
'20
'30
'40
'50
'60

Chart 2, page 5.--You will note on this chart, however, that at the end of World War II, our annual per capita consumption of steel amounted to about 1,200 pounds per individual, and by the end of 1957 it had risen to approximately 1,600 pounds. This represents an increase of about 4.5 percent per year and, combining this with the 1.8 percent increase in population, I think you have the answer for the optimism of our steel industry.

Chart 3, page 6.--This increase in steel productive capacity has involved huge expenditures of capital over the years. You will note on this chart that in 1946 steel producers expended $496 million on expansion. If you will note, the trend has always been upward since that time, and finally reached a high of $1.75 billion in the year 1957. They are expecting to spend $1 billion this year, in spite of the recession.

Having given you a very brief view of steel plant expansion in the United States, it should be rather interesting to note what is happening in the world in general.

Chart 4, page 7.--As you will note on this chart, the upper portion indicates worldwide progress in steel production from 1925 to 1956. During this time you will note that the output of steel had risen from 100 million tons in 1925 to 310 million tons in 1956--about 300 percent. During the same period production of steel in Western Europe had risen from 48 million to 98 million tons, approximately 200 percent of the 1925 figure.

In reviewing the lower chart, it is evident that Western Europe is an extremely heavy exporter of steel. In 1956 exports accounted for 25 percent of their production, whereas during the same year the United States exported only 5 percent of its production.

Chart 5, page 8.--The only figures available on world production of steel for 1957 are shown in this chart. These figures refer to the first six months of the year and may be roughly multiplied by two for the total year. You will note that the United States during the first six months, produced 60.6 million tons of steel; Russia 27.6 million tons; and the European Coal and Steel Community, 32.4 million tons.

For the full year of 1957, the United States produced about 37 percent of all the steel made in the world; Russia, about 17 percent. We can still gain some consolation from the fact that the free world countries last year produced about 75 percent of the total steel in the world, and the USSR and her satellites about 25 percent.

CHART 2

Per Capita Comparisons

(Population of Continental U. S. as of Jan. 1)

Year (Jan. 1)	(Net Tons—Add 000)		Lbs. Per Capita		(Add 000)
	Capacity	Output	Capacity	Output	Population
1957	133,459	....	1,582	....	168,744p
1956	128,363	115,200p	1,548	1,390	165,879
1952	108,588	93,168	1,404	1,205	154,649
1947	91,241	84,894	1,285	1,194	141,982
1937	78,148	56,637	1,213	879	128,825

p Preliminary.

CHART 3

IRON AND STEEL COMPANIES' ANNUAL OUTLAYS

FOR NEW EQUIPMENT AND CONSTRUCTION

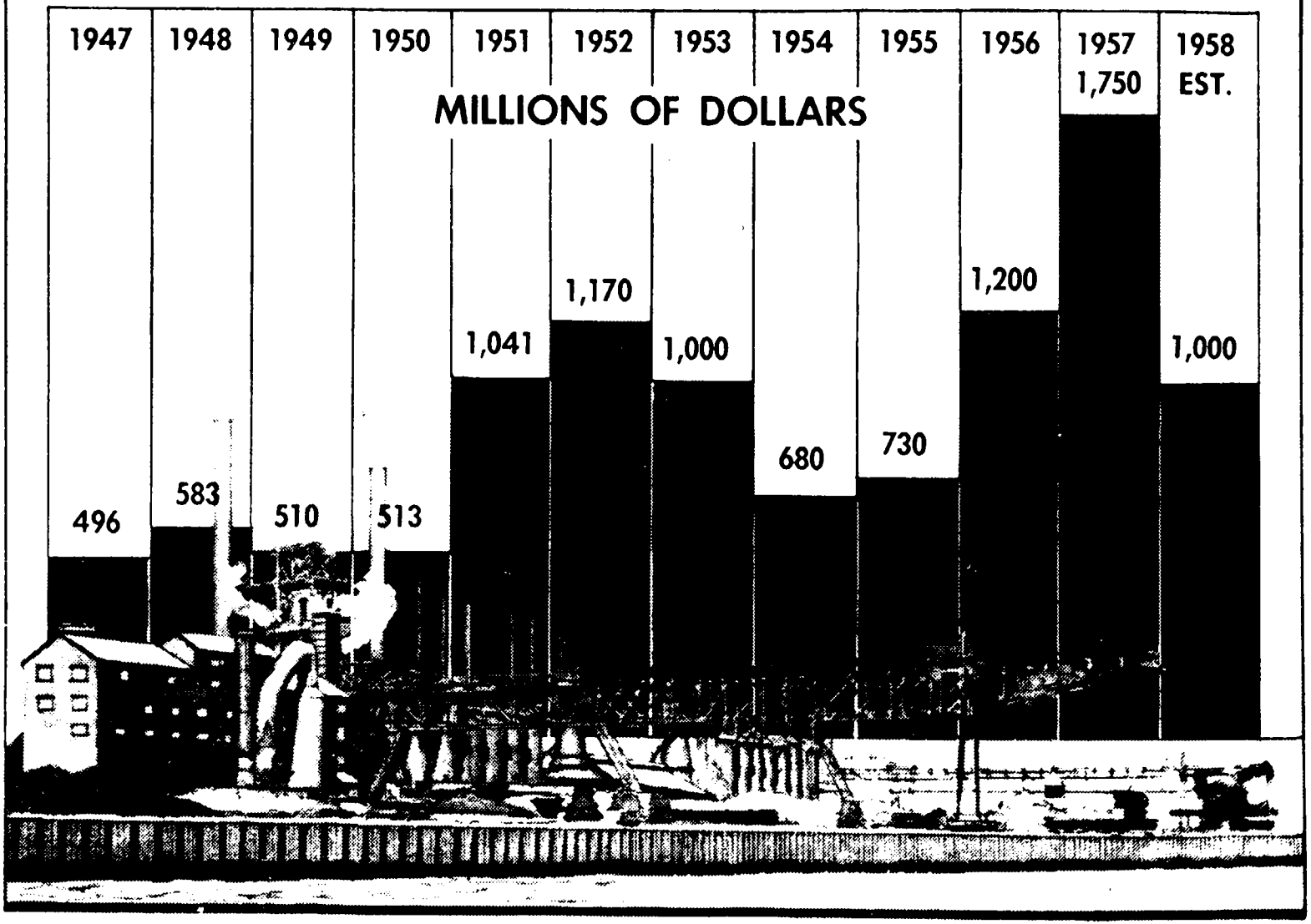

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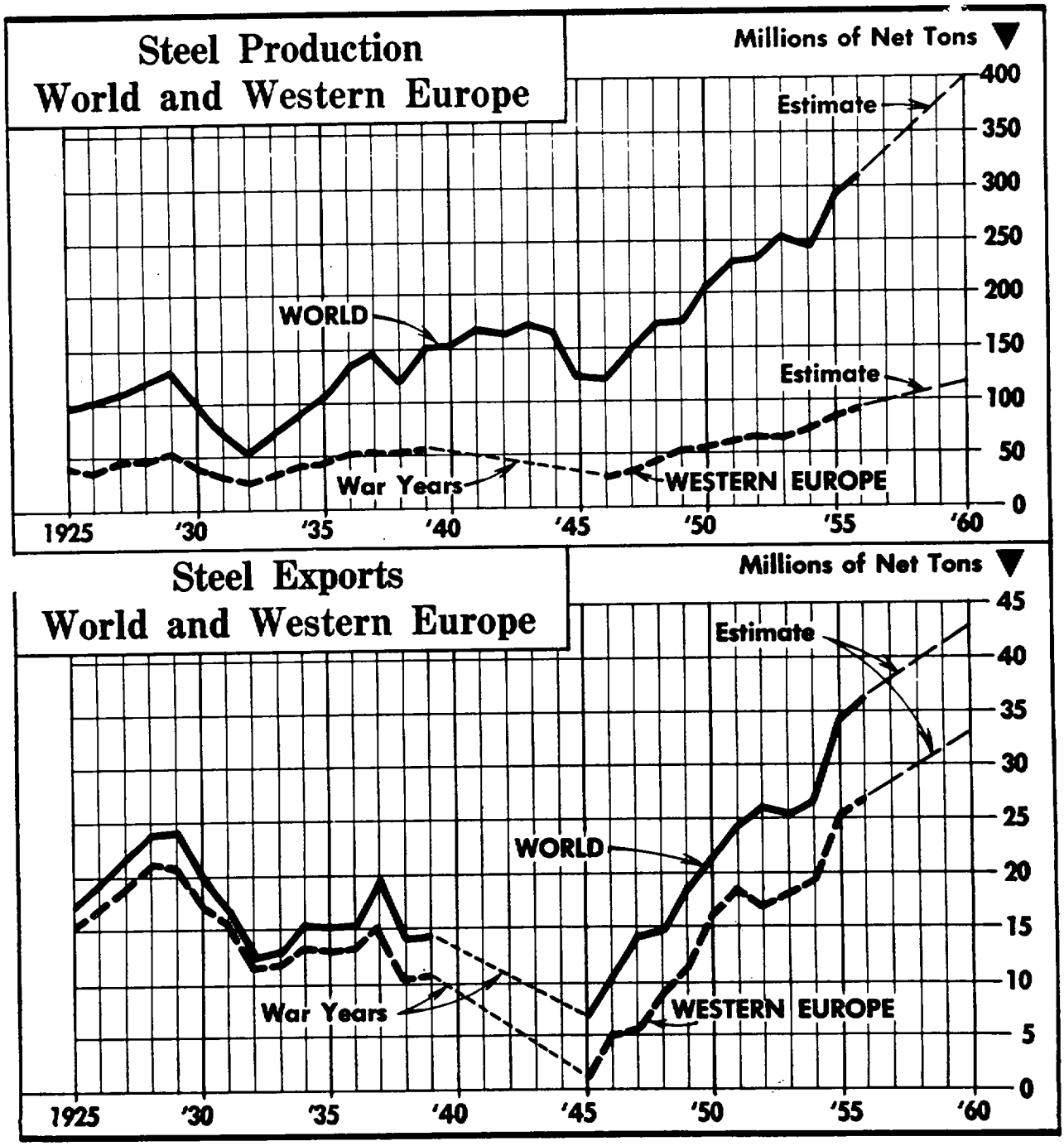
CHART 4



Note: Exports are shown in terms of crude steel equivalent.

CHART 5

	FIRST SIX MONTHS 1957	1956
United States	60.6	62.6
Russia	27.6	26.5
ECSC Nations		
West Germany	13.1	12.5
France	7.6	7.4
Belgium	3.6	3.5
Italy	3.7	3.1
Luxembourg	1.9	1.9
Saar	1.9	1.8
Netherlands	.6	.6

0270

Chart 6, page 10.--I feel, however, that a better yardstick to gage the availability of steel, which also reflects living standards, lies in the per capita consumption rather than in the total output as shown in the previous chart. This chart was compiled by the British Iron and Steel Federation for the year of 1956. However, there is an error in their chart. They show our per capita consumption as 1,232 pounds whereas it was actually 1,550 pounds. However, using their figures, you will note that our per capita consumption is reputed to be 1,232; 847 for West Germany; 788 for the United Kingdom; 561 for France and the Saar; 481 for Russia; 20 for India; and 18 for China. I am quite sure they are not throwing shells made in China around Quemoy.

It is interesting to note that the United Staters per capita consumption, according to these records, is 2.5 times that of Russia, and 70 times that of China.

Beneath the table on the screen is cited an interesting figure, which calls attention to the fact that 80 percent of Russia's steel is funneled into capital goods, representing heavy construction, machinery, et cetera, with only 20 percent allotted for consumer goods, such as automobiles, household accessories, and the like.

In the United States 55 percent of our total steel production finds its way into capital goods, with 45 percent finding its way into consumer goods.

