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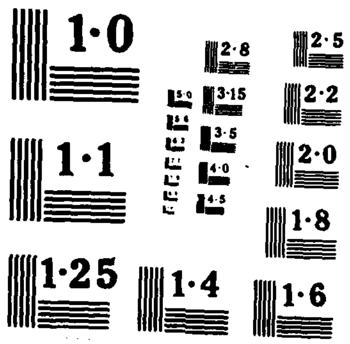
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Ferroalloys are essential to the production of steel and superalloys, and therefore, to the production of many defense items. This study examines the effects of a loss of all domestic ferroalloy capacity on the defense industrial base and industrial preparedness. If the United States had no domestic capacity, additional amounts of ferroalloys would have to be imported to meet U.S. industry requirements. This study assesses the worldwide availability of ferroalloys under peacetime and mobilization conditions.

There is ample unused capacity worldwide to meet U.S. ferroalloy requirements during peacetime. Depending on the amount of supply disruption during mobilization, there would be shortages of certain ferroalloys if the United States lost all domestic capacity. The domestic ferroalloy industry seems to have stabilized at current levels. It is recommended that domestic ferroalloy capacity be monitored for signs of further deterioration.

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LMI

Executive Summary

THE EFFECTS OF A LOSS OF DOMESTIC FERROALLOY CAPACITY

Three principal ferroalloys—ferrochromium, ferromanganese, and ferrosilicon—and their related metals are essential to the production of steel and superalloys and, therefore, many items needed for national defense. Because of large increases in ferroalloy imports and the consequent decline in domestic production, Congress asked for a study "... to determine what effect the loss of all capacity by the United States to produce domestic ferroalloys would have on the defense industrial base and on the industrial preparedness of the United States."

There is now substantial excess capacity, worldwide, for production of ferroalloys. The available capacity in reliable countries could easily compensate for a total loss of U.S. production at today's (i.e., peacetime) level. In the event of a peacetime disruption of the Republic of South Africa's large mining and processing industries, ferroalloy markets would tighten, but we believe the United States could acquire necessary supplies from other reliable sources.

In the event of a U.S. mobilization with no domestic ferroalloy capacity, the additional ferromanganese required for defense needs could be met by supplies from abroad even in the face of severe supply disruptions. In contrast, defense requirements would create a shortage of silicon metal that could not be overcome unless new processing capacity could be built.

Ferrosilicon shortages would also appear with a U.S. mobilization and worsen if supply disruptions occurred. Minor shortages could be dealt with by converting excess processing capacity abroad, but more severe shortages could only be relieved by new processing capacity. Ferrochromium shortfalls would also occur but could be met by a combination of plant conversion and drawdown of the U.S. strategic stockpile. Should African or European supplies become unavailable, the ferrochromium in the stockpile would last for only 15 months of a mobilization. Because of a worldwide shortage of processing capacity, the chromite ore in the U.S. strategic stockpile could not be processed into ferrochromium either here or abroad unless new processing capacity could be added.

Sufficient worldwide capacity to process ferromanganese is available. For the other ferroalloys, the current level of domestic processing capacity can just meet emergency needs, even with severe supply disruptions. DoD should monitor trends in domestic processing capacity and be prepared to react to any further significant erosion of ferrochromium, ferrosilicon, and silicon metal processing capacity.

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1. INTRODUCTION

BACKGROUND

Ferroalloys are essential ingredients in the production of finished steel and cast iron. The principal ferroalloys are those of chromium, manganese, and silicon, although a multitude of others are added to molten metal to produce various types of steel and cast iron. Ferroalloys are added to steel to remove dissolved oxygen, to control the effects of sulphur, and to change the properties of finished steel. Their introduction improves steel's hardenability, corrosion resistance, toughness, and resistance to high temperatures. The iron and steel industry accounts for about 90 percent of ferroalloy consumption.

The average ton of raw steel produced in the United States uses about 29 pounds of ferroalloys. Carbon and alloy steels require nearly 14 and 34 pounds of ferroalloy per short ton of raw steel, while stainless steel requires nearly 450 pounds of ferroalloys per short ton of raw steel produced. The overall average of 29 pounds of ferroalloy per short ton of steel produced reflects the dominance of carbon and alloy steel. Stainless steel accounts for only about 2 percent of total steel production.

Ferroalloy consumption is directly linked to U.S. steel production. Because of a long-term declining trend in domestic steel production, U.S. ferroalloy consumption has also declined. Domestic raw steel production peaked in 1978-1979 at 137 million short tons and fell to a cyclical low of 75 million short tons in 1982. It is now approximately 92 million short tons—far below the previous peak level. Consumption of ferroalloys as measured by domestic shipments plus imports also peaked in 1978-1979 at about 2.7 million short tons and fell to a low of 1.3 million short tons in 1982. However, the reduction in domestic ferroalloy consumption was borne disproportionately by U.S. producers: shipments by U.S. producers fell more than 50 percent (from about 1.5 million short tons to about 0.6 million short tons), while imports showed only a slight decline. As a consequence, the import market share (imports as a percentage of domestic consumption) increased from about 48 percent in 1978-1979 to 58 percent in 1982. Imports have subsequently increased even more to stand at almost two-thirds of U.S. consumption today.

The trend towards increased foreign dependence is most pronounced for ferrochromium and ferromanganese. Shipments of domestically produced ferrochromium fell from about 275,000 short tons in 1978-1979 to 117,000 short tons in 1982 and 38,000 short tons in 1984. Imports also decreased from an average of 269,000 short tons in 1978-1979 to 148,000 short tons by 1982, but they increased rapidly to 434,000 short tons by 1984. Imports held over 90 percent of the domestic market by 1984.

A similar situation occurred for ferromanganese. Domestic shipments averaged 485,000 short tons in 1978-1979. They declined to 170,000 short tons in 1982 and to 140,000 short tons by 1984. Imports amounted to an average 824,000 short tons in 1978-1979, declined to about 555,000 short tons in 1982, and remained at that level in 1984. The market share captured by imports exceeded 80 percent in 1984.

Finally, for ferrosilicon, the domestic industry has remained relatively more competitive than it has for the other ferroalloys. Domestic ferrosilicon shipments averaged nearly 700,000 short tons in 1978-1979, while imports averaged 136,000 short tons. Domestic shipments decreased by half to 334,000 short tons by 1982, but recovered to nearly 500,000 short tons by 1984. By 1984, imports had regained the absolute level reached in 1978-1979 and accounted for more than 20 percent of the domestic market.

Several other industries also require ferroalloys. The aluminum, iron castings, and semiconductor industries account for half of ferrosilicon consumption and virtually all silicon metal consumption. The production of superalloys also requires ferroalloys and their pure metals. Superalloys accounted for all of the consumption of chrome metal in 1984 and a large portion of the consumption of manganese metal and silicon metal.

THE DOMESTIC INDUSTRY

With the decline in domestic shipments, the U.S. ferroalloys industry has experienced a substantial reduction in employment and capacity. Table 1-1 displays industry employment and processing capacity for the most recent cyclical peak in 1978, the recession year of 1982, and the most current year. These data were provided by the Ferroalloys Association and are in substantial agreement with similar data available in Census of Manufacturers and Bureau of Mines publications.

TABLE 1-1. DOMESTIC FERROALLOY INDUSTRY

STATISTIC	1978	1982	1985
1. Number of Plants	29	24	17
2. Number of Employees	8,500	4,900	4,100
3. Number of Submerged Arc Furnaces	90	76	40
4. Shipments (000 Short Tons)	1,595	684	697
5. Capacity (000 Short Tons)	2,136	1,868	1,166
6. Capacity Utilization 4 ÷ 5 (%)	75	37	60

NOTE: All values as of January of the year reported.
SOURCE: The Ferroalloys Association, Washington, DC.

Domestic shipments of ferroalloys declined from nearly 1.6 million short tons in 1978 to about 700,000 million short tons by 1985. During that same time period, employment in the industry fell by nearly 50 percent and processing capacity decreased from 2.1 to 1.2 million short tons. The industry also reports about 600,000 short tons of standby capacity that could be brought on line in an emergency.

STUDY ASSUMPTIONS

The major assumption in our assessment is in accordance with the congressional requirement[1] directing the Secretary of Defense to "... conduct a study to determine what effect a loss of all capacity by the United States to produce domestic ferroalloys would have on the defense industrial base and on industrial preparedness of the United States." Thus, throughout our assessment, we assume that no U.S. domestic capability is available for the production of ferroalloys.

We make five additional assumptions in the assessment:

- Plants can be converted from the production of one ferroalloy to the production of certain other ferroalloys with specified losses in efficiency.
- All existing unused processing capability is immediately available when needed, and no leadtime is necessary to establish an infrastructure for its use.
- No country except the United States increases steel production.
- No shipping losses occur.
- U.S. demand for imported ferroalloys has priority over that of other countries.

These assumptions have the effect of understating the demand for ferroalloys and overstating their availability in the world market. Thus, we measure shortages in ferroalloys as conservatively as possible.

One final point: we have not considered the need for production of other minor ferroalloys (ferromolybdenum, ferronickel, etc.) and, consequently, have not accounted for use of some of the unused production capacity in satisfying the much lesser demand for those ferroalloys.

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[1]Section 1613, 1986 Defense Authorization Act.

No Domestic Ferroalloy Production

We consider two levels of ferroalloy demand:

- Peacetime (the same as the current level)
- Mobilization (increased demand).

For both levels, our assessment assumes that the United States has no domestic capacity for producing ferroalloys and that *additional* imports must be available to replace those ferroalloys now produced domestically. (The possibility of building new processing capacity or reactivating unused capacity once shortages develop has not been considered in detail.)

At the peacetime level, that assumption means:

- Ferrochromium and ferromanganese imports will have to be increased only slightly since most of today's U.S. consumption is already imported.
- Ferrosilicon and silicon metal imports will have to be increased significantly since most of today's U.S. consumption is produced domestically.

At the mobilization level of demand, it means that imports of all ferroalloys will have to be increased significantly.

Conversion of Plants

Ferroalloy furnaces are configured to produce a specific product. Converting to a different product entails a reconfiguration cost and some loss of efficiency. We have ignored the cost and have allowed for the possibility of converting some capacity to cover shortages during wartime. For example, some ferromanganese capacity can be converted to produce ferrochromium and some ferrochromium capacity can produce ferrosilicon, albeit both at reduced efficiencies. The production of silicon metal requires such a specialized configuration that it is not feasible to convert other capacity to produce silicon metal.

Availability of Unused Capacity

We assume that all existing unused capacity is immediately available when needed. If a major source of supply were lost suddenly, the effects would be much more disruptive than if the supply were lost over a period of years. We have assumed that all countries can immediately produce ore and ferroalloys at full-rated capacity when required without leadtime to purchase any missing infrastructure or to train skilled labor. However, if a country wishes to increase its existing capacity, it cannot do so without incurring a leadtime to purchase and install the necessary infrastructure. At the present time, plant construction leadtime is about a year and a half.

Foreign Steel Production

We assume that the major steel-producing countries do not increase their production when the United States mobilizes. If other steel producers were to increase production at the same time as the United States, the supplies of ore and processing capacity would be tighter than indicated in our analysis.

Shipping Losses

We presume no shipping losses during wartime. Under our mobilization cases, the United States becomes increasingly dependent on Japan, India, and Brazil for ferroalloys. The domestic steel industry will be worse off to the extent that shipping across the Pacific Ocean is cut off.

U.S. Priority

We assume that the United States can obtain ferroalloys produced from unused capacity, provided the required ores are also available. Demand by other countries for additional products is satisfied after U.S. demand. In some of our cases, the United States would require all available unused capacity worldwide to meet its requirements.

CASES ANALYZED

In analyzing the effects of having no domestic ferroalloy processing capacity, we considered six different cases covering peacetime and mobilization levels of demand. The cases are as follows:

- Peacetime:
  - Current steel production
  - Current steel production and a disruption of supply from the Republic of South Africa
- Mobilization and War:
  - Steel production at full capacity
  - Steel production at full capacity and a disruption of supply from the Republic of South Africa
  - Steel production at full capacity and a disruption of all African supplies
  - Steel production at full capacity, disruption of all African supplies, and disruption of European supplies.

For each case, we estimate the worldwide supply-and-demand balance for ores and ferroalloys. If supplies are short, possible solutions, such as drawing down the U.S. strategic stockpile or converting foreign capacity from production of one ferroalloy to production of another, are explored. The analysis also indicates the countries that the United States would depend on for supplies.

STUDY CONTENT

Chapter 2 presents the findings and conclusions of our assessment. It is followed by a discussion of the methodology we used to analyze the effects of a loss of domestic ferroalloy capacity and the results of the two peacetime and four mobilization cases we evaluated. A series of appendices follows with detailed backup data and analysis.

Appendix A presents production, capacity, and trade flows for major ore-, ferroalloy-, and steel-producing countries. Those data are a compendium of several sources and are arranged in a format showing the origin and destination of ores, ferroalloys, and steel in world trade. Appendix B contains an analysis of demand for ferroalloys for a U.S. mobilization. Appendix C contains a brief legislative history of actions affecting ferroalloys. Appendix D contains a series of tables presenting data used for the study. Appendix E reproduces the unclassified mobilization planning scenario that has been used in recent mobilization exercises.

2. FINDINGS AND CONCLUSIONS

FINDINGS

Upon the loss of its domestic capacity, the United States must rely on imported ferroalloys. How much it relies on other countries depends on the economy's overall demand for ferroalloys. During peacetime, ferroalloy imports would have to increase by exactly the amount of today's lost domestic production – 750,000 short tons. During a mobilization, however, imports would not only have to replace current domestic production but more ferroalloys would be needed to meet the higher levels of industrial production. We find that in a mobilization, U.S. steel production would increase to full capacity – about 45 percent above what, by historical standards, represents a depressed level of 92.5 million tons in 1984. About 1.4 million short tons of additional ferroalloy imports would be needed to make up for lost domestic capacity plus the increased demand during mobilization.

Peacetime

Under peacetime conditions, we find that there is more than enough available worldwide processing capacity to make up for lost U.S. production. The tightest supply-demand balance is in ferrosilicon since the lost U.S. production is a significant portion of world capacity. Nevertheless, there is still sufficient unused ferrosilicon capacity worldwide. Even a disruption of ferroalloy and ore supplies from the Republic of South Africa, a major world supplier of chromite and manganese ores and ferroalloys made from those ores, would have little adverse effect. Although supply and demand for silicon metal would be just in balance, no major shortages would occur in this or other ferroalloys. Certainly, some conservation could easily maintain supply-demand balance.

Mobilization

Without any U.S. domestic ferroalloy production capability and with no possibility of constructing new capability, the additional demands of mobilization create shortages of ferrosilicon and silicon metal even with no supply disruptions. The ferrosilicon shortage can be overcome by converting the excess capacity of foreign ferrochromium plants. However, the silicon metal shortages (about 50,000 short tons) cannot be overcome, and the shortfall worsens as supplies are reduced by successive disruptions. The combination of mobilization and a supply disruption in the Republic of South Africa creates a shortage of ferrosilicon that cannot be relieved through plant conversion. Additional disruption of supplies spreading to all of Africa and/or Europe leads to an even more serious ferrosilicon shortage.

Serious ferrochromium shortages occur once supply from the Republic of South Africa is disrupted. In that case, a drawdown of the U.S. stockpile of ferrochromium can cover the shortage. However, the severe shortages of both chromite ore and ferrochromium that occur once disruptions worsen to include all of Africa can be overcome by drawdown of the U.S. strategic stockpile for only the first 15 months of a mobilization. The chromite ore still available in the U.S. strategic stockpile could not be exported for processing into ferrochromium because of a worldwide shortage of processing capacity. By assumption, it could not be processed in the United States either unless new processing capacity could be constructed. A further disruption of European supplies would deepen the shortage of both chromite ore and ferrochromium. Although the United States could, at high cost, reopen U.S. mines and produce chromite ore, that option would be of no value since such ore could not be processed without new domestic capacity.

Finally, supplies of ferromanganese are always sufficient to satisfy requirements. Ample supplies of manganese ore available in Australia and Brazil can be processed, if necessary, in readily available blast furnaces. Any shortage envisaged could easily be satisfied from the ferromanganese available in the U.S. strategic stockpiles.

CONCLUSIONS

Substantial excess capacity now exists worldwide, for production of ferroalloys. Available capacity in reliable countries could easily compensate for a total loss of U.S. capacity at today's (i.e., peacetime) level of industrial production. A peacetime disruption of supplies from the Republic of South Africa's large mining and processing industries would tighten supplies of ferrochromium, but the United States could acquire enough ferrochromium from other reliable sources. Silicon metal used primarily for the production of aluminum and superalloys would also be in tight supply, but other sources would be available.

In the case of a mobilization with no domestic ferroalloy processing capacity, the additional ferromanganese required to meet U.S. defense needs could be supplied from abroad. If the supply disruptions are severe, a small drawdown of the U.S. stockpile of ferromanganese would be necessary.

In contrast, however, defense requirements during a mobilization would create immediate shortages of silicon metal and ferrosilicon and those shortages would worsen if supply disruptions occurred. Minor shortages of ferrosilicon could be dealt with by converting unused processing capacity abroad from one ferroalloy to another, but more severe shortages would require construction of new plant capacity. Silicon metal shortages cannot be overcome without construction of new capacity because plant conversion is not technically feasible.

Ferrochromium shortfalls would also occur during disruption of supplies from South Africa, but they could be met by a combination of plant conversion in Japan and Europe and drawdown of the U.S. strategic stockpile. Should all African supplies become unavailable, the ferrochromium in the stockpile would last for only

15 months of a mobilization. The chrome ore in the U.S. strategic stockpile could not be processed into ferrochromium either here or abroad because of a worldwide shortage of processing capacity. The United States would require about 1 million tons of combined processing capacity for the missing ferroalloys.

A total disruption of African and European supplies with no U.S. ferroalloy processing capacity would result in severe shortages of ferrochromium, ferrosilicon, and silicon metal during a war. The United States would have to build new processing capacity and start up high-cost domestic chrome ore mines to supply its ferroalloy requirements. About 1.4 million tons of processing capacity would be needed to cover the shortages of ferrochromium, ferrosilicon, and silicon metal.

These conclusions are based, of course, on the major assumption mandated for the study – the United States has no domestic capacity for the production of ferroalloys. If, in fact, U.S. domestic ferroalloy production capacity should remain at its current level, it would just meet the needs imposed by the most extreme disruption considered here.

In the event that the U.S. domestic capacity to produce ferroalloys is permitted to deteriorate completely, a possible solution to extreme disruptions would be to construct new capacity at the time the disruptions occur. We have not considered that solution in detail, but we have determined that neither the United States nor Canada has the capability to construct new processing plants. In the West, that capability is restricted to three firms: one in Japan, one in Germany, and one in Norway. The Norwegian firm is the subsidiary of a major foreign ferroalloy producer with plants in the United States. Current plant construction time is 15 to 18 months, but that time reflects a "soft" market for new capacity and the availability of such equipment as specialized electric transformers. Under mobilization conditions, longer leadtimes would almost certainly occur. DoD should not depend on the timely construction of new plants to meet those shortages identified in this study.