Translating these figures in a different fashion, the average American can purchase each year 45 percent of this 1,232 pounds, or 554 pounds of steel for his own use, whereas the Russian may purchase only 20 percent of 481 pounds, or about 96 pounds for his use, a ratio of 5.7 to 1.

In the case of Western Europe, 66 percent of their steel is channeled into capital goods, and 34 percent into consumer goods.

Chart 7, page 11.--Steel, as well as any other commodity, is governed by the law of supply and demand and the allocations of steel to certain uses show up quite well on this chart.

You will note that the average Russian steelworker must spend all of his income from 225 hours of work to purchase a suit of clothes, whereas in the United States only 20 hours of work are required to make the same purchase.

	Pounds	World Rank in Steel-making
United States	1232	1
West Germany	847	3
United Kingdom	788	4
France and Saar	561	5
Russia	481	2
India	20	18
China	18	12
Western Europe	456	
Russia (including Eastern Europe)	453	
Latin America	73	

In commenting on those figures, the British publication states, "On a somewhat empirical basis it has been estimated that approximately 80 per cent of Russian steel consumption goes into capital goods, while the corresponding percentage in Western Europe is 66 per cent and in the United States 55 per cent. This, again, is indicative of a heavy concentration on investment, as opposed to the production of consumer goods."

CHART 7

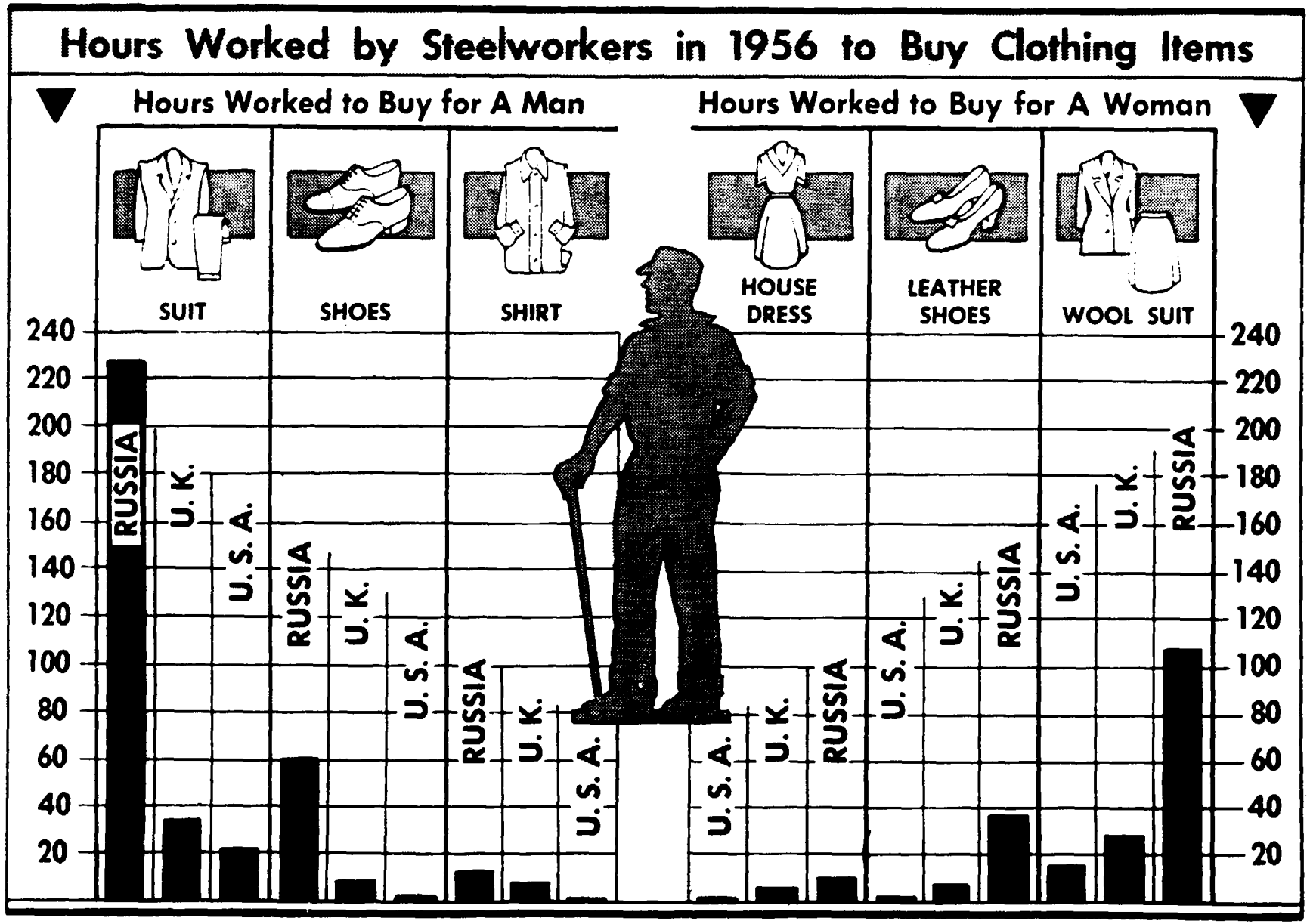

Hours Worked by Steelworkers in 1956 to Buy Clothing Items
Hours Worked to Buy for A Man
Hours Worked to Buy for A Woman
SUIT
SHOES
SHIRT
HOUSE DRESS
LEATHER SHOES
WOOL SUIT
240
220
200
180
160
140
120
100
80
60
40
20
RUSSIA
U. K.
U. S. A.

Chart 8, page 13.--Effective mechanization of farm equipment in the United States, which comes under the form of consumer goods, is reflected in staple commodity prices, which is well demonstrated by the fact that the Russian steelworker must spend his income from 7 hours of work to purchase the list of commodities shown, as compared to 1 hour of work for the average American steelworker.

Chart 9, page 14.--As to imports and exports, I gave brief mention of this previously. The United States is not a heavy importer or exporter of steel. In 1947 our exports of steel amounted to 6 million tons. In the interim between 1947 and 1956 they dropped to a low of 2.5 million tons, and increased again in 1956 to 4.2 million tons.

Very little steel was imported into this country in 1947, reaching a high of slightly over 2 million tons in 1951, and then dropping back to 1.5 million tons in 1956.

Chart 10, page 15.--Iron and steel scrap--though scrap is not considered a natural resource--definitely play an important part in the production of steel, accounting for the difference between the tonnages of pig iron and the tonnage of steel produced in the United States in any one year.

On this chart you will note that in 1946 we exported only about 150,000 tons of scrap; however, by 1956 this had increased to 5.9 million tons, about half of it going to Italy and Japan.

In case of national emergency, the United States could have converted this 5.9 million tons of scrap into steel, and, if we had discontinued exportations during such a year, this would have added another 4.2 million tons. In other words, we could have produced 10 million tons of additional steel through that source utilizing practically no natural resources yet representing about 10 percent of our steel output.

Having discussed briefly the production of steel in this country and abroad, I feel now that it would be well to consider briefly just one intermediate step between the raw materials for the making of steel and the final step, steel itself. This intermediate step represents the blast furnace which converts our raw materials into pig iron.

While the United States produced 113 million tons of steel in 1957, our blast furnaces produced only 79 million tons of pig iron.

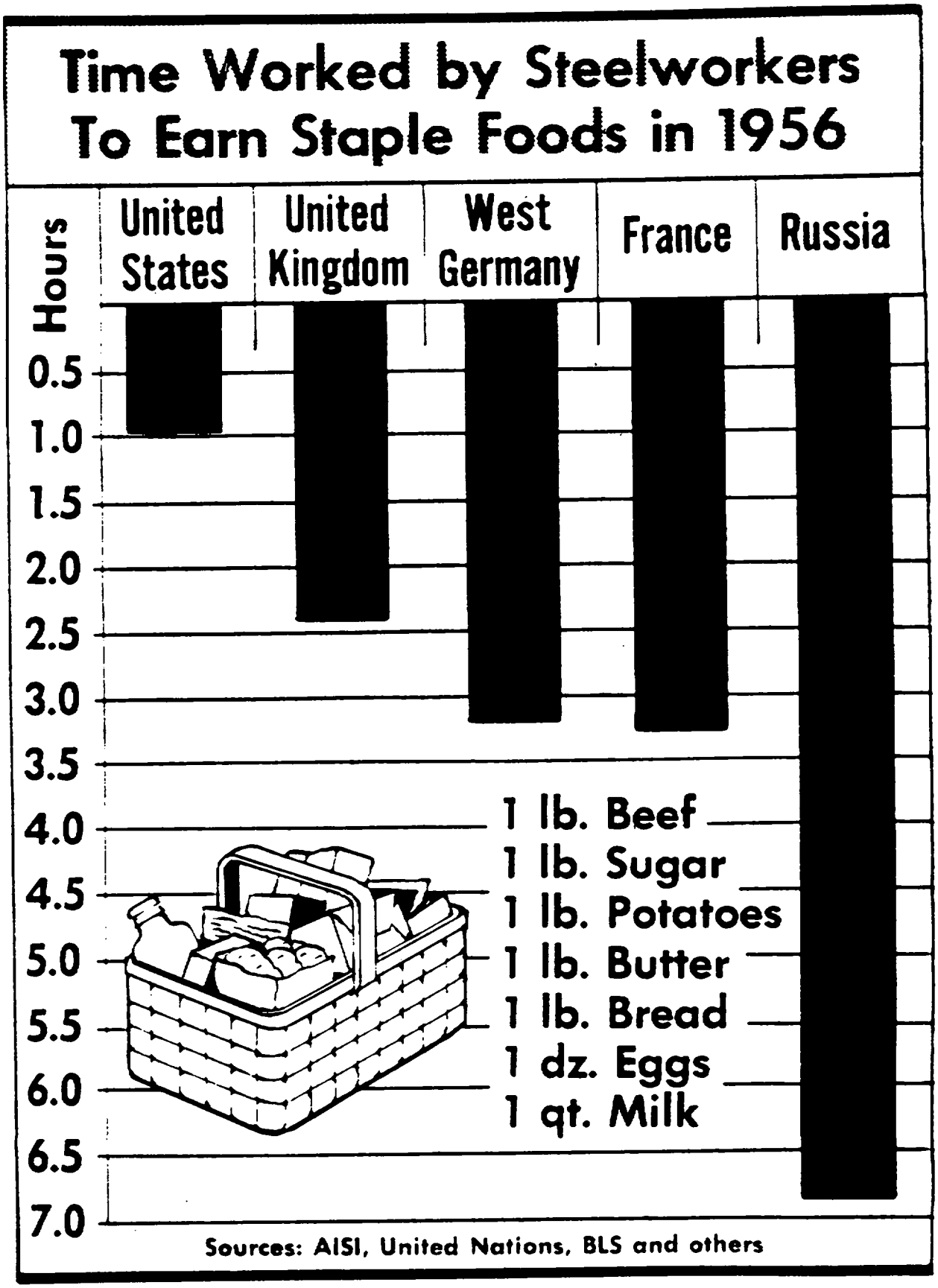

Time Worked by Steelworkers
To Earn Staple Foods in 1956
Hours
United States
United Kingdom
West Germany
France
Russia
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
1 lb. Beef
1 lb. Sugar
1 lb. Potatoes
1 lb. Butter
1 lb. Bread
1 dz. Eggs
1 qt. Milk
Sources: AISI, United Nations, BLS and others

CHART 9

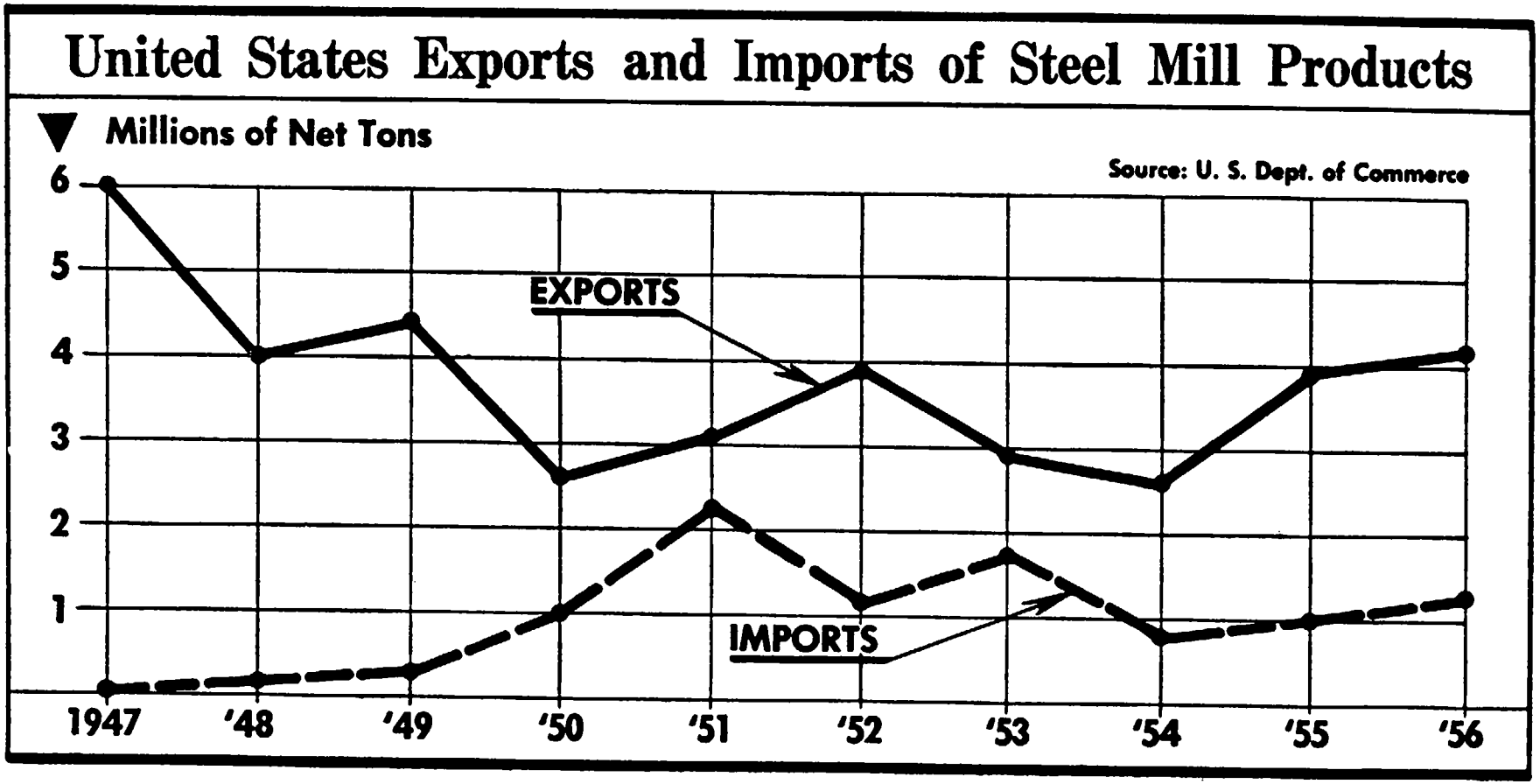

United States Exports and Imports of Steel Mill Products
Millions of Net Tons
Source: U. S. Dept. of Commerce
6
5
4
3
2
1
EXPORTS
IMPORTS
1947
'48
'49
'50
'51
'52
'53
'54
'55
'56

CHART 10

EXPORTS OF IRON AND STEEL SCRAP FROM THE UNITED STATES

BY COUNTRIES OF DESTINATION

(Net Tons)

Year	Italy	United Kingdom	Japan	West Germany	Canada	Mexico	France and Saar	Other Countries	Total
1956	1,254,070	553,511	2,010,792	238,776	688,520	325,157	337,902	447,979	5,866,707
1955	1,140,519	1,015,549	715,825	665,253	421,913	276,956	246,372	509,945	4,992,332
1954	222,138	181,342	318,874	219,267	45,184	225,762	46	393,247	1,605,860
1953	—	9,055	68,334	—	76,762	157,086	—	5,305	316,542
1952	1,300	9,634	4,362	—	195,439	136,271	148	5,556	352,710
1951	473	—	3,105	—	89,632	140,304	—	11,826	245,340
1950	115	—	1,605	—	81,000	124,537	—	9,707	216,964
1949	—	38	—	—	162,631	123,624	379	8,922	295,594
1948	506	—	—	—	168,072	37,759	—	35,687	242,024
1947	527	141	—	—	119,395	33,978	—	40,182	194,223
1946	—	—	—	—	82,176	48,192	—	18,738	149,106

Includes tin plate scrap but not tin plate seconds.

Source: U.S. Department of Commerce

0250

Chart 11, page 17.--While blast furnace practice has not changed radically over recent years, these furnaces have been made more efficient.

You will note on this chart that a blast furnace of today produces about 10 percent more pig iron from the raw material fed to the furnace than was the case in 1948.

Chart 12, page 18.--This chart analyzes the increase in efficiency in the blast furnace over the last 10 years, from 1948 through 1957. If you will proceed from the bottom of the chart to the top, you will note that the total production of raw materials required to produce a ton of pig iron indicates a decrease of about 10 percent, as previously mentioned.

The savings thereby are represented by about 6 percent in iron-bearing materials. In other words, they use 6 percent less of iron-bearing materials. There is a 12 percent reduction of coke and a 20 percent reduction of limestone.

The decrease in tonnage of iron-bearing materials results from higher iron feed to the furnace. Reduction of coke is almost directly proportional to reduction in total raw materials, involving less BTU's and reducing gas. The saving in limestone reflects a lower silica content in the iron materials fed to the furnace.

Now, having followed through on the pig iron and steel production, I would like to transfer this discussion to the raw materials used in the making of iron and steel.

The main raw material constituent in the production of iron and steel is iron ore. In spite of the increased demand for iron ore by the steel industry, the United States still has huge iron ore potentials.

Chart 13, page 19.--This chart provides the most recent estimates of iron ore reserves in the United States from statistics gathered by the U. S. Geological Survey in 1957.

The tonnages listed on this chart as reserves are those which have been proven by drilling and exploration, whereas those listed as potential are estimated, with little development work having been done on this type of material to date.

CHART 11

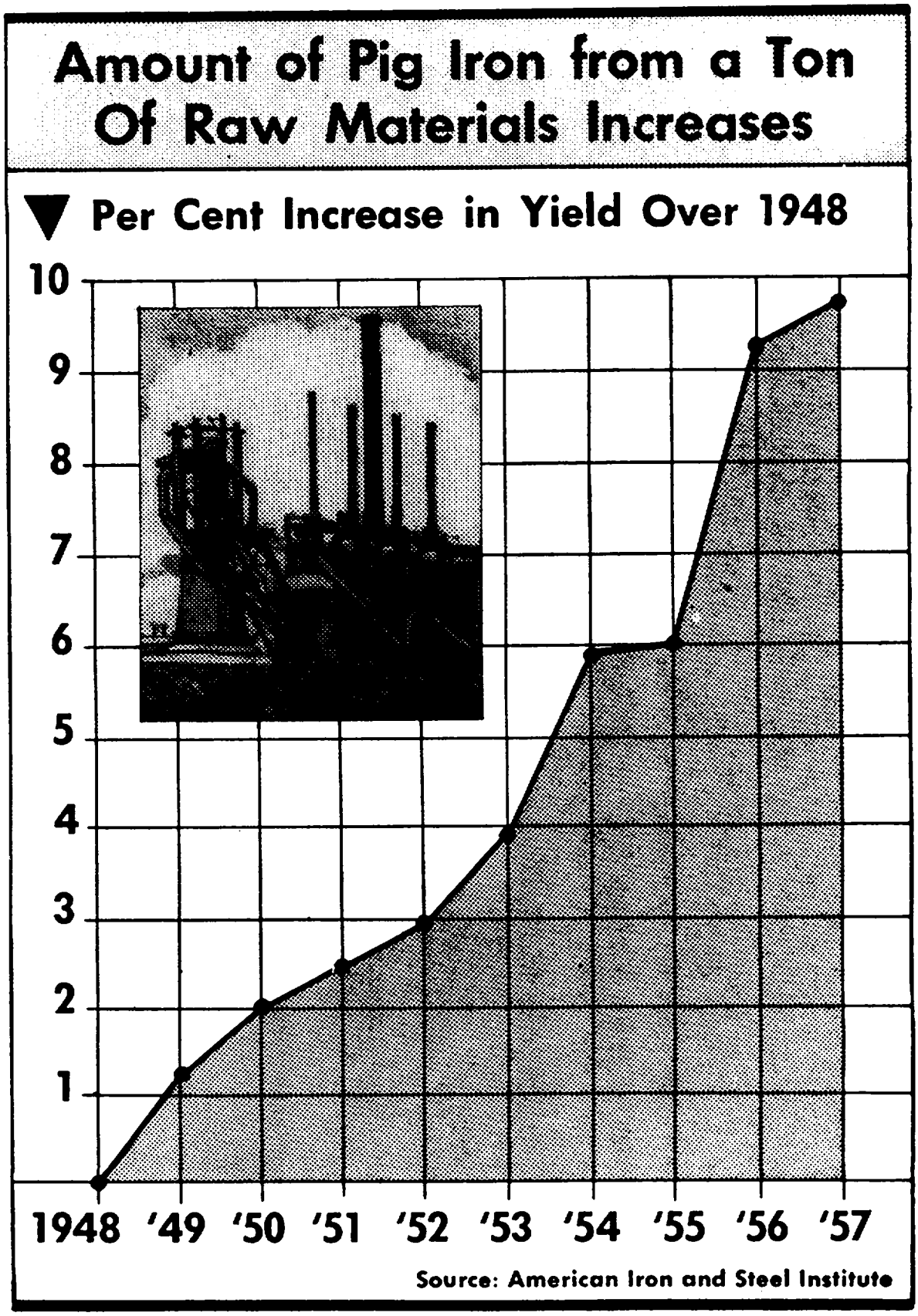

Amount of Pig Iron from a Ton Of Raw Materials Increases
Per Cent Increase in Yield Over 1948
10
9
8
7
6
5
4
3
2
1
1948
'49
'50
'51
'52
'53
'54
'55
'56
'57
Source: American Iron and Steel Institute

CHART 12

Net Tons Consumed per Ton of Pig Iron

Year	Total Iron-bearing Materials	Coke	Limestone	Total All Materials Consumed
1957	1.807	0.842	0.350	2.999
1956	1.802	0.850	0.362	3.014
1955	1.860	0.873	0.387	3.120
1954	1.859	0.873	0.395	3.127
1953	1.869	0.906	0.418	3.193
1952	1.875	0.922	0.426	3.223
1951	1.881	0.924	0.432	3.237
1950	1.903	0.922	0.429	3.254
1949	1.918	0.935	0.428	3.281
1948	1.928	0.954	0.440	3.322

CHART 13

GEOLOGICAL SURVEY
JULY 15, 1957

U.S. ORE RESERVES

	Fe	THOUSANDS OF LONG TONS RESERVE	POTENTIAL	TOTAL
N.E.REGION				
Maine, New Jersey, New York, Pennsylvania, Rhode Island and Ohio	43	160,000	1,230,000	1,390,000
	27	700,000	1,630,000	2,330,000
S.E.REGION				
Alabama, Georgia, Kentucky, Maryland, Mississippi, No.Carolina Tennessee, Virginia, WestVirginia	50	60,000	110,000	170,000
	37	550,000	610,000	1,160,000
	31	-	10,500,000	10,500,000
LAKE SUPERIOR REGION				
Michigan, Minnesota, Wisconsin	50	2,015,000*	-	2,015,000
	25-45	Large	35,000,000	35,000,000
	22	5,500,000	15,000,000	20,500,000
CENTRAL & GULF REGION				
Arkansas, Iowa, Missouri, South Dakota	50	-	3,000	3,000
	40	170,000	113,000	283,000
WESTERN REGION				
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington Wyoming	50	490,000	210,000	700,000
	40	-	290,000	290,000
GRAND TOTAL	50	2,565,000	323,000	2,888,000
GRAND TOTAL	22-45	7,080,000	64,373,000	71,453,000

Reserves have been divided by geographical location and divisions have been made, as you will note, between materials containing more than 50 percent metallic iron and those containing less than 50 percent metallic iron. The reason for this division, based on metallic iron content, lies in the fact that very few ores are considered acceptable for blast furnace use today unless they contain more than 50 percent metallic iron. This holds true with the exception of some ores, such as those from the State of Alabama, which are considered self-fluxing.