A complete loss of U.S. capacity to produce ferroalloys has not yet occurred. Changing economic conditions suggest, in fact, that the industry capacity is stabilizing at the current level. We recommend that DoD closely monitor industry trends and be prepared to react to further significant erosion of capacity.

3. ANALYSIS OF SUPPLY AVAILABILITY

METHODOLOGY

This chapter presents our analysis of the effects of a loss of capacity by the United States to produce ferroalloys. The evaluation is based on a comparison of the U.S. requirement for ferroalloys with its ability to obtain them. When essential requirements for ferroalloys exceed their supply, the industrial base is considered to be unable to produce all necessary defense material. The specific steps of the analysis are as follows.

- Determine the additional demand for ferroalloys. During peacetime, additional ferroalloys must be imported to replace lost domestic production. During mobilization and war, the additional imports must replace domestic production and provide for increased demand caused by mobilization.
- Determine the location and amount of unused ore-mining capacity worldwide (chromite and manganese ore).
- Determine the location and amount of unused ferroalloy processing capacity worldwide.
- Compare the additional U.S. demand with the lesser of unused processing capacity or unused mining capacity.
- If the processing capacity is inadequate, determine whether other ferroalloy processing capacity is available for conversion.
- Eliminate a country or a region from the world supply as a disruption occurs.
- Replace that country's exports by using a portion of the available unused capacity.
- Recompute the amount of unused capacity available.
- Compare the additional U.S. demand for ferroalloys to the lesser of the unused processing capacity or unused ore capacity.
- Repeat the last three steps above with progressively larger amounts of supply withdrawn from the world market, corresponding to more severe disruptions.

DEMAND FOR FERROALLOYS

A loss of domestic ferroalloy processing capacity requires additional imports to replace those currently produced domestically. Imports of ferrochromium and ferromanganese would increase only slightly since the United States already relies on imports for most of its requirements for those ferroalloys. Imports of ferrosilicon would increase substantially since about 75 percent of the ferrosilicon consumed in the United States is produced here.

During a mobilization, DoD's demand for steel would increase, with a resulting increase in the demand for ferroalloys. The domestic steel industry would produce at its current full capacity of 135 million tons.[1] Appendix B presents a derivation of steel demand under mobilization conditions. It shows DoD direct and essential civilian demand pushing U.S. steel production to its capacity. Demand for aluminum, iron castings, and semiconductors would also increase during mobilization. Imports would have to replace the lost domestic production and at the same time, supply the additional requirements imposed by higher levels of industrial production.

Table 3-1 shows the quantities of ferroalloys required during peacetime and mobilization. During peacetime conditions, current domestic production of 756,000 short tons would have to be replaced by imports. During a mobilization, an additional 637,000 short tons would have to be imported to meet the total production requirements of 1,393,000 short tons.

[1]Capacity figure from Department of the Interior, Bureau of Mines, *Minerals Facts and Problems*, 1985.

TABLE 3-1. FERROALLOY DEMAND

(Thousand Short Tons – Gross Weight)

COMMODITY	PEACETIME			MOBILIZATION			
	Ferroalloy Requirements	Net Domestic Production	Additional Imports Required to Replace Domestic Production	Ferroalloy Requirements	Imports Required to Replace Domestic Production	Additional Imports Required for Increased Production	Total Additional Imports
Ferrochromium	442	23	23	621	23	179	202
Ferromanganese	628	124	124	893	124	265	389
Ferrosilicon	619	469	469	771	469	152	621
Silicon metal	165	140	140	206	140	41	181
Total	1,854	756	756	2,491	756	637	1,393

FERROALLOY PROCESSING CAPACITY

The additional imports needed by the United States would require unused capacity in foreign countries to be placed into production. The production of ferroalloys depends on access to both ore and processing capacity. The United States does not have economic reserves of chromite or manganese ore, and so all ore processed domestically into ferroalloys is imported. Table 3-2 lists the countries that produce chromite and manganese ores and their unused mining capacity. The ore used to produce ferrosilicon is abundant in the United States and worldwide.

Although the Communist countries are major producers of ores, they have very little unused mining capacity. Africa is the major source of ores for the non-Communist world, and the African countries tend to have large amounts of unused mining capacity. Large deposits of manganese ore are also available in Brazil and Australia.

TABLE 3-2. WORLDWIDE CHROMITE AND MANGANESE ORE MINING CAPACITY

(Thousand Short Tons – Gross Weight)

COUNTRY	CHROMITE			MANGANESE		
	1984 Production	1984 Capacity	Unused Capacity	1984 Production	1984 Capacity	Unused Capacity
Albania	960	1,066	106			
Australia				1,874	3,611	1,737
Brazil	310	413	103	2,425	3,750	1,325
China				1,760	1,826	66
Finland	280	617	337			
Gabon				2,336	3,611	1,275
Greece	30	56	26			
India	485	627	142	1,433	2,222	789
Japan	7	7	0	68	83	15
Mexico				571	833	262
Philippines	300	561	261			
South Africa	3,314	4,818	1,504	3,361	9,250	5,889
Turkey	670	792	122			
USSR	3,300	3,300	0	11,100	12,667	1,567
Yugoslavia						
Zimbabwe	500	1,244	744	30	30	0
Other Africa	96	172	76	195	637	442
Other Asia	113	126	16	38	81	43
Other South America	41[a]	96	55	6[b]	42	36
Eastern Europe				141	192	51
Middle East	62	106	44			
Total	**10,468**	**14,001**	**3,536**	**25,338**	**38,835**	**13,497**
Communist	4,301	4,462	161	13,007	14,727	1,720
Non-Communist	6,167	9,539	3,375	12,331	24,108	11,777

[a]Cuba.
[b]Chile.
SOURCE: Department of the Interior, Bureau of Mines, "Minerals Facts and Problems," 1985.

Table 3-3 displays worldwide ferroalloy production and unused processing capacity. The countries listed in Table 3-3 would be potential sources for the additional ferroalloys required by the United States. The loss of U.S. processing capacity would require the activation of 756,000 tons of this unused capacity.

The non-Communist world has about 4 million tons of unused processing capacity. The continuing trend is for processing capacity to move to those countries

TABLE 3-3. WORLDWIDE FERROALLOY PRODUCTION AND UNUSED CAPACITY

(Thousand Short Tons – Gross Weight)

COUNTRY	1984 PRODUCTION	1984 CAPACITY	UNUSED CAPACITY
Australia	145	166	21
Brazil	753	932	179
Canada	244	350	106
China	989	1,029	40
France	776	998	222
West Germany	453	640	187
Greece	77	105	28
India	251	625	374
Italy	236	391	155
Japan	1,564	2,394	830
Mexico	258	258	0
Norway	1,057	1,291	234
Philippines	56	98	42
South Africa	1,617	1,966	349
Spain	275	542	267
Sweden	196	446	250
Turkey	61	176	115
USSR	3,643	4,122	479
Yugoslavia	335	356	21
Zimbabwe	220	323	103
Other Africa	7	68	61
Other Asia	487	491	4
Other South America	208	267	59
Other Western Europe	454	746	292
Eastern Europe	1,033	1,258	225
Total	**15,395**	**20,038**	**4,643**
Communist	6,000	6,765	765
Non-Communist	9,395	13,273	3,878

SOURCE: Department of the Interior, Bureau of Mines, "Minerals Facts and Problems," 1985.

that produce ore. South Africa is now the largest producer of ore and ferroalloys in the non-Communist world. Table 3-4 gives an indication of the importance of South Africa as an exporter of ore and ferroalloys. That table shows those countries that import the largest portions of South Africa's production and the percentage of their imports.

TABLE 3-4. IMPORTANCE OF SOUTH AFRICAN EXPORTS TO UNITED STATES AND ITS TRADING PARTNERS

COMMODITY	IMPORTING COUNTRY	PERCENT OF COUNTRY'S IMPORTS
Chromite Ore	Japan	47
	West Germany	55
	United Kingdom	92
	USA	76
Manganese Ore	Japan	52
	Belgium-Luxemburg	43
	France	23
	West Germany	67
	Italy	57
	United Kingdom	52
	Norway	30
	Spain	45
	Other OECD[a]	30
Ferrochromium	Japan	48
	France	25
	West Germany	36
	Italy	17
	United Kingdom	18
	Spain	42
	Canada	51
	USA	62
Ferromanganese	Italy	22
	United Kingdom	67
	Turkey	28
	USA	26

[a]OECD: Organization for Economic Co-operation and Development.

SOURCE: OECD Import Microtables, 1983, Series C.

For the United States, 62 percent of its ferrochromium imports come from South Africa. The United States imports very small quantities of chromite ore, but 76 percent of it comes from South Africa. Japan and West Germany depend on South

African supplies of ore and ferroalloys, and since those two countries are major exporters of steel to the United States, the United States also depends on South Africa indirectly through them.

FERROALLOY AVAILABILITY DURING PEACETIME

The cases presented here as well as those presented for mobilization-level demand are all based on the assumptions specified in Chapter 1. The major assumption, of course, is that the United States has no ferroalloy processing capability.

Case 1

In this case, steel production remains at its current (i.e., peacetime) level, approximately 92.5 million short tons. To support that level of steel production and other peacetime industry requirements, an additional 23,000 tons of ferrochromium, 124,000 tons of ferromanganese, 469,000 tons of ferrosilicon, and 140,000 tons of silicon metal would have to be imported (see Table 3-1).[2]

The unused capacity available worldwide to supply the U.S. requirement for additional imports is presented in Table 3-5. Since the United States does not produce ore, the amount of excess mining capacity available worldwide does not change. Worldwide processing capacity decreases for two reasons. First, it decreases by the amount of unused capacity assumed lost from the United States, and second, a portion of the worldwide unused capacity must be put into production to replace current U.S. production.

Table 3-5 provides information about changes in supply and demand attributable to the assumptions of this case. The first column lists the unused mining capacity worldwide for ores used in producing ferroalloys. The second column gives the amount of ferroalloy that could be processed from the quantity of

[2]Supply and demand for silicon metal are included in this and all other cases because it is the predominant metal consumed.

TABLE 3-5. PEACETIME SUPPLIES OF FERROALLOYS WITH NO U.S. PROCESSING CAPACITY

(Thousand Short Tons – Gross Weight)

COMMODITY	UNUSED ORE CAPACITY (1)	FERROALLOY PROCESSED FROM ORE (2)	UNUSED PROCESSING CAPACITY WORLDWIDE (3)	ADDITIONAL IMPORTS REQUIRED BY U.S. (4)
Ferrochromium	3,536	1,414	931	23
Ferromanganese	13,497	6,748	2,887	124
Ferrosilicon	a		715	469
Silicon metal	a		152	140

[a]Quartz ore is abundant and is not a constraint.

ore listed in Column 1 based on engineering relationships.[3] Information on excess ore capacity for ferrosilicon and silicon metal is not presented since supplies are essentially infinite. The third column lists unused worldwide processing capacity, excluding the United States. The fourth column lists the additional imports required to replace U.S. production (from Table 3-1). Comparison of the second and third columns indicates whether there is enough ore to supply the processing capacity or conversely whether processing capacity limits production. In this case, as in most of the cases analyzed, more ore is available than processing capacity. When the third column (unused processing capacity) exceeds the fourth column (additional imports required), U.S. requirements can be met.

For ferrochromium and ferromanganese, the unused ore capacity exceeds the unused processing capacity; i.e., the world cannot process as much ore as can be mined. However, there is more than enough unused processing capacity to replace the lost U.S. production. Loss of the U.S. processing capacity has the biggest effect

[3]The approximate relationships between ores and processed ferroalloys are:
2.5 tons ore = 1 ton ferrochromium
2 tons ore = 1 ton ferromanganese.

on ferrosilicon and silicon metal because of the current large U.S. production that we have assumed to be lost. Although the worldwide unused capacity is great enough to replace the lost U.S. production, the margin is the smallest of the three bulk ferroalloys. The United States is the third largest producer of ferrosilicon in the world and replacing its production absorbs a large portion of the world's unused processing capacity. Virtually all the unused capacity for silicon metal would have to be put into production to replace lost U.S. production.

Case 2

This case differs from the first case in that it assumes a disruption of all supplies from the Republic of South Africa. Such a disruption would not only affect U.S. imports from South Africa but also those of major processing countries such as Japan and West Germany. The importance of South African exports in world markets is shown in Table 3-6. South Africa is a significant producer of ores and ferroalloys and has substantial unused mining and processing capacity.

TABLE 3-6. SOUTH AFRICAN SUPPLIES LOST THROUGH DISRUPTION

(Thousand Short Tons – Gross Weight)

COMMODITY	NON-COMMUNIST WORLD PRODUCTION	SOUTH AFRICAN PRODUCTION FOR EXPORT	SOUTH AFRICA AS PERCENT OF NON-COMMUNIST WORLD
Ore			
Chromite	6,167	841	14
Manganese	12,331	2,439	20
Ferroalloy			
Ferrochromium	2,222	1,006	45
Ferromanganese	4,114	461	11
Ferrosilicon	2,462	134	5

SOURCE: OECD Import Microtables, 1983, Series C.

Table 3-7 shows the world supply-and-demand balance after eliminating South African ore and ferroalloy exports to the world markets. Column 4, the additional U.S. needs, does not change from the previous case because U.S. demand does not change. The decline in the first three columns of Table 3-7 is due to the disruption of South African supplies. For example, unused chromite ore capacity declines by 2.345 million tons – a loss of 1.504 million tons of unused mining capacity plus 0.841 million tons of chromite ore production that was exported. Even though unused ore and processing capacities both decline, adequate unused capacity is available elsewhere to replace South African supplies in the world market and to fill most of the U.S. requirement for additional imports. The small shortfall – 4,000 short tons – of silicon metal capacity (Column 4 less Column 3) cannot be replaced since the United States does not stockpile silicon and other ferroalloy capacity cannot be converted to produce silicon metal. However, a combination of conservation and substitution should make the shortfall manageable.

TABLE 3-7. PEACETIME SUPPLIES OF FERROALLOYS WITH SOUTH AFRICAN SUPPLY DISRUPTION

(Thousand Short Tons – Gross Weight)

COMMODITY	UNUSED ORE CAPACITY (1)	FERROALLOY PROCESSED FROM ORE (2)	UNUSED PROCESSING CAPACITY WORLDWIDE (3)	ADDITIONAL IMPORTS REQUIRED BY U.S. (4)
Ferrochromium	1,191	476	120	23
Ferromanganese	5,228	2,614	2,372	124
Ferrosilicon			693	469
Silicon metal			136	140

FERROALLOY AVAILABILITY DURING A MOBILIZATION

We now consider the world supply-and-demand balance with the supply reduced by the loss of U.S. capacity and the demand increased to support full capacity steel production in the United States. Ferrochromium imports to the United States must increase by 202,000 short tons, ferromanganese by 389,000 short tons, ferrosilicon by 621,000 short tons, and silicon metal by 181,000 short tons. Communist Bloc countries are assumed to discontinue exports to the West during a mobilization.

Case 1

Table 3-8 shows the supply of ferroalloys available and those needed by U.S. industry during mobilization and wartime. In this case, no disruptions to the non-Communist world supplies are assumed. Ample ore and processing capacity exists to meet U.S. demand for ferrochromium and ferromanganese. However, a shortage of processing capacity occurs for ferrosilicon and silicon metal. To relieve the ferrosilicon shortages, furnaces can be converted from the production of ferrochromium.[4] In this case, 75,000 tons of the remaining ferrochromium capacity would have to be converted to meet U.S. demand for ferrosilicon. For the silicon metal shortage, the United States would need to develop a processing capacity of

TABLE 3-8. SUPPLIES OF FERROALLOYS DURING MOBILIZATION

(Thousand Short Tons – Gross Weight)

COMMODITY	UNUSED ORE CAPACITY (1)	FERROALLOY PROCESSED FROM ORE (2)	UNUSED PROCESSING CAPACITY WORLDWIDE (3)	ADDITIONAL IMPORTS REQUIRED BY U.S. (4)
Ferrochromium	3,214	1,285	538	202
Ferromanganese	11,813	5,906	2,427	389
Ferrosilicon			583	621
Silicon metal			129	181

[4]The rate of conversion is 1 ton of ferrochromium capacity equivalent to 0.5 ton of ferrosilicon capacity. This rate is based on materials supplied by the Ferroalloys Association.

52,000 short tons (the difference between the 181,000 short tons required and the 129,000 short tons of unused capacity available) or would have to accept the shortage.

Case 2

Case 2 combines the assumptions of the previous case with that of a disruption of supplies from the Republic of South Africa to the West. That disruption causes serious shortages, as shown in Table 3-9. Column 3 shows that ferrochromium processing capacity is short by 273,000 tons. When the additional U.S. demand of 202,000 tons is added, the total shortfall is 475,000 tons.

TABLE 3-9. FERROALLOY SUPPLIES DURING MOBILIZATION WITH SOUTH AFRICAN SUPPLY INTERRUPTION

(Thousand Short Tons – Gross Weight)

COMMODITY	UNUSED ORE CAPACITY (1)	FERROALLOY PROCESSED FROM ORE (2)	UNUSED PROCESSING CAPACITY WORLDWIDE (3)	ADDITIONAL IMPORTS REQUIRED BY U.S. (4)
Ferrochromium	869	347	– 273	202
Ferromanganese	3,544	1,777	1,912	389
Ferrosilicon			561	621
Silicon metal			67	181

Table 3-4 lists some of the Western countries dependent on ore from South Africa. The interruption of South African supplies means that countries that export ferroalloys to the United States would have to find new ore sources. India and Zimbabwe have unused ore and processing capacities. Brazil, the Philippines, Finland, and Turkey have excess ore capacity but no excess ferrochromium processing capacity. Brazil and Turkey could, however, convert some of their excess ferromanganese processing capacity to the production of ferrochromium. Japan and

Sweden currently produce ferrochromium and also have excess ferromanganese capacity. They could produce more ferrochromium provided ore were available.

If all possible ferromanganese capacity were to be converted to ferrochromium, there would still be a shortage of 130,000 tons. At that point, the non-Communist world would have no excess chromite ore mining capacity and no unused ferrochromium processing capacity and no more unused ferromanganese processing capacity left to convert. The United States would then be forced to draw down the ferrochromium in the stockpile.

Shortages of processing capacity for ferrosilicon and silicon metal now total 174,000 tons; the United States would need 60,000 tons of ferrosilicon capacity and 114,000 tons of silicon metal capacity to meet its requirements.

Case 3

Case 3 adds to the assumptions of the previous case the disruption of supply from all African countries to the West. The shortages that develop under the assumption of the previous case worsen. Table 3-10 displays the effects of the loss of all supplies from Africa on the supply-and-demand balance for ferroalloys.