The figures of prime interest to us are the figures near the bottom of the chart, labeled "Grand Total."

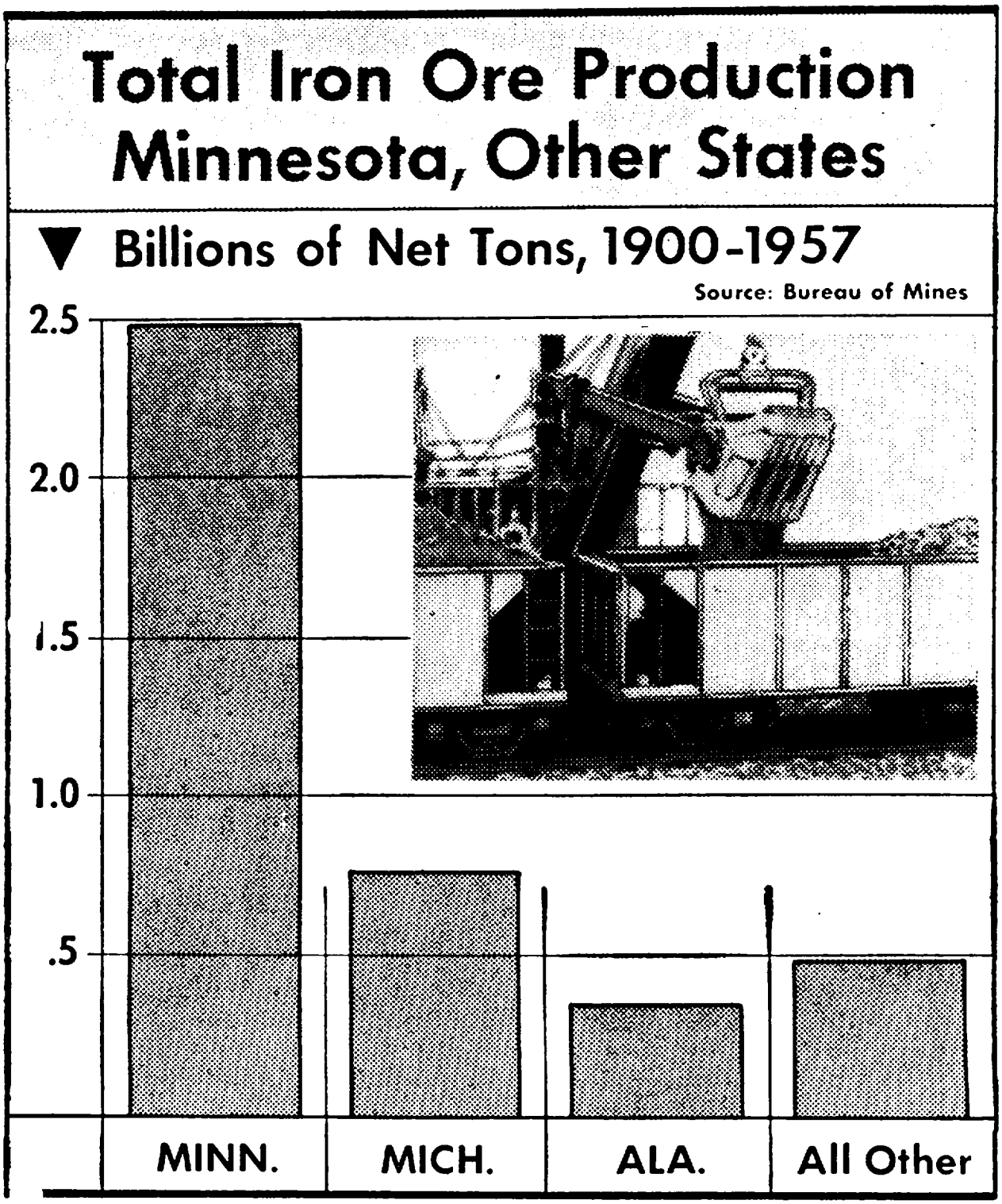
In glancing at these grand totals it is evident that our reserves and potential of ore in the United States containing 50 percent or more metallic iron amount to 2.9 billion tons. We have in the United States mined to date approximately 4 billion tons of iron ore in our entire history.

Ores, containing 22 to 45 percent iron amount to a grand total of 71 billion tons. This low-iron category contains the tonnage which will provide the Nation with the long-range production required from our iron ore deposits in the future, with production from taconite in Minnesota and jasper in Michigan now under way.

Chart 14, page 21.--After reviewing the present-day reserves of iron ore in the United States, I would like to present figures to show the effect of mining in the past to supply the steel industry with its rapidly increasing needs. The major portion of this supply has come from the Lake Superior district, consisting of the States of Minnesota, Michigan, and Wisconsin. On this chart you will note the tonnages or iron ore shipped from the principal ore-producing States, which places the State of Minnesota well in the foreground, with shipments in excess of 2.5 billion tons. Michigan has produced approximately 860 million tons. The reserves in the State of Wisconsin are relatively small, and have been included in the figures for Michigan shipments.

You will note that the State of Alabama has produced less than 500 million tons, and all other States combined have produced approximately 500 million tons.

CHART 14


Total Iron Ore Production
Minnesota, Other States
Billions of Net Tons, 1900-1957
Source: Bureau of Mines
2.5
2.0
1.5
1.0
.5
MINN.
MICH.
ALA.
All Other

For years the Lake Superior district has contributed approximately 80 percent of all of the iron ore required for steel production in the entire United States. During the recent 1950's, however, production has dropped to about 60 percent of total United States requirements, due to imported ore. This district, however, still contributes about 80 percent of the local United States production.

To convey to you in simple words a picture of these tremendous shipments and their effect on the resources of the Lake Superior district, take the year of 1957, when approximately 80 million tons of iron ore were shipped from that district alone. If you were to load that ore into a single train of standard ore cars, such as we use today, that train would reach a length of 6,600 miles. It would originate in Minnesota, extend 1,400 airline miles to Seattle and beyond, reaching its end in Tokyo, Japan.

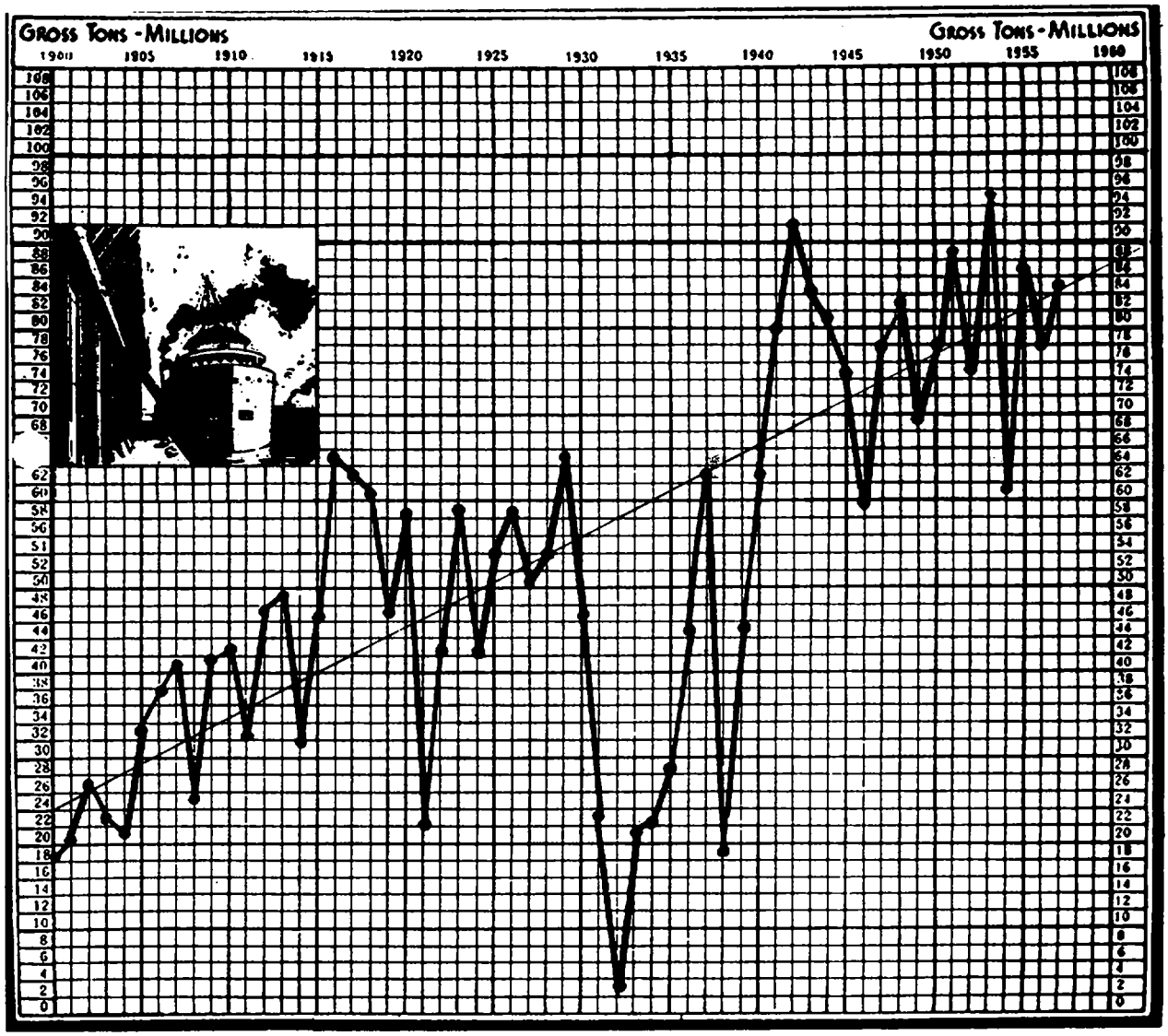
Over 3 billion tons of iron ore have been shipped from the Lake Superior district as a whole, and, if you were to load this ore into a similar train, that train would extend 9 times around the earth at the equator. To put it another way, if all of the ore produced in the Lake Superior district were placed in one single cone, that cone would have a base of 3.6 million square feet and a height of 14,945 feet, which is about equivalent in size to Mount Whitney in California.

Chart 15, page 23.--Increased demands from 1900 to 1957 are noted on this chart and are represented by the inclined line representing the trend in shipments from the Lake Superior district, and the jagged line, with peaks and valleys, represents the tremendous swings in annual output--again the ups and downs of the raw material industry. This same type of curve would, no doubt, be applicable to the production of limestone and coke, since these vary in the same fashion, depending upon steel output.

On this chart you will note that shipments in 1957 were about 500 percent of those in 1900.