TABLE 3-10. FERROALLOY SUPPLIES DURING MOBILIZATION WITH ALL AFRICAN SUPPLIES INTERRUPTED

(Thousand Short Tons – Gross Weight)

COMMODITY	UNUSED ORE CAPACITY (1)	FERROALLOY PROCESSED FROM ORE (2)	UNUSED PROCESSING CAPACITY WORLDWIDE (3)	ADDITIONAL IMPORTS REQUIRED BY U.S. (4)
Ferrochromium	49	20	– 744	202
Ferromanganese	1,545	772	1,912	389
Ferrosilicon			500	616
Silicon metal			67	181

There is a shortage of 946,000 tons of ferrochromium processing capacity (744,000 tons from Column 3 plus 202,000 tons from Column 4), and unused capacity for mining chromite ore has about disappeared. Even if processing capacity could be found, the available ore is insufficient to supply the United States' ferroalloy requirements for mobilization. In this situation, the United States would have to draw down supplies of ferrochromium from the strategic stockpile.

The strategic stockpile currently holds both processed ferrochromium and chromite ore in the following amounts:

Chromite ore	–	1,835	thousand short tons – gross weight
Ferrochromium	–	751	thousand short tons – gross weight
Chrome metal	–	4	thousand short tons – gross weight

Under the existing stockpile upgrading program, additional amounts of chromite ore will be processed into ferrochromium. Because the worldwide shortage of processing capacity is so severe, the United States will not be able to import ferrochromium and will have to supply all ferrochromium requirements domestically. The stockpile of ferrochromium could supply U.S. needs for about 15 months. The stockpile also contains ore, some of which could be processed if foreign countries converted excess ferromanganese capacity. Allowing for the maximum amount of conversion, the West would still have a shortage of 500,000 tons of ferrochromium processing capacity. Adding the United States' additional demands from Column 4 of Table 3-8, the total shortage is 702,000 tons of processing capacity worldwide.

Unused ferromanganese processing and ore capacity are nearly equivalent and adequate. However, the countries with ore capacity do not have enough excess processing capacity to process their ore. Japan would have the most excess processing capacity followed by Spain, Sweden, and Norway. They would receive ore from Brazil and Australia. This calculation assumes no losses during shipment among these countries.

Ferrosilicon processing capacity and silicon metal capacity continue to be in short supply. The United States would need about 1 million tons of processing capacity to satisfy ferroalloy requirements. The capacity for ferrosilicon and silicon metal would be needed immediately while the ferrochromium capacity would be needed after the ferrochromium in the stockpile is depleted.

Case 4

Case 4 is the worst case scenario assessed; it adds a disruption of European supplies to the disruption of Case 3. The disruption of European supplies means the loss of a great deal of processing capacity. Severe shortages exist for chromite ore and for processing capacity for ferrochromium, ferrosilicon, and silicon metal. Table 3-11 shows the severity of the shortages. For the first time, the supply and demand of ferromanganese (Column 3 compared to Column 4) are nearly equal.

TABLE 3-11. FERROALLOY SUPPLIES DURING MOBILIZATION WITH SUPPLY INTERRUPTIONS IN AFRICA AND EUROPE

(Thousand Short Tons – Gross Weight)

COMMODITY	UNUSED ORE CAPACITY (1)	FERROALLOY PROCESSED FROM ORE (2)	UNUSED PROCESSING CAPACITY WORLDWIDE (3)	ADDITIONAL IMPORTS REQUIRED BY U.S. (4)
Ferrochromium	– 425	– 170	– 1,260	202
Ferromanganese	1,545	772	381	389
Ferrosilicon			– 640	616
Silicon metal			23	181

The non-Communist world would be completely dependent on Brazil, India, and the Philippines for chromite ore. Australia, Brazil, India, and Mexico would produce manganese ore. Much of both ores would have to be exported by these countries for processing elsewhere.

Because of the magnitude of the shortages, the United States would probably need to be self-sufficient in the production of ferrochromium, ferrosilicon, and silicon metal. The ferrochromium in the stockpile would satisfy industry requirements for about 15 months. After that, the United States would need to process the ore in the stockpile, but would be unable to unless domestic processing capacity is available. If the stockpiled ore could be processed, it would satisfy U.S. requirements for an additional 15 months, after which the United States would have to rely on its domestic reserves of high-cost chromite ore.

At today's prices, the chromium deposits found in the United States are not competitive with foreign sources of supply and consequently none are mined. In times of national emergency when cost is not a consideration, those resources could be utilized. Table 3-12 indicates the potential domestic sources of supply of chromite, estimated annual production measured by chromium content, and time required to bring production on line. Again, this option is only feasible with U.S. processing capacity.

Within 2 years, U.S. production would reach 132,000 metric tons, and within 3 years, it would reach its maximum production of 235,000 metric tons of chromite ore. Since the worldwide shortage of processing capacity precludes the processing of domestic ore in another country, the United States would need 1.4 million tons of processing capacity to meet its requirements.

In order to satisfy its demand for ferrochromium, ferrosilicon, and silicon metal, the United States would need the following processing capacity during a mobilization and war:

Year 1:	797	thousand short tons
Year 2:	1,252	thousand short tons
Year 3:	1,427	thousand short tons
Year 4:	1,350	thousand short tons

TABLE 3-12. POTENTIAL U.S. CHROMITE PRODUCTION

(Thousands of Metric Tons)

SOURCE	ANNUAL PRODUCTION CHROMIUM CONTENT	LEADTIME (YEARS)
Gish	16	2
Bar Rich Mine	16	2
McGuffy Creek	NA	2
Pilliken Mine	65	2
Southwest Oregon	35	2
Subtotal	132	
Mouat/Benboe	72	3
Seiad Greek/Emma Bell	17	3
Gasquet Mountain	14	NA
Subtotal	103	
GRAND TOTAL	235	

SOURCE: Office of Technology Assessment, *Strategic Materials: Technologies to Reduce U.S. Import Vulnerability*, Washington, DC Table 5-12, p. 151.

The capacity requirement declines in Year 4 because the United States would be completely dependent on domestic production of chromite ore, which cannot satisfy total demand.

In addition to producing ferrochromium from the chrome ore in the stockpile or from mining domestic ore, the United States could also produce ferrosilicon and silicon metal from abundant domestic quartz provided processing capacity were available.

METALS

Chrome metal, manganese metal, and silicon metal are used to give aluminum and cast iron certain desirable properties. Although consumed in small quantities, they are necessary in the production of many defense goods. Chrome and manganese metals are produced by electrolysis or by a metallothermic process. Silicon metal is produced in a submerged arc furnace like other ferroalloys. Table 3-13 shows the supply and consumption of the pure metals. Imports of chrome metal are substantial on a percentage basis, but actual consumption is small. Imports are a small portion of consumption of manganese and silicon metals.

TABLE 3-13. U.S. METALS SUPPLY AND CONSUMPTION: 1980-1984

(Thousand Short Tons)

	1980	1981	1982	1983	1984
Chrome Metal					
Domestic Shipments	4	3	2	3	3
Net Imports	4	4	2	3	5
Reported Consumption	6	4	3	4	4
Net Imports as a % of Consumption	67	100	67	75	125
Manganese Metal					
Domestic Shipments	22	20	15	17	14
Net Imports	-4	5	2	0	9
Reported Consumption	25	24	17	18	28
Net Imports as a % of Consumption	–	21	12	0	32
Silicon Metal					
Domestic Shipments	125	124	81	123	139
Net Imports	7	20	24	24	20
Reported Consumption	123	123	82	100	114
Net Imports as a % of Consumption	6	16	29	24	18

SOURCE: Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984.

Only 4,000 tons of chrome metal were consumed in 1984, most of which was used to produce superalloys. The important property of the superalloys is an exceptional resistance to corrosion and oxidation at temperatures above the range where steel can be used. Since the superalloys retain their strength under conditions of high temperature and stress, they are critical for certain parts of jet engines that must operate in a high-temperature, highly corrosive environment. Turbine blades and vanes, turbine disks, and combustion liners are made from superalloys. Superalloys are also used in land- and sea-based turbine engines.

While superalloys may be producible with reduced amounts of chrome, another critical material, e.g., cobalt, would have to be substituted for the chrome. Chrome cannot be eliminated completely from superalloys. Since many weapon systems use turbine engines, chrome metal is essential for the production of these weapon systems.

Some pure manganese metal is also used in producing steel. Most of the manganese metal consumed domestically goes into nonferrous alloys, predominantly aluminum alloys and some copper alloys. Aluminum alloys with manganese added can better resist corrosion. Aluminum alloys are used in electrical products and in containers and packaging. Manganese adds strength to copper alloys and is also used as a deoxidizer. Copper alloys with manganese are used in propellers and marine fittings.

Silicon metal is also used by the aluminum and chemical industries as a deoxidizer and a strengthening agent. Silicon is processed into lubricants, low-temperature hydraulic fluids, electric insulators, and moistureproof agents.

Ultra-high-purity silicon is used to produce semiconductors, photovoltaic cells, and infrared optical devices. Computers and most sophisticated electrical equipment use integrated circuits that require semiconductors.

Silicon could become much more important as technology progresses. Silicon metal is used in advanced ceramics that have applications in electronics and as a metal substitute. As a metal substitute, ceramics would have better heat, wear, and corrosion resistance than metals and their use could lead to lighter and more efficient turbine engines.

SUMMARY OF FINDINGS

In this chapter, we have evaluated the implications of a loss of domestic ferroalloy processing capacity. The evaluation has been conducted for supply-and-demand levels experienced in peacetime and expected during mobilization and across a number of supply disruptions affecting the availability of ferroalloy imports to the United States and other Western countries.

The major findings for each of these situations are summarized in Table 3-14. The display traces the supply situation for each ferroalloy and indicates actions possible to counter a shortage.

TABLE 3-14. SUMMARY OF FINDINGS

DEMAND ASSUMPTIONS	SUPPLY ASSUMPTIONS			
	No Supply Disruptions	Supply Disruption Republic of South Africa	Supply Disruption All of Africa	Supply Disruption All of Africa and All of Europe
Peacetime ● No U S Processing Capacity	● Ample processing capacity worldwide (includes Soviet bloc)	● Large FeMn excess capacity worldwide ● Extremely tight supply/demand balance in silicon metal	Not Analyzed	Not Analyzed
Mobilization ● No U S Processing Capacity ● Steel Output at Full Capacity ● No Soviet Bloc Supplies	● Ample ore and processing capacity for FeCr and FeMn ● Shortage of FeSi processing capacity, but more than sufficient FeCr excess capacity for conversion ● Silicon metal processing capacity shortfall (conversion impossible) ● United States needs 50,000 tons of ferroalloy processing capacity	● FeCr shortage requires Japanese and European conversion of processing capacity (FeMn to FeCr) and drawdown of U S chrome ore stockpile ● Adequate FeMn processing capacity and ore ● Shortfall of FeSi capacity and silicon metal; no capacity available for conversion ● United States needs 175,000 tons of ferroalloy processing capacity	● Severe shortage of chromite ore and FeCr processing capacity ● Chrome ore available in U S stockpile cannot be processed anywhere ● FeCr in stockpile good for 15 months ● Adequate supplies of manganese ore (Australia, Brazil, India, Mexico) and processing capacity (Brazil, Europe, and Japan) ● Shortages of FeSi processing capacity and silicon metal ● United States needs 1 million tons of ferroalloy processing capacity	● Deepening shortage of chrome ore and FeCr processing capacity ● Chrome ore in U S stockpile cannot be processed anywhere ● FeCr in stockpile good for 15 months ● Manganese ore adequate but FeMn processing capacity inadequate ● FeMn stockpile drawdown adequate for 3+ years ● Shortage of FeSi processing worldwide and silicon metal ● United States needs 1 4 million tons of ferroalloy processing capacity ● U S ore production also required

KEY: FeCr, ferrochromium; FeMn, ferromanganese; FeSi, ferrosilicon.

APPENDIX A

U.S. AND WORLD SUPPLY RELATIONSHIPS

U.S. INDUSTRY STATISTICS

Approximately 90 percent of the ferroalloys consumed in the United States are used in the domestic steel industry, and thus much of the demand for ferroalloys depends on the level of domestic steel production. Table A-1 shows the trends for steel consumption, production, and imports.

TABLE A-1. SUPPLY STATISTICS FOR THE STEEL INDUSTRY: 1975-1984

(Million Short Tons)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	AVERAGE ANNUAL PERCENT CHANGE
Raw Steel Production	117	128	125	137	136	112	121	75	85	92	-2.6
Steel Mill Product Shipments	80	89	91	98	100	84	88	62	68	74	0.9
Net Imports	9	11	17	19	15	11	17	15	16	25	12.0
Apparent Consumption	89	101	108	117	115	95	105	76	84	99	1.2
Net Imports as a Percent of Consumption	10	11	16	16	13	12	16	20	19	25	

SOURCE: Department of Commerce, "U.S. Industrial Outlook," 1984 and 1986.

During the 10-year period 1975 through 1984, the steel industry had a period of expansion, followed by two recessions: a mild one in 1980 and a severe one in 1982. Domestic steel consumption increased at an average rate of 1.2 percent per year during the 10-year period. However, domestic steel production actually decreased by 2.6 percent a year while imports increased by 12 percent a year. The domestic steel industry has contracted while the market share for imports has about doubled to one-fourth of the market. Because of the decline in domestic steel production, the demand for ferroalloys also declined.

During the same period, the ferroalloy industry experienced trends similar to those in the steel industry. Domestic shipments have declined while imports have increased. Table A-2 shows the import share has doubled, going from 32 percent in 1975 to 63 percent in 1984. While the overall import share for ferroalloys is around 63 percent, the import shares for certain ones are much higher. The United States imports 94 percent of the ferrochromium consumed and 85 percent of the ferromanganese consumed. Ferrosilicon is the only bulk ferroalloy for which the domestic industry still has a major share of the market.

TABLE A-2. FERROALLOY CONSUMPTION, PRODUCTION, AND IMPORTS: 1975-1984

(Thousand Short Tons – Gross Weight)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Average Annual Percent Change
Ferrochromium											
Domestic Shipments	227	267	275	248	284	234	191	[illegible]	50	38	[illegible]
Net Imports	310	245	228	309	227	270	426	143	279	419	[illegible]
Apparent Consumption	600	533	496	527	488	502	629	238	295	446	[illegible]
Net Imports as a Percent of Consumption	52	46	46	59	47	54	68	60	94	94	
Ferromanganese											
Domestic Shipments	682	626	460	471	498	355	340	[illegible]	[illegible]	[illegible]	[illegible]
Net Imports	420	511	617	762	886	654	780	539	461	532	2.7
Apparent Consumption	1,187	1,037	1,060	1,164	1,370	1,004	1,117	[illegible]	539	628	-6.8
Net Imports as a Percent of Consumption	35	49	58	66	65	65	70	74	86	85	
Ferrosilicon											
Domestic Shipments	543	689	710	685	711	557	514	334	359	498	[illegible]
Net Imports	30	86	104	124	92	43	139	62	146	114	16.0
Apparent Consumption	580	774	804	825	798	586	693	373	463	618	0.7
Net Imports as a Percent of Consumption	5	11	13	15	12	7	20	17	32	18	
Ferroalloy Industry											
Domestic Shipments	1,452	1,582	1,445	1,404	1,193	1,146	1,045	621	549	676	-8.1
Net Imports	760	842	949	1,195	1,205	967	1,345	744	885	1,065	3.8
Apparent Consumption	2,367	2,344	2,360	2,516	2,655	2,092	2,439	1,341	1,297	1,692	-3.7
Net Imports as a Percent of Consumption	32	36	40	47	45	46	55	55	68	63	

SOURCE: Appendix D, Table D-1.

WORLD TRADE FLOWS

The Organization for Economic Co-operation and Development (OECD) collects import data for countries belonging to the OECD.[1] The trade flow in ferroalloys is intertwined with the trade flows in steel and the ores used to make ferroalloys. A

[1] OECD Import Microtables, 1983, Series C.

very complex set of interdependencies emerges. A few countries, South Africa and the Soviet Union for example, mine ore; process ferroalloys; and, especially in the case of the latter, produce steel. Ore production is limited to countries with economically producible reserves, but most countries that produce steel have at least some ferroalloy-processing capacity. Each country is unique in how it divides its dependency between its domestic industry and imports. Many countries both import and export large quantities of ferroalloys while others only import or only export a single one.

Tables in this appendix present the 1983 trade data for chromite and manganese ores, ferroalloys, and steel products. They show the amount of trade between each importing and exporting country. The importing countries are necessarily limited to those belonging to the OECD—most of Europe plus Canada, the United States, Japan, Australia, and New Zealand. The OECD countries account for 50 percent of world steel production and 83 percent of non-Communist steel production.[2]

Each trade table shows import-export trade flows, measured in gross weight of the commodity.[3] The importing countries are those belonging to the OECD and are arranged across the top of the table. The exporting countries, not limited to the OECD, are listed down the first column. The column labeled "Domestic Production" is taken from the Bureau of Mines' "Minerals Yearbook" and has been converted into metric tons.

The last column shows, for each exporting country, domestic production less exports to the OECD countries. This column indicates how much of the exporting

[2]Yugoslavia participates in the OECD under a special status.

[3]Quantities are in metric tons so the OECD data must be converted to conform to data from the Bureau of Mines, which is given in short tons (1 short ton = 0.907 metric ton).

country's production is consumed internally (or perhaps exported in more finished form). The data do not cover trade flows for the non-OECD world (Africa, South America and Asia), nor do the data show the extent to which countries in Africa, South America, and Asia trade with each other. However, the OECD produces 83 percent of the free world's steel, and so these trade flows must be relatively small. The tables also do not show trade flows within the Communist Bloc.

The data are nearly complete with a few exceptions. For example, data on imports into Australia are almost never available, but other sources show that Australia is not a major steel producer. U.S. imports of manganese ore were not available from the OECD tables, but those data are available from the Bureau of Mines.

The OECD classification scheme breaks ferroalloys into ferromanganese, ferrosilicon, and other ferroalloys. This last category contains ferrochromium and other alloys, so it is impossible to break out ferrochromium alone. Data from the Bureau of Mines indicate that ferrochromium accounts for about one-half of the other ferroalloys produced. For some countries, the quantities reported contain mostly ferrochromium; for others very little.

Trade Flows in Steel Products

In 1983, worldwide steel production was 662 million metric tons (730 short tons). The major producers were the Soviet Union (23 percent of total), Japan (15 percent), the United States (12 percent), West Germany (5 percent), and other Communist countries (7 percent). Table A-3 shows the large and complex trade in steel throughout the world. Approximately 10 percent of world production enters world trade – an average 10 percent of the steel produced by any one country is consumed elsewhere. Many countries that produce steel products are both importers and exporters of steel. For example, West Germany is the largest exporter

TABLE A-3. WORLD TRADE IN IRON AND STEEL: 1983

(Gross Weight – Thousand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY											
	Canada	U.S.	Belgium Luxemburg	Denmark	France	West Germany	Greece	Italy	Netherlands	U.K.	Austria	Finland
Canada		2,093.2	6.4		10.4	12.4	32.9	77.0		17.9		0.4
U.S.	461.3		2.5	0.3	3.1	6.4	0.7	61.2	7.0		0.1	0.3
Japan	128.3	3,697.0	38.7	9.9	33.5	97.5	63.4	24.9	17.8	56.2	4.0	5.8
Australia	12.4	168.1	19.1		16.5	76.7	36.1	14.5	1.2	10.4		
Austria	4.8	31.2	22.8	38.0	79.5	671.1	5.4	279.2	59.0	77.2		9.4
Belgium Luxemburg	85.1	546.9		107.7	2,898.3	2,730.8	76.2	780.9	904.9	429.6	77.2	39.3
Denmark		0.1	10.6		17.4	131.6	0.1	6.9	28.4	75.0	7.8	7.4
Finland	1.5	178.3	32.7	103.6	38.6	265.2	0.4	15.1	41.1	74.2	7.7	
France	101.8	821.2	794.3	93.7		1513.0	210.7	1,447.1	263.5	297.8	43.2	46.8
West Germany	56.2	1,248.7	959.8	403.7	1,913.3		135.7	806.0	1,280.6	914.3	410.0	109.9
Italy	9.0	379.0	128.7	18.1	1,383.1	1,515.4	106.8		108.3	188.0	130.0	3.2
Netherlands	9.1	337.1	650.9	63.5	159.0	940.1	261.0	210.9		470.0	9.5	10.7
Norway		1.7	19.2	43.7	11.7	111.0	0.1	7.3	171.3	107.1	0.1	16.6
Spain	19.1	504.7	163.8	10.1	423.1	577.3	12.5	65.8	48.3	136.5	1.3	24.1
Sweden	15.4	190.7	59.2	261.4	132.1	480.6	33.3	67.4	76.0	304.4	8.5	139.7
Switzerland	0.2	0.8	10.5	11.1	54.3	450.2	1.2	97.3	21.4	8.0	31.1	3.2
U.K.	104.8	348.6	119.7	144.8	183.7	359.6	392.5	146.7	137.2		19.7	54.3
USSR			5.5	16.7	23.2	75.2	17.9	149.3	0.4	10.3	2.8	28.1
East Germany			39.1	55.3	65.6		4.8	178.6	20.1	27.3	14.2	16.1
Poland	0.2	45.9	30.6	9.1	18.3	180.6	0.4	0.3	10.5	57.3	18.9	33.5
Czechoslovakia	1.5	17.3	15.9	39.7	61.3	363.3	33.7	148.4	28.2	17.4	21.0	62.6
Hungary		1.8	1.1	14.1		164.3	14.1	79.0		7.4	65.9	7.7
Romania		4.3	2.9		38.8	110.9	1.1	13.1	2.6	19.8	4.4	12.3
Bulgaria			18.9	0.1	20.1	57.7	17.1	35.2	8.8	13.9	5.3	
S. Africa	8.3	505.2	23.9		1.8	101.0	38.4	11.1	1.9	44.0		
Mexico	5.1	570.6	2.7			20.0			0.3	0.1		
Venezuela	5.3	141.9	27.8			113.8			1.0			
Brazil	40.7	1,127.5	5.8	9.9	0.6	40.5	8.1	33.4	0.3	2.4	[illegible]	7.6
S. Korea	28.0	1,418.2	3.1		1.4	44.9	8.3	0.4	2.1	20.6		0.1
Other	5.7	495.2	83.9	8.1	77.4	344.4	30.4	189.2	11.7	68.8	10.8	
Total	1,103.8	14,875.2	3,300.1	1,462.6	7,646.1	11,555.5	[illegible]	4,946.2	3,253.9	3,455.3	897.2	633.1

NOTE: Totals may not add due to rounding.
SOURCE: OECD Import Microtables, 1983, Series C.

TABLE A-3. WORLD TRADE IN IRON AND STEEL: 1983 (Continued)

(Gross Weight – Thousand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY									EXPORTING COUNTRY	
	Norway	Portugal	Spain	Sweden	Switzerland	Turkey	Yugoslavia	Other[a]	Total	Domestic Production[b]	Production Less Exports to OECD
Canada	0.1		3.9	0.2	1.2	16.8		1.8	2,274.6	12,825.0	10,550.4
U.S.	0.6	0.1	6.3	1.7	1.2	9.9	2.2	5.0	569.9	76,745.8	76,175.9
Japan	82.3	8.8	17.2	31.3	17.6	101.1	4.1	318.4	4,757.8	97,158.7	92,400.9
Australia								119.1	355.0	5,623.4	5,268.4
Austria	13.1	2.8	5.3	60.4	105.0	23.2	87.9	4.5	1,579.8	4,409.8	2,830.0
Belgium - Luxemburg	109.4	77.3	51.2	227.3	216.1	9.5	3.3	27.5	9,391.5	13,448.1	4,056.6
Denmark	43.4	0.9	0.1	114.5	6.7			6.0	456.9	492.5	35.6
Finland	40.7	0.4	5.0	158.2	10.9	1.6	0.5	8.0	983.7	2,415.3	1,431.6
France	55.2	72.8	312.0	168.3	300.0	26.9	40.4	31.5	6,634.2	17,619.4	10,985.2
West Germany	189.9	227.9	212.8	505.4	590.9	148.7	115.1	34.8	10,263.7	35,721.3	25,457.6
Italy	6.7	20.1	65.5	4.6	294.1	105.2	106.3	13.2	4,585.3	21,669.1	17,083.8
Netherlands	114.2	47.6	91.9	121.7	70.8	129.8	2.0	16.5	3,716.3	4,476.0	759.7
Norway		3.8	5.7	79.5	0.9	0.1	0.1	6.4	595.3	830.8	235.5
Spain	6.4	52.3		40.1	17.9	11.5	29.1	9.9	2,253.8	12,728.8	10,475.0
Sweden	221.5	25.1	28.3		16.0	34.8	15.7	18.0	2,138.1	4,209.4	2,071.3
Switzerland	2.1	0.1	1.3	5.3		46.7	1.1		746.0	952.4	206.4
U.K.	112.0	21.7	113.6	165.0	122.3	23.3	16.1	229.5	2,815.1	14,982.7	12,167.6
USSR	0.5	2.7				116.0	302.5	0.2	751.3	152,483.0	151,731.7
East Germany	3.3	39.8	15.5	42.6	17.2	35.2	21.8	2.7	599.2	7,217.9	6,618.7
Poland	22.9		0.3	50.5	0.5	12.8	156.8	0.7	650.1	16,232.6	15,582.5
Czechoslovakia	8.7	4.0	4.0	38.4	9.9	6.8	415.8	4.1	1,302.0	15,020.8	13,718.8
Hungary	8.0	1.2		4.3	3.1	25.0	67.8		464.8	3,615.3	3,150.5
Romania		2.2	24.3	6.2	5.0	39.6	71.6		339.1	12,590.1	12,251.0
Bulgaria		0.1	25.0		0.9	144.7	26.9		374.7	2,830.7	2,456.0
S. Africa		22.4	21.3		7.1	92.5		0.6	879.5	7,002.9	6,123.4
Mexico									598.8	6,976.6	6,377.8
Venezuela					0.1	10.0			299.9	2,557.7	2,257.8
Brazil		9.9	25.2	2.7	3.4	84.1		0.1	1,402.9	14,656.2	13,253.3
S. Korea	0.1	10.0		0.1		0.3		4.8	1,541.8	11,912.5	10,370.7
Other	8.7		104.3	6.5	3.1	56.8	47.3		1,662.3	82,969.1	81,306.8
Total	1,049.8	654.0	1,140.0	1,834.8	1,821.9	1,412.9	1,534.4	863.3	64,983.4	662,373.9	597,390.5

[a]Other = New Zealand, Iceland, and Ireland.

[b]Source: U.S. Department of Interior, Bureau of Mines, Minerals Yearbook, 1984.

NOTE: Totals may not add due to rounding.

SOURCE: OECD Import Microtables, 1983, Series C.

of steel products to the OECD, but West Germany imports slightly more than it exports.

Table A-4 lays out the trading partners and dependencies for ferroalloys of the major steel producers. The Soviet Union and other Communist Bloc countries are self-sufficient in ore and ferroalloy-processing capacity. Japan, the United States, and West Germany are all heavily dependent on the Republic of South Africa.

TABLE A-4. TRADE RELATIONSHIPS OF MAJOR STEEL PRODUCERS

	SOURCES OF FERROCHROMIUM AND OTHER FERROALLOYS (% of imports)	SOURCES OF FERROMANGANESE (% of imports)	SOURCES OF FERROSILICON (% of imports)	SOURCES OF CHROMITE ORE (% of imports)	SOURCES OF MANGANESE ORE (% of imports)
Soviet Union and Communist Bloc	Self	Self	Self	Self	Self
Japan	South Africa (48) Brazil (21)	a	Norway (24) Brazil (23) Venezuela (10)	South Africa (47) Communist Bloc (22)	South Africa (52) Australia (25)
United States	South Africa (43) Zimbabwe (12) Yugoslavia (11)	France (34) South Africa (26)	Norway (20) Canada (19) Brazil (19)	South Africa (76)	Gabon (46) Brazil (21)
West Germany	South Africa (36) Norway (12) Zimbabwe (10)	Norway (42) France (35)	Norway (51) France (16)	South Africa (55) Albania (31)	South Africa (67) Australia (23)

[a]Negligible quantities of imports.

The largest importers of steel products are the United States (23 percent of all imports), West Germany (18 percent), France (12 percent), and Italy (8 percent). Table A-5 shows the sources of steel imports for those countries.

TABLE A-5. SOURCES OF STEEL PRODUCT IMPORTS FOR THE OECD

IMPORTING COUNTRY	SOURCE COUNTRY	THOUSAND METRIC TONS	SOURCE COUNTRY IMPORTS AS A PERCENT OF TOTAL IMPORTS
United States	Japan	3,697	25
	Canada	2,093	14
	South Korea	1,418	10
	West Germany	1,249	8
	Brazil	1,128	8
West Germany	Belgium-Luxemburg	2,731	24
	Italy	1,515	13
	France	1,513	13
	Netherlands	940	8
France	Belgium-Luxemburg	2,898	38
	West Germany	1,913	25
	Italy	1,383	18
Italy	France	1,447	29
	Belgium-Luxemburg	781	16

Trade Flows in Ferroalloys

World trade flows for each of the major bulk ferroalloys are tabulated in this subsection. Table A-6 shows trade flows in ferromanganese. The major producers are the Soviet Union and Japan. Each country uses most of its production for home consumption in steelmaking and exports only token quantities to the OECD.

No one country is the dominant supplier of ferromanganese for the OECD. The three largest suppliers are the Republic of South Africa (23 percent), France (28 percent), and Norway (22 percent). South Africa exports about half its ferromanganese production to the OECD, and France and Norway each exports about 70 percent of its production to the OECD. France and Norway depend on South Africa and Gabon for 80 to 90 percent of their ore requirements.

The United States is the largest importer of ferromanganese within the OECD, taking 40 percent of all exports. The largest source of U.S. imports is France accounting for one-third of all ferromanganese imports into the United States.

TABLE A-6. WORLD TRADE IN FERROMANGANESE: 1983

(Gross Weight – Thousand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY										EXPORTING COUNTRY	
	U.S.	Belgium – Luxemburg	France	West Germany	Italy	U.K.	Sweden	Turkey	Other[a]	Total	Domestic Production[b]	Production Less Exports to OECD
Belgium – Luxemburg	2.2		4.7	7.3					0.2	14.4	89.8	75.4
France	100.9	26.4		34.5	22.8	7.0	5.6	1.9	8.6	207.7	274.8	67.1
West Germany	4.9	6.0	1.8		5.5	1.9	0.4	0.6	6.4	27.5	151.5	124.0
Norway	22.7	19.0	14.1	41.3	9.9	21.6	20.7	2.7	10.3	162.2	224.0	61.8
Portugal	15.2		0.6		4.1	1.3		0.3	1.3	22.8	33.6	10.8
S. Africa	75.6		0.8	4.1	14.4	66.1	2.0	6.2	4.4	173.6	350.1	176.5
Mexico	31.3								7.7	39.0	138.8	99.8
Brazil	24.6							2.7	6.8	34.1	103.4	69.3
Other	15.7	2.7	0.8	11.0	8.0	1.0	0.1	7.5	14.1	60.9	3,828.0[c]	3,767.1
Total	293.0	54.1	22.8	98.2	64.7	98.9	28.8	21.9	59.8	742.2	5,194.0	4,451.8

[a]Other = Canada, Japan, New Zealand, Denmark, Greece, Ireland, Netherlands, Austria, Finland, Iceland, Norway, Portugal, Spain, Switzerland, and Yugoslavia.

[b]Source: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984.

[c]The USSR accounts for 1,751.4 tons in the other category. USSR production is consumed within the Communist Bloc.

NOTE: Totals may not add due to rounding.

SOURCE: OECD Import Microtables, 1983, Series C.

France depends on Gabon and South Africa for almost all the ore it processes. South Africa supplies an additional 20 percent of U.S. imports of ferromanganese. The remaining U.S. imports are spread fairly evenly among Norway, Portugal, Mexico, and Brazil, all with a 5 to 10 percent share of imports.

As shown in Table A-7, the largest producers of ferrosilicon are the USSR, the United States, and Norway. The USSR and the United States produce mainly for their own consumption and do not export appreciable quantities to the OECD. Norway is the major exporter to the OECD with 30 percent of total OECD imports, followed by Brazil (11 percent) and France (9 percent).

Japan and West Germany are the largest importers of ferrosilicon. Japan depends on Norway and Brazil; West Germany depends on Norway and France. The United States accounts for 16 percent of the ferrosilicon imports into the OECD. The largest source of supply for the United States is Norway with 20 percent of U.S. imports.

Table A-8 shows trade flows of all other ferroalloys combined. Ferrochromium is the largest component in this category with the remaining flows accounted for by a number of minor or specialty ferroalloys. The USSR, the Republic of South Africa, and Japan are the largest producers of other ferroalloys. They account for 92 percent of world production. South Africa exports almost all of its production (predominantly ferrochromium) to OECD countries. Japan and the Soviet Union consume most of their ferrochromium production.

The major sources of ferrochromium and other ferroalloy imports to the OECD are South Africa, Zimbabwe, Sweden, and Brazil. The United States depends on South Africa, Zimbabwe, Yugoslavia, and Brazil for its ferrochromium imports. South Africa, Zimbabwe, and Brazil process their own chromite ore into ferrochromium. Sweden depends on Finland and South Africa for ore; Yugoslavia depends on Albania.

TABLE A-7. WORLD T. ADL 'N F.RROSILICON: 1983

(Gross Weight – housand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY										EXPORTING COUNTRY	
	U S	Japan	Belgium – Luxemburg	France	West Germany	Italy	U K	Sweden	Other[a]	Total	Domestic Production[b]	Production Less Export to OECD
Canada	26 5	15 8			0 6					42 9	85 3	42 4
U S		0 4			0 8				12 6	13 8	284 8	271 0
France	5 7	19 9	5 8		30 8	13 5		0 1	3 5	79.3	192 3	113 0
West Germany	2 1		10 5	5 1		13 2		0 6	5 4	36.9	70.7	33 8
Iceland	7 1	8 5	0 4	1 0		0 8				17.8	50 8	33 0
Norway	27 0	65 6	9 7	13 8	95 0	10 5		21 6	12 2	255 4	345 6	90 2
Sweden	0 3	4 2	1 3	2.2	5 9	0 6			0 8	15 3	15 4	0 1
USSR	14 3	0 9	3 3	0 3	7.4	1.2		1 4	2 5	31 3	720 2	688 9
Yugoslavia	1 2	15 1		0 1	8 6	5 8			0 6	31 4	81 6	50 2
S Africa		10 4	0 1	0 1					0 9	11 5	99 8	88 3
Venezuela	21 8	28 4			2 2					52 4	46 3	(6 1)
Brazil	26 3	62 7			1 8				0 3	91 1	156 9	65 8
Philippines		20 0								20 0	20 0	0
Other	4 7	22 0	1 8	3 8	34 9[c]	0 5	69 7[d]	0 2	12 6	150 3	1,168 3	1,018 0
Total	137 0	273 9	32 9	26 4	188 0	46 1	69 7	23 9	51.4	849 3	3,338 0	2,487 7

[a]Other = Canada, Denmark, Greece, Ireland, Netherlands, Austria, Finland, Iceland, Norway, Portugal, and Spain.

[b]Source: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984.

[c]27.3 tons classified secret.

[d]All secret.

NOTE: Totals may not add due to rounding.

SOURCE: OECD Import Microtables, 1983, Series C.

TABLE A-8. WORLD TRADE IN FERROALLOYS OTHER THAN FERROMANGANESE AND FERROSILICON: 1983

(Gross Weight – Thousand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY													EXPORTING COUNTRY	
	Canada	U.S.	Japan	Belgium Luxemburg	France	West Germany	Italy	U.K.	Finland	Spain	Sweden	Other[a]	Total	Domestic Production[b]	Production Less Exports to OECD
U.S.	10.2		2.4	4.4		0.8		0.2			0.1		18.1	323.8	305.7
Japan		4.5			1.7	8.2	0.1				1.0		15.5	711.1	695.6
Australia		14.0	0.5									1.0	15.5	21.8	6.3
Belgium Luxemburg	1.3	0.2	0.1		5.0	6.1	1.3				0.8		14.8	0	(14.8)
Finland					8.1	3.0					6.6	0.4	18.1	59.0	40.9
France	1.2	0.5	2.3	6.9		15.7	10.5	5.7	1.2	7.3	0.3	0.9	52.5	238.5	186.0
West Germany	0.1	1.5	1.6	8.0	5.7		6.3		0.2	2.3	2.4	1.7	29.8	70.7	40.9
Italy	0.1	0.2	0.4	0.9	9.7	13.3		6.1			0.1		30.8	96.1	65.3
Norway		5.7	2.5	14.9	19.6	60.7	15.5	31.9	9.3		12.5	2.9	175.5	273.9	98.4
Portugal		9.0	3.4	1.0		26.7	2.2			2.0		3.8	48.1	49.0	0.9
Sweden	0.3	9.5	0.1	0.1	18.0	27.0	5.9	26.1	1.0	4.3		0.3	92.6	161.4	68.8
Turkey		12.9		3.9	5.1	7.0		2.1			1.0		32.0	29.9	(2.1)
USSR		0.1	9.1	4.8	1.9	3.7	0.2		6.8		3.8		30.4	749.2	718.8
Czechoslovakia				1.3	0.2	11.0	2.4	2.6				0.4	17.9	41.7	23.8
Albania		3.3		5.7	1.5	1.5	2.7			2.4	7.6	1.0	25.7	35.4	9.7
Yugoslavia	2.5	41.8	1.5	4.8	0.2	0.2	8.8			0.5	0.5		60.8	129.7	68.9
Zimbabwe	2.1	45.3	32.9	2.1	8.0	52.6	28.4	16.6	0.3	5.5	0.2	0.1	194.1	157.8	(36.3)
S. Africa	20.6	167.8	220.4	1.4	56.4	185.2	19.3	25.4		20.6	16.4	2.3	735.8	790.9	55.1
Mexico		4.9	11.4										16.3	45.4	29.1
Dominican Republic	0.6	16.0	7.0	1.4	4.7	2.7	2.6	2.9	2.5	0.7	2.2		43.3	54.4	11.1
Brazil	0.9	36.4	95.4	0.5	2.1	14.9	0.8	0.5	0.5	0.1	2.6	0.6	155.3	327.4	172.1
Indonesia		1.9	10.6	0.7	2.0	4.4			1.6		1.3		22.5	20.9	(1.6)
Philippines			21.5										21.5	21.8	0.3
New Caledonia		8.4	16.8		63.7	18.1	1.6			0.3	4.1		113.0	69.8	(43.2)
Other	0.3	9.8	23.8	10.2	9.2	45.3	5.7	18.9	6.4	3.2	3.5	15.1	151.4	1,360.4	1,209.0
Total	40.2	393.7	463.7	73.0	222.8	508.1	114.3	139.0	29.8	49.2	67.0	30.5	2,131.3	5,840.0	3,708.7

[a]Other = New Zealand, Denmark, Greece, Ireland, and Netherlands.