The highest peaks on the chart reflect the demand for iron ore during the period of World War I, World War II, and the Korean conflict, and an alltime peak production was reached in 1953. Postwar slumps, as well as those caused by the depression of the thirties and the business recessions are plainly evident.

CHART 15



Yearly Shipments of Lake Superior Iron Ore
By Lake Vessels -- From 1900 to Date

Prior to 1910 practically all shipments were made directly from the mine to the blast furnace without beneficiation of any kind. However, beneficiation of iron ores, involving lower grade materials, has made rapid strides, and by 1934 constituted 23 percent of our total production, and last year made up a total of 40 percent.

Within the last five years, beneficiation potential has reached its alltime peak in the Lake Superior district in the production of taconite and jasper concentrates, which are pelletized to form a very superior iron ore product.

Total reserves of finished high-grade products are only roughly estimated at the present time, and run between 20 and 30 billion tons, enough to provide us with an iron ore supply to produce many times over the total amount of steel produced in the history of the United States since its inception.

In view of the tremendous inroads into the iron ore reserves of the Lake Superior district, however, there appears to be only one answer to the matter of maintaining our national self-sufficiency in this important supply of raw material. This answer lies in the increased output of taconites and jaspers. The only other road to be taken is that of importation of foreign ores, which will not provide us with that self-sufficiency we have enjoyed over the last century.

Production of this taconite and jasper material will be subject to huge investments in plant and equipment, as I pointed out to you. It has been estimated that one company now producing taconite pellets, with a capacity of 7.5 million tons per year, has expended $175 to $200 million. Another, reaching a capacity of 10 million tons per year, is reputed to have spent in the neighborhood of $300 million.

In viewing the time element to obtain production from taconites and jasper plants, these large plants could not be put into operation overnight, and, were we to be engaged in a shooting war tomorrow, we could not expect production from this source of any consequence until about 1963 or 1964. By that time the war no doubt would be over, win, lose, or draw.

The products of these plants contain from 60 to 64 percent metallic iron, as compared with about 51 percent in standard ores. This increase in iron content would yield approximately 20 percent more iron in a blast

furnace; consequently, it is conceivable that four of our present-day blast furnaces may be doing the work of five today on our standard ores.

Production of these pellets, rather than of the conventional Lake Superior ores we know today, would require more manpower, more equipment, more fuel, and more power, with the result that production costs would be greatly increased.

Chart 16, page 26.--Many estimates have been made as to the amount of iron ore required by our steel industry for the future, and on the screen now is one which appears to be quite realistic.

You will note several outstanding items on this chart; (a) gradual reduction in tonnage of present day types of merchantable ores to be shipped from the Lake Superior district; (b) the moderate increase in taconite and jasper pellet production, represented by block 4; (c) the rather uniform production from the northeastern, southern, and western districts of the United States, block 5; (d) a tremendous increase in the importation of Canadian ores, block 6; (e) the relatively moderate increase of imported ores, other than Canadian, represented by block 7.

To those familiar with the discovery of new deposits of iron ore throughout the world, however, it is evident that the dividing line between blocks 6 and 7 could easily be shifted to a very great degree, resulting in less Canadian imports and more imports from other sources, or vice versa. However, there is a matter to be considered in connection with national emergency which applies to block 7 ores, imported from points other than Canada.

During World War II a relatively small amount of ore was imported into the United States. Available records cover one fleet of 10 ore carriers in this service, having a combined capacity of 177, 360 dead weight long tons. In a period from 23 January 1942, to 15 July 1942, five of these ships were sent to the bottom, four by submarine action and one by a mine, eliminating 102, 000 dead weight long tons from the availability of this fleet. As a result of these sinkings, importation of iron ores from South America was sharply curtailed in 1942, discontinued entirely in 1943 and 1944, and begun again on a curtailed program only in 1945, with a constant increase since. These statistics are on file in the Public Information Office of the Maritime Administration.

CHART 16

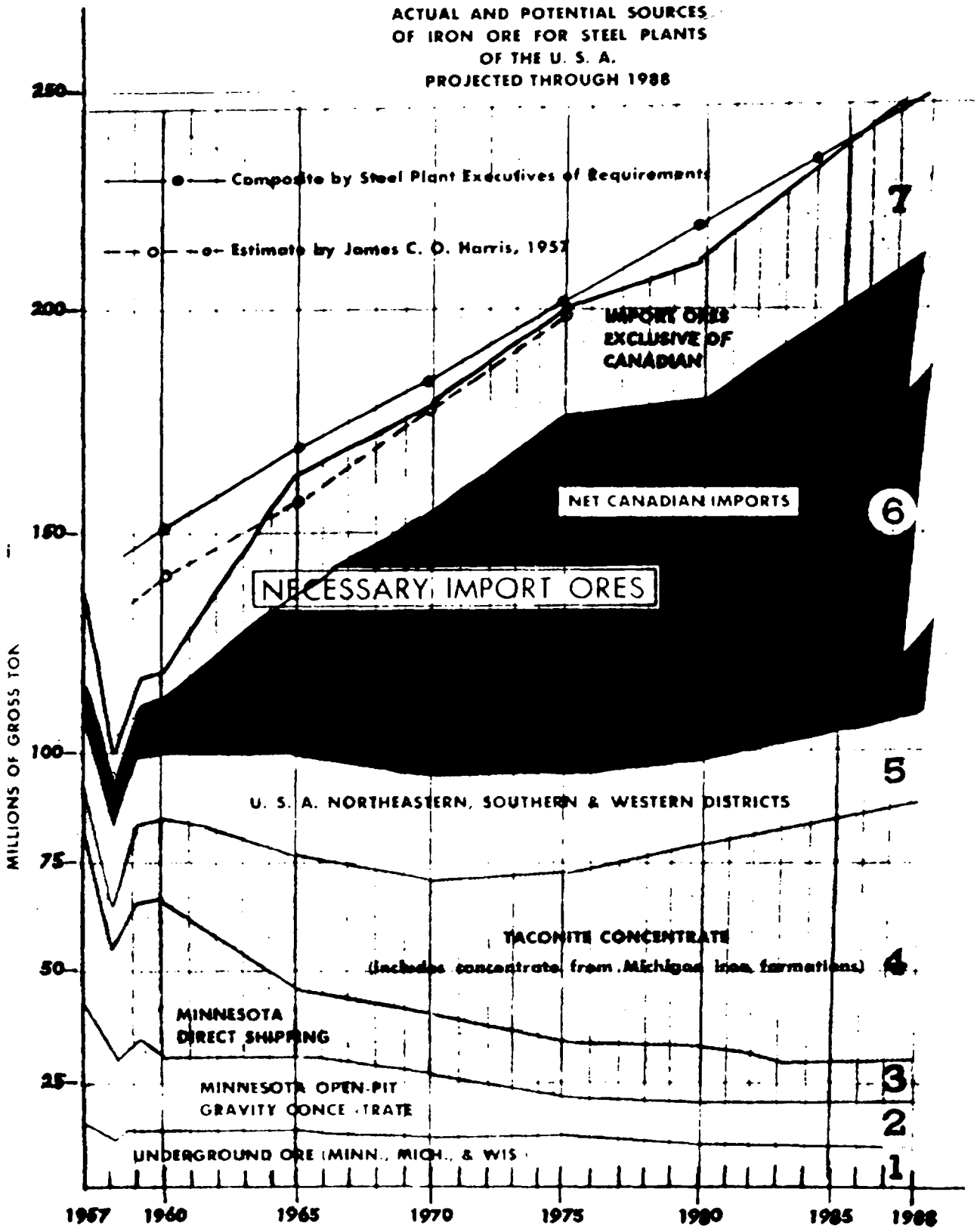

ACTUAL AND POTENTIAL SOURCES
OF IRON ORE FOR STEEL PLANTS
OF THE U. S. A.
PROJECTED THROUGH 1988
Composite by Steel Plant Executives of Requirements
Estimate by James C. O. Harris, 1957
IMPORT ORES
EXCLUSIVE OF
CANADIAN
NET CANADIAN IMPORTS
NECESSARY IMPORT ORES
U. S. A. NORTHEASTERN, SOUTHERN & WESTERN DISTRICTS
TACONITE CONCENTRATE
(includes concentrate from Michigan iron formations)
MINNESOTA
DIRECT SHIPPING
MINNESOTA OPEN-PIT
GRAVITY CONCENTRATE
UNDERGROUND ORE (MINN., MICH., & WIS.)
MILLIONS OF GROSS TON
250
200
150
100
75
50
25
1957
1960
1965
1970
1975
1980
1985
1988
7
6
5
4
3
2
1

Chart 17, page 28.--In the case of importation of iron ores, the map on the screen shows you that portion of the world from which iron ore imports were obtained in the year 1956. Any nation indicated by a solid black dot is one from which we imported 1 million tons or more of iron ore during that year, while those having a black dot with a white center represent the importation of less than 1 million tons. By merely viewing the map, I think you will agree that I need say no more concerning the vulnerability of sea lanes in case of a national emergency which would apply to all of these countries with the exception of Canada.

Chart 18, page 29.--This chart gives a breakdown of the tonnage of iron ore imports from major sources including the years 1950 through 1956. In the first column you will note that the total tonnage of imports indicates that 9 million tons were imported in 1950, and by 1956 this had increased to 34 million tons, representing an increase of about 300 percent. Foreign development by producers indicate huge further importations of iron ore.

Sources of imported iron ore are indicated on the chart, and these imports in 1956 represented about 33 percent of the total ore consumed in this country. This is naturally of great concern to our iron ore producers for several reasons:

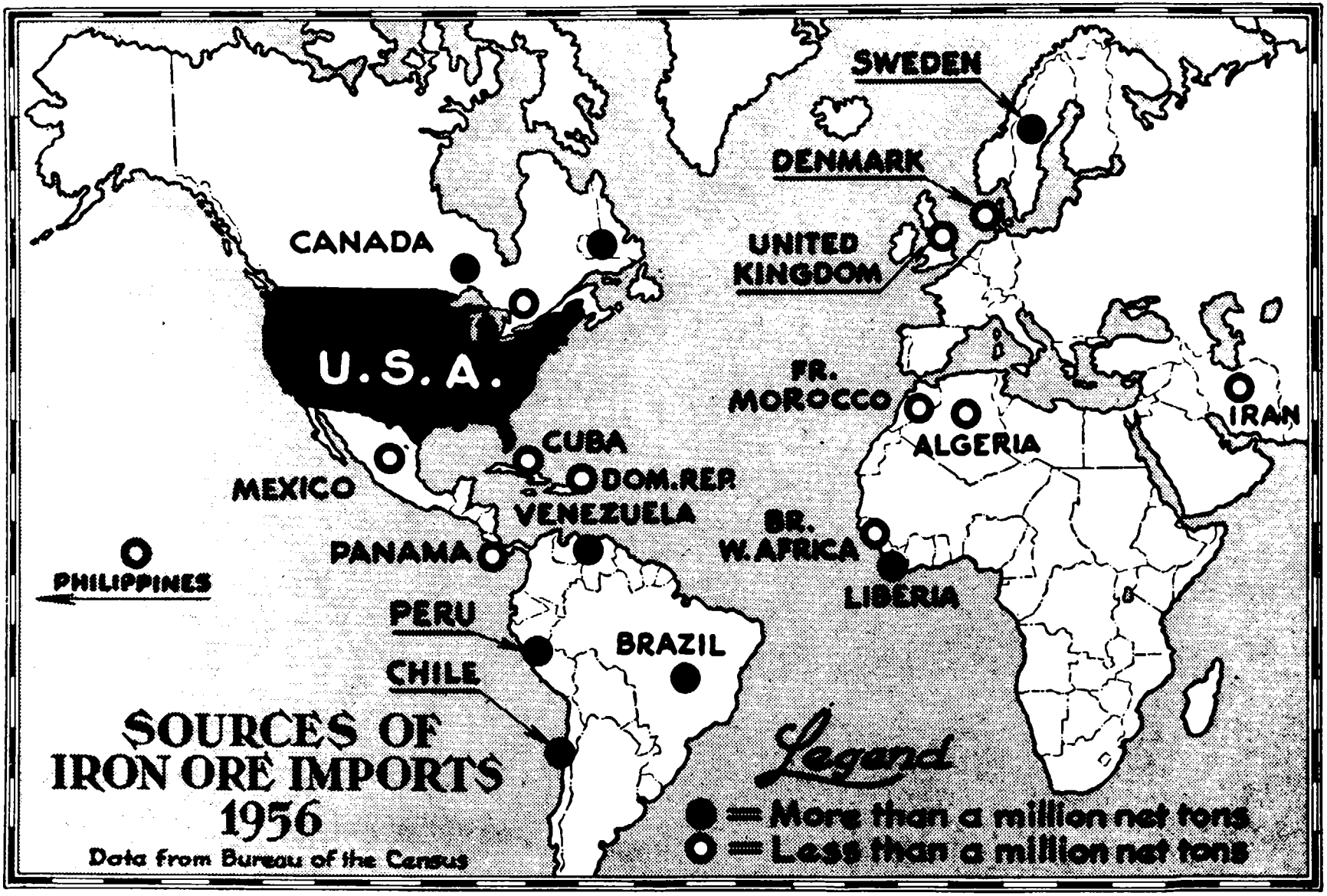
1. There are those who would advocate conservation of our present standard ores for use in a future emergency. This would definitely make ghost towns out of some of the cities in our iron ore ranges, and, also, many of the mines, once closed, could never be reopened, especially the underground mines. We would lose all of the development work, and the mine would be in such condition that it is doubtful that we could rehabilitate these mines.