[b]Source: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984.

NOTE: Totals may not add due to rounding.

Trade Flows in Chromite and Manganese Ores

Ore production is concentrated in a few countries that have economically producible reserves. Table A-9 shows trade flows in chromite ore. The largest producers are the Soviet Union (35 percent of world production), South Africa (26 percent), and Albania (11 percent). The Soviet Union exports small quantities of ore to the OECD countries. South Africa exports only a small proportion of its ore production and instead processes most of its ore into ferrochromium.

TABLE A-9. WORLD TRADE IN CHROMITE ORES AND CONCENTRATES: 1983

(Gross Weight – Thousand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY								EXPORTING COUNTRY	
	U S	Japan	West Germany	Italy	U K	Yugoslavia	Other[a]	Total	Domestic Production[b]	Production Less Exports to OECD
Turkey		21 3	18 9	37 6	2 3	4.0	6 4	90.5	511 5	421 0
USSR		66 6		5 5		54 2		126 3	2,938.7	2,812 4
Albania	5 4	76 6	77 8	120 2		144 6	45 0	469 6	897 9	428.3
Madagascar	18 3	29 8						48 1	45.4	(2.7)
S Africa	124 3	301 7	135 1	21 6	91 9		88 7	763 3	2,231 2	1,467 9
India		77 7						77 7	421 8	344 1
Philippines	11 1	36 9	3 9	1 2	0 5		1 0	54 6	266 7	212 1
Other	5 1	34 5	12 0	5 9	5 6		32 4	95 5	1,200 8	1,105 3
Total	164 2	645 1	247 7	192 0	100 3	202 8	173 5	1,725 6	8,514 0	6,788 4

[a]Other = Canada, Belgium – Luxemburg, Denmark, France, Greece, Ireland, Netherlands, Austria, Finland, Iceland, Norway, Portugal, Spain, Sweden, Switzerland, and Turkey.

[b]Source: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984

NOTE: Totals may not add due to rounding.

SOURCE: OECD Import Microtables, 1983, Series C.

Japan is the largest importer of chromite ore accounting for 37 percent of OECD imports. Although Japan gets some ore from all major producers, it depends on South Africa for almost half its imports. The United States produces only small quantities of ferrochromium domestically, depending on South Africa for most of the small amount of chromite ore it requires.

Table A-10 describes trade flows and production of manganese ore. The Soviet Union is the largest producer in the world, accounting for 44 percent of production. South Africa (13 percent of world production), Brazil (10 percent), and Gabon (9 percent) are the major non-Communist producers of manganese ore.

South Africa and Gabon provide most of the exports to the OECD, accounting for 41 percent and 25 percent, respectively, of the manganese ore imported by OECD countries. Japan is the largest importer with 31 percent of the total. France (14 percent), Norway (12 percent), and West Germany (8 percent) also import substantial quantities of manganese ore.

The United States imports relatively small amounts of manganese ore from Gabon (46 percent of imports) and Brazil (21 percent).

TABLE A-10. WORLD TRADE IN MANGANESE ORES AND CONCENTRATES: 1983

(Gross Weight – Thousand Metric Tons)

EXPORTING COUNTRY	IMPORTING COUNTRY												EXPORTING COUNTRY	
	U S [a]	Japan	Belgium – Luxemburg	France	West Germany	Italy	U K	Norway	Spain	Yugoslavia	Other[b]	Total	Domestic Production[c]	Production Less Exports to OECD[c]
Australia	26 6	404 1	19 4	12 1	99 2		3 2	26 4		15	0 6	606 6	1,353 2	746 6
Communist					0 6	1 1	4 0			31 4		37 1	11,604 6	11,567 5
Gabon	155 1	44 6		484 5		129 4		304 3	111 2	40 5	38 7	1,308 3	1,866 6	558 3
S Africa	23 0	846 2	69 8	173 5	291 7	218 2	193 1	184 4	95 8		63 9	2,159 6	2,885 2	725 6
Other Africa		32 6	42 6	30 4	15 9	8 7	35 0	15 0	2 5	41 9	31 8	256 4	246 7	(9 7)
Brazil	71 6	33 1	22 5	42 7	11 5	15 9	119 2	70 5			26 4	413 4	2,091 5	1,678 1
India		206 2										206 2	1,319 7	1,113 5
Other	57 7	56 3	8 2	2 0	16 0	15 4	22 8	4 2	1 2	52 7	10 0	246 5	485 2	238 7
Total	334 0	1,623 1	162 5	745 2	434 9	383 3	369 9	623 4	213 7	130 0	214 1	5,234 1	21,852 7	16,618 6

[a]Bureau of Mines data – U.S. data are not available in OECD tables.
[b]Other = Canada, Ireland, Italy, Netherlands, Finland, Portugal, Sweden, New Zealand, Denmark, Austria, Turkey.
[c]Source: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984.
NOTE: Totals may not add due to rounding.
SOURCE: OECD Import Microtables, 1983, Series C. Totals may not add due to rounding.

APPENDIX B

DEMAND FOR FERROALLOYS

INTRODUCTION

Ferroalloys have no utility on their own; rather, they are used in the production of other products, principally cast irons, steel, aluminum, and superalloys. Thus, projections of the demand for various ferroalloys are based on projections of U.S. production of those principal products.

Table B-1 displays the consumption of each ferroalloy by end use. On a total-tonnage basis, 89 percent of consumption is for the production of steel and cast iron. Ferrochromium is vital to stainless steel and ferromanganese to carbon and alloy steel, while ferrosilicon is used mostly in cast irons and aluminum alloys.

TABLE B-1. DEMAND FOR FERROALLOYS: 1984

(Thousand Short Tons – Gross Weight)

	FERROCHROMIUM	FERROMANGANESE	FERROSILICON	TOTAL	PERCENT OF TOTAL CONSUMPTION
Carbon Steel	9 2	457.9	75.3	542 4	34 2
Alloy Steel	48 5	98.9	39.4	186 8	11 8
Stainless Steel	313 1	19 3	57 6	390 0	24 6
Other	5 0	1 8	38.3	45 1	2 9
Total Steel	375 8	577 9	210.6	1,164 3	73 5
Cast Irons	7 6	17 6	217 5	242 7	15 3
Superalloys	11 5	0 5	0 3	12 3	0 8
Aluminum Alloys and Other	6 0	26 9	131 9	164 8	10 4
Total	400 9	622 9	560 3	1,584 1	100 0

SOURCE: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook," 1984.

CURRENT PEACETIME DEMAND

The U.S. domestic steel industry produced 92 million tons of raw steel and shipped 74 million tons of steel products in 1984.[1] The United States also imported 25 million tons of steel products, for a total U.S. consumption of 99 million tons.

DoD buys very little steel directly. It does, however, buy tanks, ships, ammunition, and the like, all of which contain large amounts of steel. Since steel is a controlled material under the Defense Production Act of 1950, DoD collects steel usage data by prime contractors and subcontractors as part of the Defense Priorities and Allocations System (DPAS).

The DPAS identifies steel requirements by defense program. It reports total direct demand – defined as steel bought by prime contractors and subcontractors to produce end items purchased by DoD. The system does not include indirect demands for steel; e.g., equipment made of steel that the contractor uses to make the defense end items. Table B-2 shows DoD demand for steel annualized on the basis of DPAS data for 1984 and part of 1985. Total direct demand by prime and subcontractors in peacetime is about 2 million tons per year. Again, indirect demand for steel by industries supplying subcontractors is not measured.

The other major source estimating the DoD demand for steel is the Defense Economic Impact Modeling System (DEIMS). That system defines DoD demand as steel bought directly by DoD plus the steel used by prime contractors to manufacture defense products and that used indirectly by suppliers and subcontractors to prime contractors. An input-output model relating inputs at each stage of production is used for this purpose. DEIMS also calculates ferroalloy production needed to satisfy steel production.

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[1]The difference between raw steel production and shipments of finished steel products is the result of a processing loss of about 20 percent.

TABLE B-2. DoD DIRECT STEEL DEMAND – DPAS

(Thousand Short Tons)

DEFENSE PROGRAM		STEEL DEMAND
A1	Aircraft	16.4
A2	Missiles	16.3
A3	Ships	452.1
A4	Tank/Automotive	182.6
A5	Weapons	8.9
A6	Ammunition	626.0
A7	Communications	1.7
B1	Building Supplies	8.4
B8	Production	0.3
C2	Construction	473.1
C3	Maintenance	1.0
C8	Controlled Materials	64.5
C9	Miscellaneous	7.6
D1	Canada	0.9
	TOTAL	1,859.8

SOURCE: DD Form 614, "Materials Requirements."

DEIMS estimates of demand are in dollars rather than tonnage and thus are not strictly comparable to DPAS estimates. DEIMS breaks demand into DoD purchases and purchases by industrial sectors supplying goods to DoD. "Direct" defense purchases are those made by DoD and are very small.

Since DEIMS is based on an input-output model of the economy, "indirect" purchases include all purchases throughout the economy that are used to produce defense goods. Thus, some of DEIMS indirect demand by subcontractors to DoD prime contractors would be included in the DPAS report of direct demand. However, the DEIMS-reported indirect demand is much broader than DPAS-reported direct demand. The sum of direct and indirect demand in DEIMS is *conceptually* the most inclusive estimate of steel required to produce the end items required by DoD.

For 1984, DEIMS estimates show total (direct plus indirect) DoD steel purchases of $4.8 billion, or 7.6 percent of domestic steel production. If the United

States shipped 74 million tons of steel products in 1984, DoD direct and indirect purchases would be 5.6 million tons. This compares with 1.8 million tons reported by DPAS for its less-inclusive measure of demand.

MOBILIZATION

Mobilization is

> "1. The act of preparing for war or other emergencies through assembling and organizing national resources. 2. The process by which the armed forces or part of them are brought to a state of readiness for war or other national emergency. This includes assembling and organizing personnel, supplies, and material for active military service."[2]

A mobilization can be selective, partial, full, or total depending on the resources required. A selective mobilization is oriented toward domestic emergencies that are not the result of enemy attack; other levels of mobilization that call for more extensive resources are directed toward war or other emergencies involving an external threat.

The demand for steel during a mobilization must be placed in context. The current unclassified mobilization planning scenario involves full mobilization with a worldwide conventional conflict lasting 3 years. In that scenario, the United States commits forces in the Middle East, Western Europe, and the Pacific. The current unclassified mobilization planning scenario is reproduced as Appendix E.

During the period of tensions preceding the conflict, the United States engages in a series of preparations. Some of the actions that would have an effect on the demand for steel would be surge production of critical war reserve materiel items, filling DoD war reserve stocks, and increasing military support to friendly nations.

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[2]Joint Chiefs of Staff *Dictionary of Military and Associated Terms*, JCS Publication 1, 1984.

Other Studies

No complete, systematic study of DoD demand for steel during wartime has been made. A few studies have looked at parts of the problem and have made some estimates or provided "rules of thumb." Considerable evidence supports the conclusion that a mobilization would require the domestic steel industry to produce at today's full capacity. That capacity corresponds to actual U.S. steel production of 137 million tons of raw steel in 1978 and in 1979. Much of that capacity has since been retired as a result of the pressures of foreign competition. Current U.S. steel capacity is about 135 million tons of raw steel, or about 108 million tons of finished steel products.

A study team at the Industrial College of the Armed Forces (ICAF) concentrated on the demand for steel plate during peacetime and mobilization.[3] Its report also presents a brief discussion of military requirements for all steel. Based on World War II experience and more recent information from the Arab-Israeli War, the ICAF study estimates military requirements to be 52 million tons per year of raw steel, or 41.6 million tons of finished steel products.

In 1985, DoD and the Federal Emergency Management Agency (FEMA) prepared a joint study of steel plate rolling capacity.[4] The study reports demand estimates for steel plate from the FEMA Macro Model, which includes direct and indirect demand. During the first year of mobilization, defense-related demand is 10.5 million tons, an amount equal to total U.S. production of steel plate in 1979 – the most recent peacetime peak. During peak usage in the third year of the war, defense needs are projected to be 11.2 million short tons, exceeding 1979 steel

[3]John G. Coburn, *et al.*, "The U.S. Steel Industry – Implications for National Defense," The Industrial College of the Armed Forces, National Defense University, May 1984.

[4]FEMA, "An Analysis of Domestic Steel Plate Rolling Capacity," September 1985.

plate production by 7 percent. Steel plate accounts for about 9 percent of steel consumption, and the results of the FEMA Macro Model indicate that defense direct and indirect requirements would consume the full capacity of this segment of the steel industry during mobilization and war.

A study conducted by Georgetown University Law Center on international steel trade[5] discusses defense requirements for steel during wartime. The basis of the estimate in that study is a FEMA study published in 1979. FEMA calculated that, after mobilization, during a 3-year war, 26 percent of steel industry output would be required for direct military purposes and 56 percent would be required for essential support of the military. The FEMA tonnage numbers are classified, so it is impossible to know its demand estimate. Trozzo uses 1974 production of 147 million tons of raw steel to estimate that 120 million tons of raw steel would be needed in the war years to support the military effort. Such a level of production would nearly coincide with full steel capacity and would leave little room for nonessential civilian demand.

A recent unpublished study by the National Security Council (NSC), the Department of Commerce, FEMA, and DoD estimates wartime requirements for critical materials. The DEIMS model was used in conjunction with an input-output model of the economy. Although most of the study is classified, Table B-3 shows unclassified estimates of the increase in output above current levels for certain defense-related industries. The input-output model provides the dollar value of output for the various industries in the economy. The model results indicate that U.S. steel production would increase to full capacity. The study also concludes that imports would have to increase over current levels.

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[5]Charles Trozzo, "Steel Trade," Chapter 3 in *U.S. International Economic Policy 1981: A Draft Report*, International Law Institute, Georgetown University Law Center, 1982.

TABLE B-3. MOBILIZATION-INDUCED INCREASES IN DEFENSE-RELATED OUTPUT OF STEEL PRODUCTS

INDUSTRY	WAR OUTPUT AS A PERCENT OF PEACETIME PEAK
Ammunition	823
Other Ordnance	822
Tank Components	564
Shipbuilding	499
Military Facilities	448
Small Arms	401
Aircraft	192
Aircraft and Engines and Parts	200
Aircraft and Equipment Not Elsewhere Classified	215
Guided Missiles	185
Electronic Measuring Instruments	514
Semiconductors	486
Radio and TV	443
Metal Products Not Elsewhere Classified	337

Steel Demand

We need to estimate the demand for steel during mobilization and war in order to derive the demand for ferroalloys. Since no definitive estimate of defense demand for steel is available, data from a variety of sources must be combined. DoD wartime demand added to current peacetime demand gives a total demand of 145 million tons of raw steel, which is an overestimate since it does not allow for any austerity in the civilian economy. The DPAS data in Table B-2 are a good estimate of DoD direct peacetime demand for defense programs. Other studies cited also provide information on the behavior of specific defense programs under mobilization. By using the best available information for each defense program, we have built an estimate of wartime steel demand.

The Army Armament and Ammunition Command performed a special analysis for LMI to estimate wartime demand in the weapons and ammunition program categories. Ammunition would be the largest consumer of steel in a conventional war.

The Air Staff provided information on the wartime steel demand for aircraft and missiles. The ICAF study contains a specific estimate for the tank-automotive category and a general factor of 5 for mobilization demand. The NSC study provided the factors listed in Table B-3. Table B-4 shows the DoD direct demand for steel during mobilization and war. These figures are based on the factors mentioned above. We estimate that DoD direct demand for steel would increase from 1.9 million tons in peacetime to 15.6 million tons in wartime; i.e., mobilization would increase defense steel demand by a factor of 8.4.

TABLE B-4. DoD DIRECT STEEL DEMAND – DURING MOBILIZATION

(Thousand Short Tons)

DEFENSE PROGRAM		PROJECTED STEEL DEMAND	SOURCE OF FACTORS USED TO PROJECT DEMAND
A1	Aircraft	130.8[a]	Air Staff
A2	Missiles		
A3	Ships	2,256.0	ICAF study
A4	Tank/Automotive	1,318.4	ICAF study
A5	Weapons	312.8	Army Armament & Ammunition Command
A6	Ammunition	9,039.4	Army Armament & Ammunition Command
A7	Communications	7.5	Table B-3
B1	Building Supplies	37.6	Table B-3
B8	Production	1.5	Table B-3
C2	Construction	2,119.5	Table B-3
C3	Maintenance	4.5	Table B-3
C8	Controlled Materials	322.5	Table B-3
C9	Miscellaneous	38.0	Table B-3
D1	Canada	0.9	No factor
	TOTAL	15,589.4	

[a]Actual factors are classified.

It is not enough merely to supply the steel necessary for direct defense requirements. During a war, indirect defense requirements and essential civilian needs must also be supplied. Indirect defense requirements cover goods and equipment needed to produce defense goods; e.g., machine tools, trucks for shipping, computers to control production, replacement of worn-out items, etc. Essential civilian requirements are the goods and services needed to provide a minimum level of food, clothing, shelter, transportation, medical care, etc., to the civilian population.

From DEIMS, we know that DoD direct plus indirect requirements were 7.6 percent of finished steel production in 1984. By applying the mobilization factor of 8.4, we estimate defense-related steel demand of 64 percent of current domestic production. This yields 47 million tons of finished steel for DoD direct and indirect requirements.

The 1979 FEMA study indicated that the amount of steel required for essential civilian support is twice the military steel requirement. Using that estimate, we arrive at the need for 94 million tons of steel products for essential support. Table B-5 shows our estimates of the mobilization-level requirements for steel products.

TABLE B-5. STEEL PRODUCT REQUIREMENTS DURING MOBILIZATION AND WAR

(Million Short Tons)

Defense Requirement	47[a]
Essential Civilian	94[b]
Total	141
Current Capacity	108
Shortfall	33[c]

[a]Based on defense demand as a proportion of total from DEIMS and an average factor for mobilization demand from Tables B-2 and B-3.

[b]Based on relationship between military demand and essential support in 1979 FEMA study.

[c]The shortfall would be expected to be made up by imports.

Table B-5 shows a shortfall of 33 million tons of finished steel products. Some of the shortage could be alleviated by imports. The United States imported

25 million tons of steel in 1984. About 36 percent of the imports came from the Pacific (Japan, Australia, and South Korea) and 27 percent came from Europe. These areas, however, may not be able to supply the United States with additional imports during a war. Any remaining shortfall would require a combination of conservation, substitution, and austerity.

FERROALLOYS

The quantities of ferroalloys required to produce a given quantity of steel can be derived from engineering relationships. Table B-6 shows the "pounds per ton" relationships between steel and ferroalloys. The last line shows the weighted average pounds of each ferroalloy in an average ton of steel. In 1984, 86 percent of steel production was carbon steel, 12 percent was alloy steel, and 2 percent was stainless steel. Although stainless steel requires the largest amount of ferroalloys, it is a very small percentage of total production.

TABLE B-6 POUNDS OF FERROALLOY PER TON OF STEEL

	FERROCHROMIUM	FERROMANGANESE	FERROSILICON	TOTAL
Carbon steel	0 2	11 5	1 9	13 6
Alloy steel	8 9	18 3	7 3	34 5
Stainless steel	358 3	22 1	71 7	452 1
Weighted average	8 4	12 5	7 7	28 6

Table B-7 shows the quantities of ferroalloys required for the steel industry to produce at full capacity of 135 million tons. Stainless steel production is about 2 percent of total production or 2.7 million tons. Carbon steel production would be 116.6 million tons and alloy steel production would be 15.7 million tons.

TABLE B-7. FERROALLOY REQUIREMENTS FOR FULL CAPACITY STEEL

(Thousand Short Tons – Gross Weight)

	FERROCHROMIUM	FERROMANGANESE	FERROSILICON	TOTAL
Carbon steel	12	670	111	793
Alloy steel	70	144	57	271
Stainless steel	485	30	97	612
Total	567	844	265	1,676

Full capacity steel production would require 1.7 million tons of ferroalloys. An additional 230,000 tons of ferroalloys would be used in iron castings and an additional 560,000 tons would be required by the aluminum and semiconductor industries.

APPENDIX C

LEGISLATIVE HISTORY

COMPENDIUM OF LEGISLATION

Trade-Related Legislation

The Trade Expansion Act of 1962. This Act provides, in part, the authority for Presidential action against imports that threaten to impair the national security. Specifically, Section 232 of the Act directs the Secretary of Commerce upon "application of an interested party," to make an appropriate investigation "immediately" to determine whether the article in question "... is being imported into the U.S. in such quantities or under such circumstances as to threaten to impair the national security." Absent a contrary Presidential finding, the Act directs the President to "... take such action, and for such time as he deems necessary to adjust imports [so that they] will not threaten to impair the national security."

Section 232(c) defines "national security" rather broadly. The national security includes the "economic welfare of individual domestic industries" whose "weakening ... may impair the national security."

Trade Act of 1974 (P.L. 93-618, Title IV, Sec 406). The relevant sections of this Act provide for investigations and possible relief when imports are injuring domestic industry. The applicable section is 19 U.S.C. Sec 2251, which replaced Section 301 of the Trade Expansion Act whereby a representative of the industry may petition the International Trade Commission (ITC) for import relief "for the purpose of facilitating orderly adjustment to import competition ...."

The investigation must determine whether imports are in such quantities as to be a "... substantial cause of serious injury, or the threat thereof, to the domestic industry producing an article like or directly competitive with the imported article." The Commission is to take into account all relevant economic factors including but not limited to (1) the significant idling of productive facilities; (2) significant unemployment; (3) the inability of a significant number of firms to operate profitably; (4) a decline in sales or a downward trend in production, profits, wages, or employment; and (5) a decline in the proportion of the market supplied by domestic producers. Relief granted pursuant to this Act is meant to be temporary to allow the industry to adjust to import competition.

Another relevant part of the Trade Act of 1974 provides for investigation of domestic market disruption due to imports of a product produced by a Communist country. Market disruption exists whenever

> "... imports of an article, like or directly competitive with an article produced by such domestic industry, are increasing rapidly, either absolutely or relatively, so as to be a significant cause of material injury, or threat thereof, to such domestic industry." (19 U.S.C. Sec 2436(e)(2).)

The investigation is conducted the same as under Section 2251 above.

Tariff Act of 1930 (P.L. 17-361). Section 303 of the Tariff Act (19 U.S.C. Sec. 1303) provides for the levying of countervailing duties to protect domestic industry from subsidized imports. The countervailing duty is to be equal to the net amount of the subsidy and applies to direct subsidies as well as indirect subsidies.

Production and Material-Related Legislation

Defense Production Act of 1950 (50 U.S.C. App 2061 *et seq.*). This is the single most important statute affecting DoD's ability to secure materials. Only Titles I, III, and VII from the original legislation remain in effect today. The Act is "ordinary course legislation" meaning that the powers of the Act are available in everyday situations as well as in emergencies.

Title I provides the authority to place defense production ahead of civilian demand for production. Title III authorizes loan and purchase authority to expand industrial capacity. Title VII provides for industry-Government cooperation. Of particular interest are the provisions of Title III. It authorizes: (1) loan guarantees to expedite production under Government contracts; (2) loans for capacity expansion for production or mining of strategic materials; (3) purchases of metals, minerals, and other materials for transfer to the Strategic and Critical Materials Stockpile; and (4) installation of Government-owned equipment in private facilities.

The Strategic and Critical Materials Stockpiling Act (50 U.S.C. App 98 *et seq.*). (Discussion adapted from Strategic and Critical Materials for Defense Needs, Volume I, Main Report, Institute for Defense Analyses, Report R-264, October 1981, pp. 143-155.)

As the name implies, this Act provides for a stockpile of materials for use if imports are interrupted and industrial requirements expand in an emergency. The Act dates back to 1939, but a major revision occurred in 1979. The objective of the stockpile remains to acquire stocks of materials deficient or insufficiently developed domestically to supply the military, industrial, and essential civilian needs of the United States for national defense. Precluded is the use of stockpile materials for "economic or budgetary purposes," or for "controlling or influencing commodity prices" (Senate Report 96-201, p. 3; P.L. 96-41, Sec 3(b)(1)). The Act defines strategic and critical materials as those "... needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency and not found or produced in the United States in sufficient quantities to meet such needs" (P.L. 96-41, Sec 12(1)). With respect to stockpile goals, the 1979 Act requires that quantities in the stockpile "... be sufficient to sustain the United States for a period of not less than three years in the event of a national emergency" (P.L. 96-41, Sec 3(b)(2)). Finally, disposal of materials excess to stockpile requirements requires congressional authorization (P.L. 96-41, Sec 5(b)). In addition, acquisitions and disposals are to be conducted by means of competition, with U.S. industry and consumers given first call on surplus materials (P.L. 96-41, Sec 6(b)(3); Senate Report 96-201, p. 5).

National Materials and Minerals Policy, Research and Development Act (P.L. 96-479). This Act, passed in 1980, provides a coordinating framework for Executive Branch material policy decisions, which are now highly decentralized in a number of agencies. Pursuant to the Act, the President submitted to Congress a plan of action to be taken in four areas—land availability, materials research and development, minerals data collection, and strategic and critical materials stockpiles.

National Critical Materials Act of 1984 (P.L. 98-373). This Act establishes a National Critical Materials Council to advise and assist the President in formulating critical materials policy.

GOVERNMENT INTERVENTIONS

There have been several investigations of the effects of ferroalloy imports on the domestic industry and on national security.

In 1962 and 1970, there were investigations under Section 232, the national security clause of the Trade Expansion Act of 1962. Both investigations resulted in a finding that imports of ferrochromium were not in quantities large enough to harm national security.

The ITC began an investigation July 1977 to determine whether the domestic industry was being injured by imports. The initial finding was that imports of low-carbon ferrochromium were not a threat to the domestic industry. In December 1977, the same investigation resulted in positive findings for high-carbon ferrochromium. The ITC recommended increased tariffs for high-carbon ferrochromium. In January 1978, the President ruled that the relief recommended by the ITC was not in the nation's interest.

A second investigation in early 1978 again produced positive findings for high-carbon ferrochromium. The ITC again recommended increased tariffs to protect the domestic industry against imports of high-carbon ferrochromium. In November 1978, the President raised the duty on high-carbon ferrochromium for 3 years. The tariff was increased 4 cents per pound of chromium content on high-carbon ferrochromium valued at 38 cents per pound or less.

When the tariff increase was due to expire, the ITC advised the President that termination of the relief would have an adverse economic impact on the domestic industry. In September 1981, the President extended the tariff increase for 1 year and it was not extended thereafter.

Just prior to the President's decision on tariffs, the Ferroalloys Association petitioned the Department of Commerce for relief from imports under the national security clause (Section 232) of the Trade Expansion Act of 1962. Immediately before the investigation was completed, the President began a 10-year program to upgrade the chromium and manganese ores in the national defense stockpile into ferroalloys. The program was authorized for 3 years with the option to renew each year for another 7 years. Actual processing of the ores began in 1984. Also, the Generalized System of Preferences tariff was terminated for high-carbon ferromanganese to provide some relief to the domestic industry.

The Department of Commerce concluded its Section 232 investigation with positive findings that imports of high-carbon ferrochromium and high-carbon ferromanganese are a threat to national security. In May 1984, the President decided that imports are not a threat to national security and that the stockpile upgrade program is adequate protection.

Two other major actions affecting the industry occurred in 1984. An investigation of imports of ferrosilicon from the Soviet Union under Section 406 of the Trade Act of 1974 found that Soviet exports to the United States were not harming the domestic industry. The other action concerned ferrochromium imports from Spain. A Department of Commerce investigation under the Tariff Act of 1930 had led to countervailing duties on imports from Spain. The government of Spain requested another investigation which resulted in revocation of the duties.

APPENDIX D

INDUSTRY STATISTICS

INTRODUCTION

The analysis of worldwide ferroalloy supply and demand conducted for the study necessitated the compilation of a consistent industry data base. These data portray the behavior of the ferroalloys market in the United States plus production, capacities, and exports of producers and supplies in the world at large.

Numerous sources were used to develop the data base. The primary source was various editions of the *Minerals Yearbook*, Volume 1, "Metals and Minerals," published by the U.S. Department of the Interior, Bureau of Mines. In certain instances, reasonable judgment had to be applied to this and other sources to reconcile differences that arise due to differences of definition, revisions, or possibly error. Reconciliation was especially necessary when data were drawn from different sources. Association data (the Ferroalloys Association, American Iron and Steel Institute) were employed and sometimes differed from Government data due to use of different definitions or coverage.

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TABLE D-1. FERROALLOY INDUSTRY STATISTICS: 1975-1984

Thousands of short tons of alloy (gross weight & contained metal)

Ferroalloy	1975 GW	1975 CM	1976 GW	1976 CM	1977 GW	1977 CM	1978 GW	1978 CM	1979 GW	1979 CM	1980 GW	1980 CM	1981 GW	1981 CM	1982 GW	1982 CM	1983 GW	1983 CM	1984 GW	1984 CM
Ferrochromium																				
Domestic Shipments	227	131	267	154	275	162	248	148	284	169	234	140	191	104	117	67	50	30	38	24
Industry Stock Change	63	39	21	8	(7)	(11)	(30)	(15)	(23)	(10)	(2)	(4)	12	8	(22)	(11)	(33)	(22)	(11)	(11)
Imports	323	200	259	156	240	140	328	181	242	136	302	176	440	251	148	87	282	164	434	245
Exports	13	8	14	9	12	9	19	12	15	9	32	19	14	9	5	3	4	3	15	10
Apparent Consumption	600	362	533	309	496	282	527	302	488	285	502	293	629	355	238	141	295	168	446	248
Reported Consumption	333	198	413	244	449	265	495	292	537	318	417	247	429	249	262	152	388	226	395	227
Import Share	54%	55%	49%	50%	48%	50%	62%	60%	50%	48%	60%	60%	70%	71%	62%	62%	96%	97%	97%	99%
Ferromanganese																				
Domestic Shipments	682	522	626	482	460	350	471	356	498	375	355	263	340	251	170	124	140	107	140	105
Industry Stock Change	85	65	(100)	(77)	(17)	(12)	(69)	(53)	(14)	(11)	(5)	(6)	(3)	(2)	21	19	(62)	(47)	(44)	(33)
Imports	452	341	518	471	623	474	776	594	916	701	684	523	800	607	555	425	481	358	548	413
Exports	32	25	7	5	6	5	14	10	30	23	30	26	20	17	16	13	20	17	16	13
Apparent Consumption	1,187	903	1,037	871	1,060	807	1,164	887	1,370	1,042	1,004	754	1,117	839	730	555	539	401	628	472
Reported Consumption	1,043	799	1,052	808	1,034	794	1,150	883	1,148	881	945	722	977	747	546	426	529	391	595	454
Import Share	38%	38%	50%	54%	59%	59%	67%	67%	67%	67%	68%	69%	72%	72%	76%	77%	89%	89%	87%	88%
Ferrosilicon																				
Domestic Shipments	543	295	689	372	710	385	685	366	711	397	557	304	514	278	334	186	359	198	498	281
Industry Stock Change	7	4	(1)	(0)	(10)	(7)	16	10	(5)	(3)	(14)	(9)	40	19	(23)	(11)	(42)	(22)	6	5
Imports	70	47	98	64	115	75	136	86	114	74	71	47	155	110	77	52	159	106	144	96
Exports	40	27	12	8	11	7	12	11	22	16	28	14	16	8	15	8	13	6	30	16
Apparent Consumption	580	319	774	428	804	446	825	451	798	452	586	328	693	399	373	220	463	276	618	366
Reported Consumption	541	305	620	345	637	356	663	374	604	337	482	263	482	267	316	175	340	190	404	225
Import Share	12%	15%	13%	15%	14%	17%	16%	19%	14%	16%	12%	14%	22%	28%	21%	24%	34%	38%	23%	26%
Ferroalloy Total																				
Domestic Shipments	1,452	948	1,582	1,008	1,445	897	1,404	870	1,493	941	1,146	707	1,045	633	621	377	549	335	676	410
Industry Stock Change	155	108	(80)	(69)	(34)	(30)	(83)	(58)	(42)	(25)	(21)	(19)	49	25	(24)	(3)	(137)	(90)	(49)	(40)
Imports	845	588	875	691	978	689	1,240	861	1,272	911	1,057	746	1,395	968	780	564	922	628	1,126	754
Exports	85	60	33	22	29	21	45	33	67	48	90	59	50	34	36	24	37	26	61	39
Apparent Consumption	2,367	1,584	2,344	1,608	2,360	1,535	2,516	1,640	2,655	1,779	2,092	1,375	2,439	1,592	1,341	915	1,297	846	1,692	1,085
Reported Consumption	1,917	1,302	2,085	1,397	2,120	1,415	2,308	1,549	2,289	1,536	1,844	1,232	1,888	1,263	1,124	753	1,257	807	1,394	906
Import Share	36%	37%	37%	43%	41%	45%	49%	53%	48%	51%	51%	54%	57%	61%	58%	62%	71%	74%	67%	69%

GW Gross Weight
CM Contained Metal

Apparent Consumption = Domestic Shipments + Changes in Inventory Stocks + Imports - Exports
Import Share = Imports/Apparent Consumption

Sources:
Minerals Yearbook 1975 - 1984
Ferroalloys Association

TABLE D-2. METAL INDUSTRY STATISTICS: 1975-1984

Thousands of short tons of metal (gross weight & contained metal)

Ferroalloy Metal	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM
Chromium																				
Domestic Shipments	2	2	2	2	2	2	4	4	4	4	4	4	3	3	2	2	3	3	3	3
Industry Stock Change	0	0	0	0	0	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	0	0	0	0
Imports	2	2	2	2	2	2	4	4	4	4	4	4	4	4	2	2	3	3	5	5
Exports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apparent Consumption	4	4	4	4	4	4	8	8	8	8	8	8	7	7	4	4	6	6	8	8
Reported Consumption	4	4	4	4	4	4	5	5	6	6	6	6	4	4	3	3	4	4	4	4
Import Share	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	57%	57%	50%	50%	50%	50%	63%	63%
Manganese																				
Domestic Shipments	18	18	21	21	22	22	23	23	24	24	22	22	20	20	15	15	17	17	14	14
Industry Stock Change	0	0	0	0	(2)	(2)	(2)	(2)	0	0	0	0	1	1	(1)	(1)	(3)	(3)	0	0
Imports	4	4	7	7	7	7	9	9	7	7	8	8	8	8	5	5	6	6	13	13
Exports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apparent Consumption	22	22	28	28	27	27	30	30	31	31	30	30	29	29	19	19	20	20	27	27
Reported Consumption	22	22	28	28	27	27	28	28	28	28	25	25	24	24	17	17	18	18	28	28
Import Share	18%	18%	25%	25%	26%	26%	30%	30%	23%	23%	27%	27%	28%	28%	26%	26%	30%	30%	48%	48%
Silicon																				
Domestic Shipments	89	87	131	128	116	114	130	127	143	139	125	122	124	121	81	79	123	121	139	146
Industry Stock Change	0	0	(1)	(1)	(10)	(10)	16	16	(5)	(5)	(14)	(14)	40	40	(23)	(23)	(42)	(42)	6	6
Imports	8	8	10	10	24	24	35	34	27	27	21	21	29	29	26	26	27	27	24	24
Exports	0	0	0	0	0	0	2	2	5	5	14	14	9	9	2	2	3	3	4	4
Apparent Consumption	97	95	140	137	130	128	179	175	160	156	118	115	184	181	82	80	105	103	165	172
Reported Consumption	73	72	103	101	103	101	112	109	128	125	123	120	123	120	82	80	100	98	114	112
Import Share	8%	8%	7%	7%	18%	19%	20%	19%	17%	17%	18%	18%	16%	16%	32%	33%	26%	26%	15%	14%
Ferroalloy Metal Total																				
Domestic Shipments	109	107	154	151	140	138	157	154	171	167	151	148	147	144	98	96	143	141	156	163
Industry Stock Change	0	0	(1)	(1)	(12)	(12)	14	14	(5)	(5)	(14)	(14)	41	41	(24)	(24)	(45)	(45)	6	6
Imports	14	14	19	19	33	33	48	47	38	38	33	33	41	41	33	33	36	36	42	42
Exports	0	0	0	0	0	0	2	2	5	5	14	14	9	9	2	2	3	3	4	4
Apparent Consumption	123	121	172	169	161	159	216	212	199	195	156	153	220	217	105	103	131	129	200	207
Reported Consumption	99	98	135	133	134	132	145	142	162	159	154	151	151	148	102	100	122	120	146	144
Import Share	11%	12%	11%	11%	20%	21%	22%	22%	19%	20%	21%	22%	19%	19%	31%	32%	27%	28%	21%	20%

GW Gross Weight
CM Contained Metal

Sources:
Minerals Yearbook 1975 - 1984
Ferroalloys Association

Apparent Consumption = Domestic Shipments + Changes in Inventory Stocks + Imports - Exports
Import Share = Imports/Apparent Consumption

TABLE D-3. DOMESTIC SHIPMENTS OF FERROALLOYS: 1975-1984

Thousands of short tons (gross weight & contained metal)