2. Any conservation of this type would mean still greater expansion of our iron ore imports.

3. Our only other alternative would seem to be to substitute taconite and jasper pellets for imports, which would mean tremendous expenditures for concentrating plants and pelletizing plants, representing about $30 per ton of annual production.

4. The only means of attracting capital into these taconite and jasper plants would probably be a premium for the product. These products could be converted into pig iron at a substantial saving in cost, which could well justify a premium on the part of the consumer.

CHART 17



Note: Foreign ore sources include sources of small amounts such as Denmark, Panama and United Kingdom.

CHART 18

IMPORTS OF IRON ORE FROM SOME MAJOR SOURCES
(Millions of Net Tons)

	Total All Countries	Canada	Venezuela	Liberia	Peru	Sweden	Chile	Brazil
1956p	34.0R	15.4R	10.4R	1.4R	2.0	1.1	1.7	1.4R
1955	26.3	11.3	8.0	1.0	1.7	1.4	1.2	1.1
1954	17.7	4.0	5.8	.9	2.2	1.7	1.9	.7
1953	12.4	2.1	2.2	.8	.9	2.3	2.6	.5
1952	10.9	2.0	2.1	.6	—	2.4	2.1	1.1
1951	11.4	2.2	.7	.1	—	2.8	3.1	1.2
1950	9.2	2.1	—	—	—	2.3	2.9	.8

p = preliminary R = Record Source: U. S. Dept. of Commerce

5. The time element involved, as I stated before, in constructing one of these large plants is about four to five years from preliminary planning to final production. It is evident that, if production of taconite and jasper pellets is to be made available in case of national emergency, systematic planning must be done now to keep pace with expansion of the steel industry, at least to a point where the United States could survive on ores from the United States and Canada alone.

This, in effect, means that tonnages in blocks 4 and 7 of chart 16 should be combined and made to represent finished products of taconite and jasper.

In conclusion, insofar as iron ore is concerned, the iron ore producer does not view with alarm the fact that we are going to find it necessary to import iron ore to a certain degree, but is mainly interested in continuing on with his business in a market which is bound to be highly competitive. Higher production costs must be offset with a premium in order to allow competition with the lower production costs of the foreign deposits.

We still have ample iron ore resources in the Lake Superior district, and in the United States, for future generations, but at a price.

Now to go to one of the other principal raw materials which go into the making of steel, I'd like to give you a few figures on limestone. Limestone is used in the blast furnace for the elimination of silica and alumina inherent in iron ores.

In 1957 each ton of pig iron produced required the use of 800 pounds or more of limestone, which meant a production of 31 million tons of flux stone last year. As in the case of iron ore, a blast furnace operator naturally desires the highest grade of limestone to use as a flux, since the function is to eliminate silica from the ore and not from the limestone. Limestone is used to a small degree in the open hearth, amounting to about 150 to 300 pounds of flux per ton of steel produced. In this case limestone not only eliminates the small remaining quantity of silica but also assists in the removal of phosphorus.

Dolomite and dolomitic limestones, which contain not only calcium but also magnesium carbonate, are used to a large degree in the refractories used in the steel plants, and about 2 percent of the stone consumed in the United States goes into that process.

The processing of flux stone consists simply of crushing and screening for the elimination of fines, with the fines either being used for burned lime or being sent to the waste dump.

Limestone is of very common occurence throughout the United States and at present flux stone for the eastern and midwestern furnaces is produced in the various States in order of magnitude of production as follows:

1. Michigan
2. Pennsylvania
3. Ohio
4. West Virginia
5. Alabama
6. Illinois
7. Virginia

Lesser tonnages are produced in three Western States--California, Colorado, and Texas, reflecting lower steel production.

Ideal limestone for use as a flux represents only a very small percentage of the total limestone potential of the United States. However, as the highest grade deposits are exhausted, beneficiation processes will no doubt be developed to make a high-grade product from the low-grade reserves.

Most of the large steel companies have captive sources of limestone; consequently information is not readily available concerning the reserves of high-grade flux stone. It is believed, however, that, with beneficiation, our reserves are ample for the foreseeable future.

Now let us proceed to coal. As you may know, coal is of extreme importance in blast furnace production, and this type of coal should have three characteristics:

1. Low volatile content.
2. Low ash content.
3. Characteristics which will produce a high-strength coke.

In the early days of steelmaking, supplies were extracted from certain areas for direct use in coke ovens. In later years, however, the trend has been more and more to the blending of coals, utilizing a mixture of low-volatile and medium-volatile coals to provide the blast furnace with a desirable coke.

Chart 19, page 33.--You will note that bituminous coal, as such, appears to be in abundant supply as of this report, dated 1953, with total reserves estimated at 1.05 trillion short tons. Assuming that only 50 percent of this coal is recoverable, our reserve would have been 525 billion short tons.

Of this huge reserve, only 4 percent, or about 20 billion tons, appears to be the most desirable low-volatile coal for blast furnace coke. Generally speaking, about 15 to 30 percent of low-volatile bituminous coal is mixed with medium-volatile coal to provide a coke which may be strengthened by adding small amounts of noncoking ingredients, such as anthracite fines, petroleum coke, or low-temperature char.

It would appear that, by blending this 20 billion tons of low-volatile coal on a 3-to-1 ratio, the reserve would stand at about 80 billion tons, rather than the 20 which would be suitable for the production of coke. Coke recovery, however, would amount to only 65 percent of the total coal fed to the coking oven, and would result in 52 billion tons of final coke suitable for blast furnace use.

In 1956 and 1957, the metallurgical consumption of coke amounted to 70 million tons per year, which, if you were to take these figures at their face value, would mean a possible life of 700 years--if, however, all low-volatile coal were conserved for steel usage. The question now remains as to what portion of our annual production of low-volatile coal finds its way into the consumption for industries other than steel.

In 1957 we mined approximately 490 million tons of bituminous coal, with exports standing at 76 million tons. There are no records available as to the distribution of low, medium, or high volatile coals in local consumption or as exports to determine the effect on that 700-year life. Let us now take a look at the world reserves of coal.

Chart 20, page 34.--This chart relates to recoverable reserves of coal from selected countries in Europe, based on data obtained in 1950 and 1952, and should give you an indication of the distribution of bituminous and anthracite, as well as lignites, from these principal European countries.

CHART 19

Remaining coal reserves of the United States, January 1, 1953

Rank	Estimated total reserves remaining in the ground, January 1, 1953 (In millions of short tons)	Estimated recoverable reserves, January 1, 1953, assuming 50 percent recovery	
		(In millions of short tons)	(In quadrillions of Btu)
Bituminous coal	1,049,457	524,729	13,643
Subbituminous coal	372,934	186,467	3,543
Lignite	463,356	231,678	3,105
Anthracite and semianthracite	13,992	6,996	178
Total	1,899,739	949,870	20,469

CHART 20

STATISTICAL ANNEX

TABLE 1. - Recoverable coal reserves of selected countries, Europe

(Billion metric tons)

Country	Bituminous and anthracite	Other coals (lignites and higher grade lignites)
Federal Republic of Germany	67.2	63.0
East Germany 1/	0.2	28.6
Saar	2.8	-
France	5.7	.3
Belgium	2.8	-
Netherlands	5.0	.0
Italy	.5	.8
United Kingdom	48.7	-
Turkey	1.0	.3
Norway (Spitsbergen)	2.5	-
Portugal	.0	-
Sweden	.1	-
Austria	.0	.2
Denmark	-	.0
Greece	-	.0
Spain	6.3	1.5
Hungary	.0	1.6
Yugoslavia	.1	12.0
Rumania	1.7	1.1
Bulgaria	.1	1.4
Poland 2/	71.0	1.0
Czechoslovakia	.1	12.0
U.S.S.R. 3/	425.6	-
Total	641.4	123.8
Total western countries	142.6	66.1
Total eastern countries	498.8	57.7

1/ Reported total reserves.
2/ Includes Czechoslovakia portion of Ostrava and Upper Silesian Basin coals.
3/ Includes other coals.

NOTE: Data relate to 1950-52.

If you will bear in mind that, as of 1953, the United States had a recoverable reserve of bituminous coal of about 525 billion short tons, and, combining this with 7 billion tons of anthracite, our total reserve, for comparison purposes, would amount to 532 billion tons, to compare with the Soviet reserves of bituminous and anthracite, 425 billion metric tons. Poland is estimated to have reserves of bituminous and anthracite amounting to 71 billion tons, Germany, 67 billion tons, and the United Kingdom, 49 billion tons.

Note at the bottom of this chart the reserves of the western countries of Europe amount to 140 billion tons, and the eastern countries, 500 billion tons, largely in Russia.

Production of bituminous and anthracite coal for the free European countries in 1955 amounted to 488 million tons, with the Soviet bloc producing 401 million tons.

It is clearly evident that the Soviet bloc controls about 78 percent of the total bituminous and anthracite deposits in Europe, but produces only 45 percent of the total production, compared to free Europe with 22 percent of the reserves and a production of 55 percent of the total.

Summarizing the fuel requirements for use in steel products, it appears that neither the United States nor Soviet Russia will be in dire straits for some generations to come, assuming that research develops processes which allow the use of more high-volatile coal for the production of coke and a possible conservation of low-volatile coal.

One of the very essential elements in steelmaking, is manganese. It is on the critical list, since every ton of steel produced in the United States requires the use of about 13 pounds of metallic manganese. So far as the United States is concerned, we are definitely a "have not" nation, due to the lack of discovery of large deposits of manganese ore within our continental limits.

Over 90 percent of our total actual requirement of manganese is imported into this country, and consumption of manganese ore in 1955 for all purposes amounted to 2.2 million tons, and in 1956 2.1 million tons.

Chart 21, page 36.--Our sources of manganese for the years 1947 and 1956 are shown on this chart. In 1947 our principal sources were: Asia, 30 percent; Africa, 27 percent; Latin America, 21 percent; and Russia 22 percent.

CHART 21

Sources	Per Cent of Total Maganese Imports	
	1956	1947
Asia	31.1	29.9
Africa	38.6	26.8
Latin America	29.9	21.3
Russia	—	22.0
All Other	0.4	*
Total	100.0	100.0

If you will now refer to the left hand column, indicating sources in 1956, 10 years later, you will note a change in the lineup. Russia has disappeared, since it has refused to supply us with manganese ore since 1951. Consequently, imports from the other three foreign countries have been greatly increased, to a point where Asia now contributes 31 percent, Africa, 39 percent, and Latin America, 30 percent.

A new deposit has been developed in Amapa, Brazil. It was brought into production in 1957. It is not shown here, but is expected to produce shipments of 600,000 tons or more per year.

Another comparatively recent discovery of importance is located in French Equatorial Africa. This deposit is still undeveloped, but is reported to have a reserve of 100 million tons, with a manganese content of 40 to 50 percent.

Total world reserves of manganese were estimated in 1953 at 900 million tons of high-grade ore and approximately 200 million tons of intermediate-grade ore. The intermediate-grade ore would have to be concentrated to meet steel industry specifications. Of this 900 million tons of high-grade manganese ore, the USSR claims over one-half, or 550 million tons.

Since the United States is definitely one of the "have not" countries insofar as manganese is concerned, in case of national emergency, unless sufficient stockpiles are built up, it would be necessary for the steel companies to rework huge dumps of open-hearth slag, having a very low manganese content, as they did during World War II. The recovery of manganese from that source is possible, but it is definitely uneconomical in normal times, and there is the danger of some feedback of sulphur into the steel, which was originally removed by the manganese.

With the terrific expansion of our steel industry in future years, even technology will not prove to be the answer to obtaining our supply of manganese from local sources, since we do not have adequate reserves of low-grade ores. The same may be said of Canada. We don't know of a commercial deposit there. Practically all of our foreign sources are vulnerable in a national emergency, due to transportation over open sea-lanes.

Proceeding to the raw materials used in lesser tonnages but of equal importance, chromium is an important alloying element used in the

hardening of steels. This, insofar as the United States is concerned, presents another very pathetic picture. Metallurgical ore is imported principally from Turkey, Southern Rhodesia and New Caledonia.

In 1953 our domestic production of chrome ore amounted to 58,000 tons, and our imports amounted to 2.25 million tons. Our consumption in 1953 amounted to 1.335 million tons, the balance being placed in stockpile.

In 1953 reserves of the United States amounted to 60,000 tons of contained chromic oxide occurring in Alaska, California, and Oregon, which would scarcely make a dent in one year's consumption in this country.

Montana is estimated to have low-grade reserves of 3 million tons, however these are not generally considered desirable in current practice.

Cuba may have large deposits, known as "laterites," however, the process of concentration has not as yet been worked out.

Over one-half of all the chrome ore imported is used for alloying purposes, about one-third for refractories, and the balance consumed in the manufacture of chemicals.

All of our importations are across wide-open sealanes which are strictly vulnerable in case of national emergency.

Nickel is one of the other important alloying elements in steel, as well as in some of the other nonferrous metals, for various uses.

In the case of the steel industry, the principal use of nickel is in the production of stainless steels. Nickel is used to a considerable extent in the production of armor plate, which is reflected by the increased use of nickel during world-war periods.

The principal reserves of nickel in the United States lie in Alaska, which is reputed to have a total of 80 million tons of ore. By far the principal world reserves of nickel lie in Canada, and the Sudbury District of Ontario has for years supplied about 90 percent of the entire world's requirements, exclusive of the USSR. Substantial reserves of nickel are also available in Cuba and in New Caledonia, which are the other two substantial producers of nickel-bearing ores.

In 1953, exclusive of the USSR, the producers of nickel, based on short tons of nickel content from the ores, were Canada, supplying 144,000 tons; New Caledonia, 18,700; Cuba, 13,800; Union of South Africa, 1,890; USA, 602; and all other countries, 605. This list presents us as a "have not" nation in connection with nickel ores.

Since Canada has the greatest potential reserve of nickel and is also the major producer of nickel in the world, this should alleviate the fact that we are a "have not" country so far as this metal is concerned. The Canadian deposits, however, cannot sustain indefinite production, consequently the eventual problem seems to revolve about the ability to treat the lower-grade ores which are known to exist in the United States and Canada.

Now, one of the important resources used in the making of steel and iron, as well as in the concentration of iron ores, is water. Water must be used for cooling our furnaces. As far as I know, that presents no problem whatever.

There is a western steel plant located in a semiarid area which has overcome water shortage by reusing each gallon of industrial water a total of 40 times. They circulate it from that portion of the operation requiring the highest purity to that requiring the least purity. This certainly demonstrates the feasibility of operating a steel plant in an area where water is in short supply.

In the concentration of low-grade iron ores, water reclamation has become so efficient that large concentration plants are operating in semidesert areas and no water problems are visualized in areas of maximum ore reserves.

Insofar as technology is concerned, technological progress is evident throughout the steelmaking industry, from the production of raw materials to finished steel. Research staffs are continuously at work to provide increased efficiency and better products.

Advances in blast furnace and steel practice have been discussed previously, indicating increased output, using less raw materials.

Steelmakers have improved the open-hearth operation tremendously, only recently having developed the oxygen conversion process which bypasses the open hearth entirely, producing finished steel in the ladle from the molten pig iron.

In the case of the raw material suppliers, almost every iron ore producer of any size now has a research laboratory working continuously on the upgrading of iron ores.

Examples of new processes which have been developed, as well as older ones which have been converted to the concentration of iron ores, are as follows:

1. The ferrosilicon sink-float process, with which some of you may be familiar, was developed in the Lake Superior district for the treatment of iron ores, and has since been used throughout the world for concentration of ferrous and nonferrous ores, even for concentrating diamonds in Africa.

2. The treatment of taconites on a huge scale for the removal of magnetite is now in operation, having been originally started in the form of laboratory work.

3. In the case of hematitic jaspers, the oil flotation process that my company is using has been converted from western oil-flotation practice in nonferrous metals.

4. For the hematitic taconites and jaspers, our laboratories have developed processes for the roasting of hematite to magnetite, followed by magnetic separation methods, as they do in the taconites presently, and this now only awaits the entry of natural gaslines to make this process economically feasible.

5. Research laboratories have developed many new forms of equipment and have adapted equipment used in other fields for iron ore beneficiation, such as the Dutch State cyclone, treating very fine material, using a magnetite medium.

In general, iron ore research laboratories are working on every available avenue to bring the huge reserves of taconite and jasper into production eventually.

Coal has followed the pattern of iron ore. Little data is available indicating that limestone is at present being beneficiated, except for crushing and screening.

Insofar as manganese, nickel, and chrome are concerned, the U.S. Bureau of Mines is due a great deal of credit for having worked on the low-grade ore problems. They are, however, definitely handicapped by lack of reserve tonnages. Manganese and chrome must, no doubt, be imported and stockpiled for national emergency. The U. S. Bureau of Mines has made studies of our western nickel deposits, one of which is in production at the present time.

In conclusion, it would appear that technology is not lagging in the production of steel or in the production of raw materials for the making of steel.

In general, conservation of raw materials for iron and steel production is being practiced. However, the matter of economics governs the speed with which low-grade reserves will replace our wasting assets.

Now, gentlemen, in concluding this talk, please accept my thanks for your patience and your attention. A talk such as this must be based on statistics, and my hope is that you may now be a little bit better informed on the natural resources required in the making of iron and steel.

Thank you.

COLONEL FLYNN: We will start the question period with our student from the Bureau of Mines.

QUESTION: Mr. Holt, can you give us some idea of the relative competitive position of the taconites as compared to the high-grade iron ores and the somewhat lower-grade concentratable iron ores of the range?

DR. HOLT: You mean dollarwise?

STUDENT: Well, if you can, dollarwise; if you can't, just how close is it to being commercial at this time?

DR. HOLT: There is no question in my mind that these large plants, up to say 7.5 to 10 million tons, are very close to the borderline, but I think that they are on the right side. That's as close as I can give you the figures.

We are operating smaller plants which are to be expanded on jaspers. We know that you can decrease your costs very rapidly between, say 500,000 tons a year and 5 or 10 million tons. But, once you go over the 2-million-ton point you begin to duplicate men, facilities, and what not, and there isn't too much of a saving. So that you might put into operation a 50-million-ton-a-year plant, and I doubt that your economics would be far different from those of a 10-million-ton plant.

I think that they are very close to the margin insofar as the present price of Lake Superior ore is concerned. Lake Superior ore is priced at so much per iron unit--in other words, about 23 cents, delivered Lower Lakes.

They are definitely not getting the margin of profit that they should on the huge investments required for these 10-million-ton plants without a premium for the product. I think the only way of attracting capital into these plants is the matter of a premium, to be perfectly frank with you. I know from our company angle we find that it is right on the borderline.

QUESTION: Dr. Holt, I wonder if you will comment on the effect of the opening of the St. Lawrence Seaway on the availability of the production of iron.

DR. HOLT: I have tried to obtain statistics concerning the St. Lawrence Seaway, and as I understand it the main bottleneck in that seaway would be the Welland Canal. Now, I have seen statistics--I don't want to be hung for these figures--and I believe that the capacity is around 23 million tons per year, or something like that, one way through the canal. The statement was made, I believe, in the article that I read, that they might be able to double that, and make it 40-some million tons a year. That means that that amount of tonnage, if all of it was iron ore, could be taken up through the Welland Canal. Now, definitely, the Welland Canal is not going to be for the convenience of the iron ore importers, and what tonnage of ore will come up through the canal I don't know.

The seaway as a whole makes it perfectly feasible to bring in large boats. However, if you are going to make the most money on imported ores, you are going to have boats of 100,000-ton capacity, with drafts up to 35 or 40 feet, and they definitely would be impossible to take all the way through the St. Lawrence Seaway today.

I understand they are deepening the channel near the Welland Canal locks. Another thing about the Welland Canal is that, as well as being a bottleneck for tremendous importation of iron ore, it is located on the Canadian side, and a second one would have to be built on the Canadian side. I understood from conversation with Canadians that they have no intention of building another set of locks to assist the iron and steel industry in the United States to expand by importing ore from overseas.

QUESTION: Mr. Holt, you said that the United States was inadequately supplied with manganese and chromium. How complete a survey has been made so that we are positive of this fact?

DR. HOLT: We do know that there are substantial deposits of manganese in South Dakota, for example. They are nodules of manganese in clay, and the only way to recover those nodules is to mine the material and put it out and let it weather. It seems silly, but it is a sort of shale, and Mother Nature is the only way by which they have been able to break that up. I don't think they can even do it by heat. I believe that heat recements it.

Even if we were to develop that source and most of the sources we have now, if we are going to import 2 million tons a year, it's going to be a short-range picture at best. The Bureau of Mines I know is much more familiar with that than I am. I don't see that we have the resources either in chrome or manganese for the long-range picture.

QUESTION: Here in the last couple of days we have read in the papers that the automobile industry is announcing that it is going into the use of an aluminum engine. This, of course, would have an impact on your industry. Would you be willing to comment on what this looks like for the future?

DR. HOLT: I would certainly like to see one of those engines, if it was going to be made entirely of aluminum. Certainly anything of that type would affect the steel industry to a certain extent. As a matter of fact, some time ago some of the iron and steel magazines used to comment on the effect of plastic bottle stoppers on the steel industry. It was quite surprising. As a matter of fact, I think about 6 million tons of steel are used in the form of containers, mostly cans that you get from your corner grocery.

Even in small ways a thing of that type would affect us, but I wouldn't think it would be terrifically serious. There again you would have the

problem of getting bauxite or some material into this country for the manufacture of aluminum, unless you went to the clays, such as Anaconda is doing now.