Ferroalloy	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984 [a]	
	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM
Ferrochromium [b]	165	107	197	125	215	138	200	128	229	146	186	117	135	81	82	50	40	26	31	21
Ferrochromium-silicon	42	15	52	19	45	16	32	12	36	13	15	6	18	6	8	3	10	4	7	3
Other chromium	20	9	18	10	15	8	16	8	19	10	33	18	38	17	27	14	1	0		
Chromium alloys	227	131	267	154	275	162	248	148	284	169	234	140	191	104	117	67	50	30	38	24
Chromium metal	2	2	2	2	2	2	4	4	4	4	4	4	3	3	2	2	3	3	3	3
Ferromanganese	556	439	494	395	338	270	318	255	331	265	203	163	167	136	82	66	86	71	75	62
Silicomanganese	126	83	132	87	122	80	153	101	167	110	152	100	173	115	88	58	54	36	65	43
Manganese alloys	682	522	626	482	460	350	471	356	498	375	355	263	340	251	170	124	140	107	140	105
Manganese metal	18	18	21	21	22	22	23	23	24	24	22	22	20	20	15	15	17	17	14	14
Ferrosilicon	478	256	606	323	615	330	587	309	631	350	495	268	449	240	289	160	310	170	426	239
Other silicon	65	39	83	49	95	55	98	57	80	47	62	36	65	38	45	26	49	28	72	42
Silicon alloys	543	295	689	372	710	385	685	366	711	397	557	304	514	278	334	186	359	198	498	281
Silicon metal	89	87	131	128	116	114	130	127	143	139	125	122	124	121	81	79	123	121	139	146
Primary alloys	1,452	948	1,582	1,008	1,445	897	1,404	870	1,493	941	1,146	707	1,045	633	621	377	549	335	676	410
Other alloys [c]	521		145		137		232		232		211		172		109		189		211	
Alloy total	1,973	948	1,727	1,008	1,582	897	1,636	870	1,725	941	1,357	707	1,217	633	730	377	738	335	887	410
Alloy & metal total	2,082	1,055	1,881	1,159	1,722	1,035	1,793	1,024	1,896	1,108	1,508	855	1,364	777	828	473	881	476	1,043	573

GW Gross Weight
CM Contained Metal (Computed)

Sources:
Minerals Yearbook 1975 - 1984
1984 Annual Statistical Report, American Iron & Steel Institute
Ferroalloys Association

a excludes domestic processing of National Defense Stockpile ferroalloys.
b includes ferrochromium silicate, chromium metal, chromium briquets, & other chromium alloys
c other ferroalloys: ferroboron, ferromolybdenum, ferronickel, ferrophosphorous, ferrotitanium, ferrotungsten, ferrovanadium & others

Note: chromium & manganese metal domestic shipments (1975-1977) estimated based on known import & consumption data
Ferroalloys Association data used for ferrochromium and ferromanganese 1984

TABLE D-4. U.S. EXPORTS OF FERROALLOYS: 1975-1984

Thousands of short tons of alloy (contained metal)

Ferroalloy	1975 GW	1975 CM	1976 GW	1976 CM	1977 GW	1977 CM	1978 GW	1978 CM	1979 GW	1979 CM	1980 GW	1980 CM	1981 GW	1981 CM	1982 GW	1982 CM	1983 GW	1983 CM	1984 GW	1984 CM
Ferrochromium																				
FeCr	13	8	14	9	12	9	19	12	15	9	32	19	14	9	5	3	4	3	15	10
Cr metal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	13	8	14	9	12	9	19	12	15	9	32	19	14	9	5	3	4	3	15	10
Ferromanganese																				
FeMn	32	25	7	5	6	5	9	7	25	20	12	10	13	11	10	8	8	7	7	6
SiMn	0	0	0	0	0	0	5	3	5	3	6	4	4	3	3	2	6	4	5	3
FeMn	32	25	7	5	6	5	14	10	30	23	18	14	17	14	13	10	14	11	12	9
Mn metal	0	0	0	0	0	0	0	0	0	0	12	12	3	3	3	3	6	6	4	4
Total	32	25	7	5	6	5	14	10	30	23	30	26	20	17	16	13	20	17	16	13
Ferrosilicon																				
FeSi	40	27	12	8	11	7	12	11	22	16	28	14	16	8	15	8	13	6	30	16
Si metal							2	2	5	5	14	14	9	9	2	2	3	3	4	4
Total	40	27	12	8	11	7	14	13	27	21	42	28	25	17	17	10	16	9	34	20
Ferroalloy Total	85	60	33	22	29	21	45	33	67	48	78	47	47	31	33	21	31	20	57	35
Metal Total	0	0	0	0	0	0	2	2	5	5	26	26	12	12	5	5	9	9	8	8
Ferroalloy & Metal Total	85	60	33	22	29	21	47	35	72	53	104	73	59	43	38	26	40	29	65	43

GW Gross Weight
CM Contained Metal

Sources:
Minerals Yearbook 1975 - 1984
1984 Annual Statistical Report, American Iron & Steel Institute
Ferroalloys Association

TABLE D-5. U.S. IMPORTS OF FERROALLOYS: 1975-1984

Thousands of short tons of alloy (contained metal)

Ferroalloy	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM
Ferrochromium																				
FeCr	319	198	243	150	224	134	327	181	242	136	297	174	429	247	141	84	281	163	426	242
FeCrSi	4	2	16	6	16	6	1	0	0	0	5	2	11	4	7	3	1	1	8	3
Total	323	200	259	156	240	140	328	181	242	136	302	176	440	251	148	87	282	164	434	245
Cr metal	2	2	2	2	2	2	4	4	4	4	4	4	4	4	2	2	3	3	5	5
Ferromanganese																				
FeMn	397	306	438	417	535	416	681	531	821	639	609	474	671	522	493	384	341	266	410	322
SiMn	55	35	80	54	88	58	95	63	95	62	75	49	129	85	62	41	140	92	138	91
Total	452	341	518	471	623	474	776	594	916	701	684	523	800	607	555	425	481	358	548	413
Mn metal	4	4	7	7	7	7	9	9	7	7	8	8	8	8	5	5	6	6	13	13
Ferrosilicon																				
FeSi	70	47	98	64	115	75	136	86	114	74	71	47	155	110	77	52	159	106	144	96
Si metal	8	8	10	10	24	24	35	34	27	27	21	21	29	29	26	26	27	27	24	24
Total	78	55	108	74	139	99	171	120	141	101	92	68	184	139	103	78	186	133	168	120
Ferroalloy Total	845	588	875	691	978	689	1,240	861	1,272	911	1,057	746	1,395	968	780	564	922	628	1,126	754
Metal Total	14	14	19	19	33	33	48	47	38	38	33	33	41	41	33	33	36	36	42	42
Ferroalloy & Metal Total	859	602	894	710	1,011	722	1,288	908	1,310	949	1,090	779	1,436	1,009	813	597	958	664	1,168	796

GW Gross Weight
CM Contained Metal

Sources:
Minerals Yearbook 1975 - 1984
1984 Annual Statistical Report, American Iron & Steel Institute
Ferroalloys Association

TABLE D-6. U.S. REPORTED CONSUMPTION OF FERROALLOYS: 1975-1984

Thousands of short tons of alloy (gross weight & contained metal)

Ferroalloy	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM	GW	CM
Ferrochromium																				
HCFeCr	199	124	253	159	318	195	385	233	433	260	339	202	354	207	215	126	342	200	345	199
LCFeCr	74	51	79	54	67	45	60	40	60	41	49	33	46	31	32	21	30	20	33	22
FeCr	273	175	332	213	385	240	445	273	493	301	388	235	400	238	247	147	372	220	378	221
FeCrSi	50	19	70	26	55	21	41	15	35	13	23	9	22	8	15	5	16	6	17	6
Total	323	194	402	239	440	261	486	288	528	314	411	244	422	246	262	152	388	226	395	227
Other	10	4	11	5	9	4	9	4	9	4	6	3	7	3	4	2	1	0	2	1
Total	333	198	413	244	449	265	495	292	537	318	417	247	429	249	266	154	389	226	397	228
Cr metal	4	4	4	4	4	4	5	5	6	6	6	6	4	4	3	3	4	4	4	4
Total	337	202	417	248	453	269	500	297	543	324	423	253	433	253	269	157	393	230	401	232
Ferromanganese																				
HCFeMn	748	583	756	590	748	583	832	649	822	641	666	519	681	531	363	294	367	286	401	313
MLCFeMn	134	110	141	116	138	113	154	126	154	126	123	100	140	113	77	62	79	63	91	73
FeMn	882	693	897	706	886	696	986	775	976	767	789	619	821	644	440	356	446	349	492	386
SiMn	161	106	155	102	148	98	164	108	172	114	156	103	156	103	106	70	83	42	103	68
Total	1,043	799	1,052	808	1,034	794	1,150	883	1,148	881	945	722	977	747	546	426	529	391	595	454
Mn metal	22	22	28	28	27	27	28	28	28	28	25	25	24	24	17	17	18	18	28	28
Total	1,065	821	1,080	836	1,061	821	1,178	911	1,176	909	970	747	1,001	771	563	443	547	409	623	482
Ferrosilicon																				
FeSi50	326	158	391	190	397	191	396	191	404	195	328	157	323	155	209	101	217	104	264	127
FeSi75	125	95	122	93	127	97	152	116	146	111	116	87	127	96	83	63	96	73	109	83
FeSi	451	253	513	283	524	288	548	307	550	306	444	244	450	251	292	164	313	177	373	210
MgFeSi	90	52	107	62	113	68	115	67	54	31	38	19	32	16	24	11	27	13	31	15
Total	541	305	620	345	637	356	663	374	604	337	482	263	482	267	316	175	340	190	404	225
Si metal	73	72	103	101	103	101	112	109	128	125	123	120	123	120	82	80	100	98	114	112
Total	614	377	723	446	740	457	775	483	732	462	605	383	605	387	398	255	440	288	518	337
Silvery Pig Iron	69	12	51	9	51	9	73	13	62	11	48	9	40	7	31	5	14	3	10	2
Ferroalloy Total	1,917	1,302	2,085	1,397	2,120	1,415	2,308	1,549	2,289	1,536	1,844	1,232	1,888	1,263	1,128	755	1,258	807	1,396	907
Metal Total	99	98	135	133	134	132	145	142	162	159	154	151	151	148	102	100	122	120	146	144
Ferroalloy & Metal Total	2,016	1,400	2,220	1,530	2,254	1,547	2,453	1,691	2,451	1,695	1,998	1,383	2,039	1,411	1,230	855	1,380	927	1,542	1,051

GW Gross Weight
CM Contained Metal

Sources:
Minerals Yearbook 1975 - 1984
Ferroalloys Association

TABLE D-7. FERROALLOY CONSUMPTION FACTORS: 1984

Pounds of alloy per short ton of metal (gross weight & contained metal)

Ferrochromium

	HCFeCr		LCFeCr		FeCrSi		Cr	Total	
	GW	Cr	GW	Cr	GW	Cr	Metal	GW	Cr
Carbon Steel	0.1	0.1	0.1	0.1	.0	.0	0.0	0.2	0.1
Alloy Steel	5.8	3.3	2.2	1.5	1.0	0.4	0.0	8.9	5.1
Stainless Steel	335.5	193.2	11.7	7.8	11.1	4.0	0.0	358.3	204.9
Cast Iron	1.1	0.6	0.5	0.4	1.1	0.4	0.0	7.6	4.6
Iron & Steel Av	6.5	3.8	0.6	0.4	0.4	0.2	0.0	8.0	4.6

Ferromanganese

	HCFeMn		MLCFeMn		SiMn		Mn	Total	
	GW	Mn	GW	Mn	GW	Mn	Metal	GW	Mn
Carbon Steel	7.7	6.0	1.8	1.5	1.8	1.2	0.1	11.5	8.8
Alloy Steel	11.4	8.9	2.9	2.3	3.7	2.4	0.4	18.3	14.0
Stainless Steel	14.0	10.9	0.7	0.5	5.3	3.5	2.2	22.1	17.1
Cast Iron	2.4	1.9	0.1	0.1	2.5	2.0	0.7	0.5	3.2
Iron & Steel Av	7.6	6.0	1.7	1.4	2.1	1.4	0.2	11.2	8.9

Ferrosilicon

	FeSi50		FeSi75		MgFeSi		Si	Total	
	GW	Si	GW	Si	GW	Si	Metal	GW	Si
Carbon Steel	1.3	0.6	0.5	0.4	0.1	.9	0.0	1.9	1.0
Alloy Steel	5.4	2.6	1.7	1.3	0.2	0.1	0.0	7.3	4.0
Stainless Steel	36.9	17.7	34.7	26.4	0.0	0.0	0.0	71.7	44.1
Cast Iron	22.4	10.7	4.7	3.6	4.9	2.6	0.0	32.0	16.7
Iron & Steel Av	4.6	2.2	1.6	1.3	0.6	0.3	0.0	6.8	3.7

GW Gross Weight
CM Contained Metal (computed)

Source:
Minerals Yearbook 1984

Notes: Alloy steel includes high strength low alloy steel
Stainless steel includes tool steel

TABLE D-8 U S CHROMITE IMPORTS, WORLDWIDE PRODUCTION, AND CAPACITY: 1984

Thousands of short tons gross weight (contained chromic oxide and chromium)

Country	U.S. Imports GW	U.S. Imports Cr_2O_3	Production[a] GW	Production[a] Cr_2O_3	Production Capacity[b] GW	Production Capacity[b] Cr_2O_3	Cr	Excess Capacity GW	Util-ization	Chromite Reserves (million tons ore) Reserves	Chromite Reserves (million tons ore) Base
Australia										0	2
Brazil			310	133	413	177	125	103	75%	9	10
Canada	6	2								0	4
China											
France											
Germany											
Greece			30	13	56	24	17	26	53%	1	1
India			485	208	627	268	190	142	77%	15	66
Italy											
Japan			7	3	7	3	2	0	100%		
Mexico											
Norway											
Philippines	49	17	300	128	561	240	170	261	53%	15	32
South Africa	235	100	3,314	1,418	4,818	2,062	1,460	1,504	69%	913	6,300
Spain											
Sweden											
Turkey			670	287	792	339	240	122	85%	5	80
USSR			3,300	1,412	3,300	1,413	1,000	0	100%	142	142
USA											
Yugoslavia											
Zimbabwe			500	214	1,244	533	377	744	40%	19	830
Other										0	1
Africa											
Madagascar			66	28	139	59	42	73	48%	8	8
Sudan			30	13	33	14	10	3	91%	2	2
Asia										1	1
New Caledonia	3	2	93	40	109	47	33	16	85%	2	2
Vietnam			20	8	20	8	6	0	99%	1	1
Eastern Europe											
Albania			960	411	1,066	456	323	106	90%	7	22
Middle East											
Iran			55	24	99	42	30	44	56%	2	2
Pakistan			7	3	7	3	2	0	99%	1	1
South America											
Cuba			41	18	96	41	29	55	43%	3	3
Western Europe										1	1
Finland	11	5	280	120	617	264	187	337	45%	19	32
Total	304	134	10,467	4,480	14,004	5,994	4,243	3,537	75%	1,166	7,543

GW Gross Weight

a Chromic oxide content of chromite production estimated (.428 Cr_2O_3).

b Chromite gross weight production capacity estimated (.303Cr)

Sources: 1984 Minerals Yearbook
Mineral Facts & Problems 1985

Notes: Reserves are economic reserves
(Reserve) Base includes economic, marginally economic and subeconomic reserves

TABLE D-9. U.S. MANGANESE ORE IMPORTS, WORLDWIDE PRODUCTION, AND CAPACITY: 1984

Thousands of short tons gross weight (contained manganese)

Country	U.S. Imports GW	U.S. Imports Mn	Production GW	Production Mn	Production Capacity[a] GW	Production Capacity[a] Mn	Excess Capacity GW	Utilization	Manganese Ore Reserves (million tons Mn) Reserves	Manganese Ore Reserves (million tons Mn) Base
Australia	40	21	1,874	915	3,611	1,300	1,737	52%	75	168
Brazil	88	44	2,425	1,088	3,750	1,350	1,325	65%	21	69
Canada									0	0
China			1,760	530	1,826	550	66	96%	15	32
France										
Germany										
Greece										
India			1,433	520	2,222	800	789	64%	20	30
Italy										
Japan			68	18	83	30	15	82%		
Mexico	41	16	571	217	833	300	262	69%	4	9
Norway										
Philippines										
South Africa	36	17	3,361	1,341	9,250	3,330	5,889	36%	407	2,900
Spain										
Sweden										
Turkey			3	1	3	1	0	100%		
USSR			11,100	3,330	12,667	3,800	1,567	88%	365	560
USA					69	25	69	0%		
Yugoslavia			30	11	30	11	0	100%		
Zimbabwe										
Other										
Africa										
Gabon	133	66	2,336	1,078	3,611	1,300	1,275	65%	110	190
Ghana			132	53	429	150	297	31%	4	7
Morocco			63	33	208	75	145	30%	1	2
Asia										
Thailand			10	5	14	5	4	72%		
Other			28	10	67	24	39	42%		
Eastern Europe										
Bulgaria			50	15	56	20	6	90%		
Hungary			66	20	111	40	45	59%		
Other			25	9	25	9	0	100%		
South America										
Chile			6	2	42	15	36	14%		
Total	338	165	25,341	9,197	38,907	13,135	13,566	65%	1,022	3,967

GW Gross Weight

a Production gross weight estimated (.36Mn)

Notes: Reserves are economic reserves
(Reserve) Base includes economic, marginally economic and subeconomic reserves

Sources : 1984 Minerals Yearbook
Mineral Facts & Problems 1985

TABLE D-10. WORLDWIDE FERROALLOY PRODUCTION AND CAPACITY: 1975-1984

Thousands of short tons (gross weight)

Country	Production[a] 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Capacity[b] 1984	Excess	Utilization
Australia	83	79	125	126	127	144	127	115	103	145	166	21	87.3%
Brazil	283	344	409	451	524	609	623	630	648	753	932	179	80.8%
Canada	176	264	230	276	209	319	310	310	239	244	350	106	69.7%
China	360	420	500	660	720	1,102	1,029	970	992	989	1,029	40	96.1%
France	899	960	992	968	1,132	1,087	791	778	778	776	998	222	77.8%
Germany	624	606	520	470	554	491	461	411	323	453	640	187	70.8%
Greece	61	67	39	61	60	57	56	56	75	77	105	28	73.3%
India	218	278	303	336	274	365	290	290	250	251	625	374	40.2%
Italy	265	298	289	289	326	304	242	286	232	236	391	155	60.4%
Japan	758	2,262	2,034	1,703	2,380	2,075	1,820	1,716	1,387	1,564	2,929	1,365	53.4%
Mexico	[illegible]	103	168	188	202	199	204	227	229	258	258	0	100.0%
Norway	943	1,009	770	862	1,071	992	919	876	930	1,057	1,291	234	81.9%
Philippines		8	17	15	20	33	36	43	46	56	98	42	57.1%
South Africa	823	932	1,061	1,273	1,767	1,787	1,555	1,202	1,368	1,617	1,966	349	82.2%
Spain	314	338	337	413	475	422	323	286	279	275	542	267	50.7%
Sweden	187	207	198	201	261	199	223	185	195	196	446	250	43.9%
Turkey	10	28	42	48	37	35	45	49	38	61	176	115	34.7%
USSR	2,672	3,033	3,255	3,353	3,425	3,297	3,305	3,432	3,551	3,643	4,122	479	88.4%
USA	1,926	1,910	1,754	1,666	1,875	1,547	1,521	819	757	1,088	2,192	1,104	49.6%
Yugoslavia	215	221	209	241	275	267	291	243	276	335	356	21	94.1%
Zimbabwe	220	205	220	220	223	290	233	215	206	220	323	103	68.1%
Other													
Africa	5	5	5	5	5	5	5	6	6	7	68	61	10.3%
Asia	280	369	350	354	402	496	472	478	439	487	491	4	99.2%
Eastern Europe	763	734	788	783	763	928	977	983	1,006	1,033	1,258	225	82.1%
South America	135	145	150	132	188	187	179	147	200	208	267	59	77.9%
Western Europe	269	395	345	414	521	431	471	411	460	454	746	292	60.9%
Total	14,198	15,220	15,110	15,508	17,816	17,668	16,508	15,164	15,013	16,483	22,765	6,282	72.4%

a Production includes ferrochromium, ferromanganese, ferrosilicon, ferronickel, and other alloys.
b Production capacity includes ferrochromium, ferromanganese, ferrosilicon, and ferronickel.