QUESTION: I was under the impression that most of the large-scale taconite development in Minnesota was now being done by a combine of the steel companies themselves. I may not be correct in that, but I wonder if you could give me some indication of how much of this development of new ores is by the steel companies, and how much is by independent producers of ores, selling to the steel companies.

DR. HOLT: To go back into the history of taconite, Dr. Edward Davis, a very good friend of mine, was instrumental in starting all of it in the University of Minnesota Mines Experimental Station. Now that it has come to the development of the property and the erection of the plants, the reserve mining company is composed largely of ARMCO--American Rolling Mill--and Republic. Youngstown Sheet and Tube and Bethlehem are the principal people in the Erie project. So up to date that is true; they are principally captive projects, so to speak. That does not, however, take away from the fact that there are tremendous reserves of taconite which they don't have under their control.

QUESTION: The Paley committee report in 1952, I think, recommended a strategic stockpile of pig iron, and, if sufficient funds were not available for that purpose, a stockpile of manganese, chromium, and tungsten. Do you know whether anything has been done in any of these areas?

DR. HOLT: I am sorry I do not. I rather doubt that there has been any pile created of pig iron. Lord knows, we wish they would do that this year, which they haven't done. But I doubt that there is any stockpile of pig iron, and I am not too familiar with the manganese and chrome situation.

To me it doesn't appear practical to stockpile pig iron, although it is possible. As I tried to point out to you, the shipments of scrap have gotten up to a point where they exceed 5 million tons a year. If you want to stockpile anything, why stockpile pig iron? Why not stockpile scrap? That's all right there for the making. Just one more process through the open hearth or electric furnace and you have steel.

I am talking against our own business now. I am in the business of mining iron ore. But that is a fact. It would be more sensible, I think, to stockpile scrap than it would be to stockpile pig iron.

QUESTION: Doctor Holt, I wonder if you might bring us up to date on nickel production in Cuba. I understand that the United States Government put up quite a large plant there several years ago which was contract operated. I further understand that they are attempting to sell this plant to Freeport Sulphur, and that this private agency will probably be the buyer.

DR. HOLT: I think that is in connection with what they call laterite ores--iron nickel ores. It seems that nickel is a very important constituent of steel, but they want it when they want it, and they don't want it when they don't want it. In other words, you just can't take that lateritic iron ore and throw it into a blast furnace and expect to come out with a product in which you can control the nickel content. I understood too that this plant had been producing down in Cuba, but I am not familiar enough with it. I think that you can get information on that probably direct from the Bureau of Mines. I understood it was not successful to the point to which they expected to expand it. I don't know. I'd rather have you get your information from someone who is an authority on it.

QUESTION: Doctor is there any feasibility in processing these pellets directly into steel and bypassing the blast furnace? If so, would you care to comment on which might be done?

DR. HOLT: There is a big move on now in the steel industry in the form of what may be called direct reduction. In other words, in the blast furnace you melt down the material after it has been reduced to metallic iron and you come out with pig iron, which is a crude form of steel and has to be purified through the open hearth, and so on. There has been a big movement on in the direct reduction of iron oxide right from the iron ore, which is converted to metallic iron. Then you try to separate the unessential elements, magnetically, or otherwise. The main purpose in that has been to govern the scrap market--in other words, the price of scrap.

As I told you, scrap is essential to the steelmaker. The difference between 113 million tons of steel and 79 million tons of pig iron last year was all represented by scrap and steel plant rejects. It seems

that the individuals who are dealing in the scrap market are very shrewd and they certainly control the prices. They have a wonderful way of control, and part of that is by exportation of scrap, making it more scarce.

Whether or not you can scrap your entire present steel facilities, blast furnaces, open hearths, and what not, and go direct from iron ore into steel is a question. You would have to go from the iron ore to the metallic iron in the ore, and then go through an electric furnace or something to get it into the form of finished steel, anyway. I doubt that you are going to see that during your lifetime or mine, because it depends primarily on the use of oxygen, which is quite expensive to create, although it can be done. But I doubt that you are going to see much of a move away from our present system of steelmaking, which is by the use of the blast furnace and the open hearth, with one exception, and that is by the use of oxygen in the ladle--pig iron--rather than going through the open hearth.

I don't say it is impossible, but I don't think it is going to be too practical as we know the direct reduction process now. You must remember that iron ore is worth maybe $11 or $12 a ton at the furnace, and, if you could convert 50 percent of that ore into iron you would have a loss of $24 for the metal plus the loss of conversion; and with scrap at about $50 a ton, the direct reduction process may have possibilities as a competitor for scrap.

QUESTION: With reference to the tremendous expansion in our steel production--I believe $1 billion worth during this relatively slow year--we find that on the other hand the aluminum industry is also expanding at a tremendous rate, ostensibly based to a large degree on the premise that it can develop a competitive advantage over steel in many areas where steel now has the advantage. Isn't there a danger here, from the standpoint of the well-being of both industries, that we are developing our capacity much too fast?

DR. HOLT: Well, I rather doubt that, based on the statistics that I showed you on our population increase of 1.8 percent, and the per capita consumption of steel based on the existing figures back in 1956. That per capita consumption is increasing at the rate of 4.5 percent. You combine that with the increase in population and I don't think that the steel industry is expanding too fast. I think you are going to have a demand for steel. We are going right into it again now. Of course that may mean two cars in.

every garage and two chickens in every pot. However, the general consensus is that the steel men know what they are doing in these expansions.

Aluminum is coming to the front very fast, but structurally you would have a tough time building an entire skyscraper out of aluminum. As of today aluminum is replacing more wood and stone facing than steel.

QUESTION: I recall from your references to the steel scrap exports the considerable agitation in late 1956 and early 1957 from the industry and the Congress in particular, and subsequent very difficlut negotiations with the Japanese and the Coal and Steel Community to reduce the take in scrap, but I haven't noticed any recent publicity in the press on this subject. Has the problem disappeared, or what has happened since early 1957 in this field?

DR. HOLT: Well, I really can't give you the answer to that. I know that all the steel men that I list as acquaintances are always talking about the trouble they are having in the scrap market. When they want scrap the price is way up, when they need it, and when they don't need it the price is down. The minute they need it again it goes right back up. In other words, they would like to see some control over the price of scrap, but they don't know exactly how to do it.

QUESTION: Dr. Holt, steel has been a basic material subject to direct controls in times of mobilization. Has the industry noticed any significant difference in the military take of steel products, say, between modern weapons and those of the World War II era?

DR. HOLT: I am afraid you have me there. I have no statistics on the consumption of steel for military use whatever. I do think though, that certainly it must have some effect. One thing about it is that your military weapons have a comparatively short life. Material going into heavy construction, such as buildings, and so on, will last a very long time. Certainly, with a step-up in military usage, I think that that is part of the background of this vast steel expansion that we are talking about.

QUESTION: Doctor, with regard to the Labrador ore deposits, are they high grade, and, if they are, where is this ore being refined in the United States?

DR. HOLT: Those ores are very high grade. They call that area the old Mesabi, where they used to put the shovel in, load the cars, and take it right down to the blast furnaces. They are, however, running into the same problem that we ran into in the Mesabi Range somewhat faster--the matter of the ore on the edges being lower grade and requiring concentration. In regard to the second portion of your question, most of that ore is going to Europe at the present time or to the eastern seacoast furnaces. Small portions are being delivered to inland furnaces via the Great Lakes and transferred by rail. But that's a very minor quantity at the present time.

Labrador ores, of course, are in competition with ores coming in from Venezuela, Liberia, Brazil, and so on, in our east coast furnaces.

QUESTION: Dr. Holt, my question has to do with steel production and relates somewhat to a previous question. Every time we get into an emergency situation that calls for accelerated shipbuilding programs or other war-production items, we run into a terrific shortage and a pinch in plate steel. Do you have any idea of approximately what percentage of our steel production is capable of turning out steel plates? Are we always going to be faced with this problem in an emergency?

DR. HOLT: I am sorry I don't have a breakdown on those figures. They could be obtained very easily from the American Iron and Steel Institute. It would seem that plate is not in as much demand in peacetime as it is in wartime. Of course the members of the steel industry gear up their plants to take care of what they know of the market today, which probably accounts for your shortage in wartime. That's another thing on which I can't give you the breakdown. But they are continually building rolling mills, and a big part of that expansion in dollars, which I showed you in the early part of my talk, is not so much on open-hearth capacity as it is on rolling mills, which would get down into the steel sheets.

QUESTION: Doctor, we have been told that the copper industry has quite a process of recovery of used copper for reprocessing. Does the steel industry have any such program?

DR. HOLT: Well, the 5 million tons of iron and steel scrap which are exported, as well as the difference between 113 million tons of steel and 79 million tons of pig iron per year, cover the amount of steel and iron and steel scrap that is taken back and reworked into new steel. You

see huge junk yards all over the country filled up with scrap steel. This steel funnels back into the steel mills. The junkyard owners get the best price they can from the mill and ship the scrap to that mill. That's a continuous process, the feedback of scrap iron and scrap steel. There is also a big factor in plant obsolescence, and in farm machinery.

There is one question I didn't answer. One of the gentlemen asked something about controls, Federal controls. I could say that we don't care for them and, thank you, we had them in World War II and our underground mines operated with a margin of profit of two cents a ton before depreciation and writeoff. So, as far as controls are concerned, we think that there should be a limitation or some flexibility placed on the controls so far as the industry is concerned.

QUESTION: Does the limestone that is used have a further utilization after it has been processed with the iron ore through the furnaces?

DR. HOLT: The only use of any consequence is in making concrete aggregates or road material, road ballast. It is mainly calcium and magnesium silicates. It resists the weather very well, so it makes a good concrete aggregate. But, further than that, it is produced in such huge quantities that in the case of open-hearth slag, of course, they use that and also some blast furnace slag in making cement. That is one of the most important uses, probably even more important than the use in road work. They do produce slag in such tremendous quantities that they can never dispose of all of it.

QUESTION: Mr. Holt, since manganese appears to be one of our most critical bottlenecks, do you know of any work going on or any possibility of success in the development of a substitute for manganese to be used in the smelting process?

DR. HOLT: Manganese steel has one characteristic that we like very much, especially in mining these hard ores. It has a feature that they call "work-hardening." In other words, the teeth on these dippers with which we dip out these huge chunks of taconite and material are subject to tremendous abrasion, and manganese under those conditions will work-harden. That is true of any other place that you might use manganese. In other words, if it is subject to strain, it is very tough, and it will also become harder with usage. We have, of course, nickel and chromium and those alloys for hardening, but they don't have quite the same characteristic that manganese has. Furthermore, of that 13

pounds of manganese used in the steel, that I mentioned, only a very small portion goes into the metal. Most of it is used for deoxidizing around the open hearth. In other words, the steel, as it comes out, contains a certain amount of oxygen, and if that is not removed it is detrimental to the steel. Manganese is a very avid consumer of oxygen, so, by adding ferromanganese to the ladle, that oxygen is taken out very nicely.

As I said, those are the two main uses of manganese. One is for deoxidizing and the other one is for work-hardening the metal.

STUDENT: I was thinking of the deoxidizing process, to have a substitute for manganese for it.

DR. HOLT: They are doing that to some extent now by means of using oxygen, provided the sulphur content of the metal as it comes out of the blast furnace is low. Manganese gets rid of the sulphur as well as getting rid of the oxygen. If you were to use oxygen, which could probably get rid of the sulphur, it would still put oxygen back in the steel, and you've got to get it out.

So I don't know of any substitute for manganese today. I don't think the steel industry does.

COLONEL FLYNN: Dr. Holt, on behalf of the College, I want to thank you for a fine coverage during both the talk and the question period. Thank you, too, for coming down from the Upper Peninsula of Michigan to visit with us this morning.

DR. HOLT: Thank you very kindly.

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