Sources:
Minerals Yearbook 1975 - 1984

TABLE D-10. WORLDWIDE FERROALLOY PRODUCTION AND CAPACITY: 1975-1984 (Continued)

Thousands of short tons (gross weight)

Country	Production[a] 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Africa										
Egypt	5	5	5	5	5	5	5	6	6	7
Asia										
Indonesia	0	19	24	22	20	20	22	24	23	22
Korea, North	0	77	100	120	120	132	132	132	132	132
Korea, Republic	23	71	71	87	124	120	141	139	142	159
New Caledonia	230	173	127	89	92	145	121	120	77	101
Taiwan	26	26	27	33	41	79	56	63	65	73
Thailand	1	3	1	3	5					
Total	280	369	350	354	402	496	472	478	439	487
Eastern Europe										
Albania	0	0	0	0	0	4	31	33	39	44
Bulgaria	62	65	55	51	50	50	60	60	60	60
Czechoslavakia	177	156	198	201	193	191	191	191	191	191
Germany, D R	167	170	170	181	170	151	149	138	141	145
Hungary	11	13	13	13	13	16	17	17	15	14
Poland	346	330	352	337	337	326	326	326	326	326
Romania						190	203	218	234	253
Total	763	734	788	783	763	928	977	983	1,006	1,033
South America										
Argentina	49	53	56	51	56	54	53	67	64	63
Chile	15	17	9	8	13	13	9	6	13	13
Columbia	1	1	1	1	1	1	1			
Dominican Republic	67	71	72	41	73	51	54	16	60	71
Venezuela	3	3	12	31	45	68	62	58	63	61
Total	135	145	150	132	188	187	179	147	200	208
Western Europe										
Austria	7	9	8	8	10	11	13	15	15	15
Belgium	108	93	61	96	99	94	99	99	99	105
Finland	44	44	37	49	54	58	57	60	65	66
Iceland	0	0	0	0	17	28	37	47	56	61
Portugal	10	88	107	158	163	164	153	106	115	105
Switzerland	6	9	9	9	9	5	5	5	4	5
UK	94	152	123	94	169	71	107	79	106	97
Total	269	395	345	414	521	431	471	411	460	454

a Production includes ferrochromium, ferromanganese, ferrosilicon, ferronickel, and other alloys.

Sources:
Minerals Yearbook 1975 - 1984

TABLE D-11. U.S. FERROCHROMIUM IMPORTS, WORLDWIDE PRODUCTION, AND CAPACITY: 1984

Thousands of short tons (gross weight & contained chromium)

Country	U.S. Imports GW	U.S. Imports Cr	Ferrochromium Production GW	Ferrochromium Production Cr	Ferrochromium Production Capacity[a] GW	Ferrochromium Production Capacity[a] Cr	Util-ization	Excess Capacity GW
Australia								
Brazil	13.1	7.1	146	79	146	79	100%	0
Canada								
China			130	72	130	72	100%	0
France			22	12	94	58	24%	72
Germany	5.1	3.6	77	42	100	62	77%	23
Greece			22	12	27	17	80%	5
India	3.4	2.4	44	24	135	84	32%	91
Italy	5.7	3.6	13	7	48	30	27%	35
Japan	0.1	0.1	357	196	561	348	64%	204
Mexico			8	4	8	4	100%	0
Norway	0.1	0.0	12	7	32	20	37%	20
Philippines	5.4	3.4	36	20	60	37	60%	24
South Africa	262.9	139.3	1,006	548	1,006	548	100%	0
Spain	0.9	0.6	15	8	21	13	72%	6
Sweden	5.4	3.9	160	84	269	167	59%	109
Turkey	49.8	30.5	53	29	66	41	80%	13
USSR			476	260	677	420	70%	201
USA			31	21	302	187	10%	271
Yugoslavia	27.7	17.9	96	51	96	51	100%	0
Zimbabwe	46.2	30.4	187	103	305	189	61%	118
Other								
Africa								
Asia								
Eastern Europe			199	110	243	140	82%	44
South America								
Western Europe			66	36	66	36	100%	0
Total	425.8	242.8	3,156	1,727	4,393	2,604	72%	1,237

GW Gross Weight

Cr Contained chromium

a Ferrochromium production capacity gross weight estimated (.62Cr)

Sources:
1984 Minerals Yearbook
Mineral Facts & Problems 1985

Notes: The total ferroalloy production capacities for Japan & the U.S.A. are the 1990 Bureau of Mines figures which are higher than known capacity figures projected by the Ferroalloys Association & other sources.

TABLE D-11. U.S. FERROCHROMIUM IMPORTS, WORLDWIDE PRODUCTION, AND CAPACITY: 1984 (Continued)

Thousands of short tons (gross weight & contained chromium)

Country	U.S. Imports GW	U.S. Imports Cr	Ferrochromium Production GW	Ferrochromium Production Cr	Ferrochromium Production Capacity[a] GW	Ferrochromium Production Capacity[a] Cr	Util-ization	Excess Capacity GW
Eastern Europe								
Albania			44	24	44	24	100%	0
Czechoslavakia			30	17	30	17	100%	0
Germany, D R			23	13	23	13	100%	0
Poland			52	29	52	29	100%	0
Romania			50	28	94	58	53%	44
Total			199	110	243	140	82%	44
Western Europe								
Finland			66	36	66	36	100%	0

GW Gross Weight
Cr Contained chromium

a Ferrochromium production capacity gross weight estimated (.62Cr)

Sources:
1984 Minerals Yearbook
Mineral Facts & Problems 1985

TABLE D-12. U.S. FERROMANGANESE IMPORTS AND WORLDWIDE PRODUCTION: 1984

Thousands of short tons (gross weight & contained manganese)

Country	U.S. Imports ......Gross Weight............			......Contained Mn............			Ferromanganese Production ......Gross Weight................		
	FeMn	SiMn	Total	FeMn	SiMn	Total	FeMn	SiMn	Total
Australia	6.0	14.1	20.1	4.6	9.3	13.9	0	117	117
Brazil	9.4	46.6	56.0	7.3	30.6	37.9	117	193	310
Canada	2.1	0.9	3.0	1.4	0.6	2.0	90	50	140
China							540	0	540
France	123.0	0.4	123.4	96.4	0.3	96.7	302	33	335
Germany	24.3	0.0	24.3	19.8	0.0	19.8	188	0	188
Greece							0	0	0
India							138	11	149
Italy							69	44	113
Japan	2.8	0.0	2.8	2.2	0.0	2.2	524	257	781
Mexico	39.1	15.4	54.5	30.9	10.3	41.2	176	47	223
Norway	39.8	11.9	51.7	31.9	7.7	39.6	276	220	496
Philippines							0	0	0
South Africa	133.7	23.4	157.1	104.5	15.7	120.2	422	39	461
Spain	6.3	1.3	7.6	5.0	0.8	5.8	94	77	171
Sweden							0	0	0
Turkey							0	0	0
USSR							1,926	39	1,965
USA							75	65	140
Yugoslavia	4.5	14.5	19.0	3.4	9.5	12.9	46	28	74
Zimbabwe							2	0	2
Other									
Africa	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Asia	0.0	0.0	0.0	0.0	0.0	0.0	165	25	190
Eastern Europe	0.0	9.1	9.1	0.0	6.1	6.1	498	110	608
South America	0.0	0.0	0.0	0.0	0.0	0.0	35	25	60
Western Europe	18.2	0.8	19.0	14.3	0.5	14.8	221	17	238
Total	409.2	138.4	547.6	321.7	91.4	413.1	5,904	1,397	7,301

Notes: The total ferroalloy production capacities for Japan & the U.S.A. are the 1990 Bureau of Sources:gures which are higher than known capacity figures projected by the Ferroalloys Association & o 1984 Minerals Yearbook

TABLE D-12. U.S. FERROMANGANESE IMPORTS AND WORLDWIDE PRODUCTION: 1984(Continued)

Thousands of short tons gross weight (contained manganese)

Country	U.S. Imports Gross Weight			Contained Mn			Ferromanganese Production Gross Weight		
	FeMn	SiMn	Total	FeMn	SiMn	Total	FeMn	SiMn	Total
Asia									
Korea, North	0.0	0.0	0.0	0.0	0.0	0.0	77	0	77
Korea, Republic	0.0	0.0	0.0	0.0	0.0	0.0	66	0	66
Taiwan	0.0	0.0	0.0	0.0	0.0	0.0	22	25	47
Total	0.0	0.0	0.0	0.0	0.0	0.0	165	25	190
Eastern Europe									
Bulgaria	0.0	0.0	0.0	0.0	0.0	0.0	37	0	37
Czechoslavakia	0.0	0.0	0.0	0.0	0.0	0.0	110	0	110
Germany, D R	0.0	0.0	0.0	0.0	0.0	0.0	72	0	72
Poland	0.0	0.0	0.0	0.0	0.0	0.0	183	55	238
Romania	0.0	9.1	9.1	0.0	6.1	6.1	96	55	151
Total	0.0	9.1	9.1	0.0	6.1	6.1	498	110	608
South America									
Argentina	0.0	0.0	0.0	0.0	0.0	0.0	27	15	42
Chile	0.0	0.0	0.0	0.0	0.0	0.0	6	0	6
Venezuela	0.0	0.0	0.0	0.0	0.0	0.0	2	10	12
Total	0.0	0.0	0.0	0.0	0.0	0.0	35	25	60
Western Europe									
Belgium	0.8	0.0	0.8	0.8	0.0	0.8	105	0	105
Portugal	17.4	0.8	18.2	13.5	0.5	14.0	33	17	50
UK	0.0	0.0	0.0	0.0	0.0	0.0	83	0	83
Total	18.2	0.8	19.0	14.3	0.5	14.8	221	17	238

Sources:
1984 Minerals Yearbook
Mineral Facts & Problems 1985

TABLE D-13. U.S. FERROSILICON IMPORTS, WORLDWIDE PRODUCTION, AND CAPACITY: 1984

Thousands of short tons (gross weight & contained silicon)

Country	U.S. Imports ....Gross Weight.....		....Contained Si....		Production ....Gross Weight....		.....Contained Si.....		Production Capacity ....Gross Weight....		......Contained Si.....		Util- ization	FeSi Production Excess Capacity
	FeSi	Si	FeSi	Si	FeSi	Si	FeSi	Si	FeSi	Si	FeSi	Si		Si
Australia	0.0	0.0	0.0	0.0	28	0	18	0	33		21	0	86%	3
Brazil	35.0	6.0	22.0	6.0	174	30	117	23	228	39	153	30	76%	36
Canada	16.0	5.0	11.0	5.0	88	28	70	27	128		102	47	69%	32
China	0.0	0.0	0.0	0.0	215	24	150	24	258	26	180	26	83%	30
France	5.0	4.0	3.0	4.0	220	62	108	59	301	85	148	81	73%	40
Germany	3.0	1.0	2.0	1.0	78	8	25	8	128	13	41	13	61%	16
Greece	0.0	0.0	0.0	0.0	56	0	43	0	59		45	0	96%	2
India	0.0	0.0	0.0	0.0	45	4	33	4	89	8	65	8	51%	32
Italy	1.0	0.0	0.0	0.0	57	15	48	15	101	27	85	27	56%	37
Japan	0.0	0.0	0.0	0.0	169	0	128	0	317		240	0	53%	112
Mexico	0.0	0.0	0.0	0.0	26	0	16	0	37		23	0	70%	7
Norway	28.0	1.0	20.0	1.0	381	77	286	75	453	98	340	96	84%	54
Philippines	0.0	0.0	0.0	0.0	22	0	16	0	32		23	0	70%	7
South Africa	1.0	1.0	1.0	1.0	110	24	82	24	119	40	89	40	92%	7
Spain	0.0	0.0	0.0	0.0	68	19	52	19	123	36	94	36	55%	42
Sweden	1.0	0.0	1.0	0.0	17	18	10	18	17	23	10	23	100%	0
Turkey														
USSR	12.0	0.0	5.0	0.0	794	70	480	69	933	82	564	81	85%	84
USA					498	140	274	137	753		414	0	66%	140
Yugoslavia	0.0	0.0	0.0	0.0	90	40	67	39	116	51	86	50	78%	19
Zimbabwe	0.0	0.0	0.0	0.0	30	0	17	0			0	0		
Other														
Africa	4.0	0.0	3.0	0.0	7	0	5	0	71		51	0	10%	46
Asia	0.0	0.0	0.0	0.0	56	0	44	0	85		67	0	66%	23
Eastern Europe	1.0	0.0	1.0	0.0	55	11	33	11	55	11	33	11	100%	0
South America	28.0	0.0	21.0	0.0	68	0	46	0	110		72	0	64%	26
Western Europe	7.0	1.0	5.0	1.0	24	35	19	35	32	45	25	45	76%	6
Total	142.0	19.0	95.0	19.0	3,376	605	2,187	588	4,576	585	2,971	614	74%	785

Sources:
1984 Minerals Yearbook
Mineral Facts & Problems 1985

TABLE D-13. U.S. FERROSILICON IMPORTS, WORLDWIDE PRODUCTION, AND CAPACITY: 1984 (Continued)

Thousands of short tons (gross weight & contained silicon)

Country	U.S. Imports ....Gross Weight..... FeSi	Si	......Contained Si....... FeSi	Si	Production ......Gross Weight.......... FeSi	Si	..Contained Si....... FeSi	Si	Production Capacity ....Gross Weight.... FeSi	Si	......Contained Si..... FeSi	Si	Util-ization	FeSi Production Excess Capacity Si
Africa														
Egypt	0.0	0.0	0.0	0.0	7	0	5	0	71		51	0	10%	46
Isreal	4.0		3.0											
Total	4.0	0.0	3.0	0.0	7	0	5	0	71		51	0	10%	46
Asia														
Korea, North	0.0	0.0	0.0	0.0	36	0	27	0	49		37	0	73%	10
Taiwan	0.0	0.0	0.0	0.0	20	0	17	0	35		30	0	57%	13
Total	0.0	0.0	0.0	0.0	56	0	44	0	85		67	0	66%	23
Eastern Europe														
Poland	1.0		1.0		55	11	33	11	55	11	33	11	100%	0
South America														
Argentina	2.0	0.0	1.0	0.0	17	0	7	0	34		14	0	50%	7
Chile	1.0	0.0	1.0	0.0										
Venezuela	0.0	0.0	0.0	0.0	51	0	39	0	76		58	0	67%	19
Other	25.0	0.0	19.0	0.0										
Total	28.0	0.0	21.0	0.0	68	0	46	0	110		72	0	64%	26
Western Europe														
Austria	0.0	0.0	0.0	0.0	0	0	0	0			0	0		
Belgium	0.0	0.0	0.0	0.0	0	0	0	0			0	0		
Finland	0.0	0.0	0.0	0.0	0	0	0	0			0	0		
Iceland	3.0	0.0	2.0	0.0	0	0	0	0			0	0		
Portugal	4.0	1.0	3.0	1.0	24	35	19	35	32	45	25	45	76%	6
Switzerland	0.0	0.0	0.0	0.0	0	0	0	0			0	0		
UK	0.0	0.0	0.0	0.0	0	0	0	0			0	0		
Total	7.0	1.0	5.0	1.0	24	35	19	35	32	45	25	45	76%	6

Sources:
1984 Minerals Yearbook
Mineral Facts & Problems 1985

APPENDIX E

UNCLASSIFIED MOBILIZATION PLANNING SCENARIO

Summary Scenario involving full mobilization with a worldwide conventional conflict of 3 years duration, after 60 days of rising tensions:

Unrest in the Persian Gulf reduces oil supply for the Free World to the point of enactment of international energy sharing arrangements. After a short period of rising tensions, conflict ensues between a Persian Gulf nation and the Soviet Union. U.S. and Soviet forces become engaged in the conflict in the Persian Gulf area which escalates to a global conflict involving North Atlantic Treaty Organization (NATO)/Warsaw Pact and Korea/United Nations (UN) forces. The period of increased tensions causes the United States to take the following kinds of actions during the month preceding the decision to deploy forces: evacuation of U.S. Nationals from the Persian Gulf area directed, domestic energy conservation measures instituted, recall of 100,000 reservists ordered, Declaration of National Emergency to invoke authorities of International Emergency Economic Powers Act against selected nations made in consultation with Congress, Military Sealift Command/Military Airlift Command/Sealift Readiness Program/Ready Reserve Force, Civil Reserve Air Fleet (CRAF) alerted, foreign military and nonmilitary support to friendly nations increased, initial surge production of critical war reserve materiel items directed, fill of Department of Defense war reserve stocks implemented, and forces for U.S. Central Command (USCENTCOM) alerted for deployment.

Shortly before M-Day, the President amends and extends an earlier Declaration of National Emergency, after consulting with Congress about requirements of the National Emergencies Act, and on M-Day commits U.S. ground forces in the Persian Gulf conflict. Partial mobilization is declared, CRAF II is activated, and deployment of the USCENTCOM units to Southwest Asia with substantial ground and carrier-based air support is begun.

Soon thereafter, the President orders full mobilization, Selective Service System (SSS) induction at 100,000 per month begins, CRAF III is activated and the U.S. and Soviet forces are engaged in conventional air and naval combat in the Persian Gulf area. Warsaw Pact forces begin mobilizing against NATO and the U.S./NATO allies react with progressive buildup. Warsaw Pact forces attack with conventional weapons including chemical agents, and NATO resists. U.S./NATO allies declare war against the Soviet Union and prepare for a protracted conflict. North Korea attacks South Korea and U.S. and Soviet air and naval forces and their respective allies engage in combat in the Pacific because of Soviet efforts to interdict the Sea Lines of Communications (SLOCS). The intensity of the combat increases during the first two months. For the next ten months, moderate-to-light contact continues in Western Europe with moderate casualties and severe resource attrition. NATO Allies then mount a major offensive to regain lost territory and restore pre-war boundaries. Later, a worldwide ceasefire is negotiated followed by a negotiated peace at the three-year mark following M-Day.

Post-war actions of the United States are aimed toward rebuilding the military strength with an induction rate of 50,000 per month. Additionally, the United States continues to support the rehabilitation of Western Europe. The President establishes National post-war economic objectives and requests legislation and appropriations from Congress. The United States meets its economic recovery goals during the three-year recovery period.

END

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