Industry & Trade Summary

Refractory Ceramic Products

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PREFACE

In 1991 the United States International Trade Commission initiated its current *Industry and Trade Summary* series of informational reports on the thousands of products imported into and exported from the United States. Each summary addresses a different commodity/industry area and contains information on product uses, U.S. and foreign producers, and customs treatment. Also included is an analysis of the basic factors affecting trends in consumption, production, and trade of the commodity, as well as those bearing on the competitiveness of U.S. industries in domestic and foreign markets.[1]

This report on refractory ceramics covers the period 1988 through 1992 and represents one of approximately 250 to 300 individual reports to be produced in this series during the first half of the 1990s. Listed below are the individual summary reports published to date on the minerals and metals sectors.

USITC publication number	*Publication date*	*Title*
2426	November 1991	Toys and models
2475	August 1992	Fluorspar and certain other mineral substances
2476	January 1992	Lamps and lighting fittings
2504	November 1992	Ceramic floor and wall tiles
2523	June 1992	Prefabricated buildings
2587	January 1993	Heavy structural steel shapes
2623	April 1993	Copper
2653	June 1993	Glass containers

[1] The information and analysis provided in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

CONTENTS

INTRODUCTION

Refractory ceramic products, a small segment of the entire ceramics industry (figure 1), are important for industrial applications, such as furnace linings which offer thermal, chemical, and wear resistance (figure 2), and are vital for the production of steel, cement, glass and aluminum. The United States is the world's leading producer of refractory ceramic products and a leading supplier of advanced refractory products. Refractories are typically subjected to temperatures in excess of 1000 degrees F. (538 degrees C.) in uses ranging from fireplaces to thermal insulation for spacecraft. The two principal classifications for refractories are clay (SIC code 3255) and nonclay (SIC code 3297). This report contains information on the domestic and foreign industries producing such products as refractory ceramic bricks and blocks, retorts, crucibles, tubes and pipes; U.S. and foreign tariff policies in effect for these products; and the U.S. industry's performance in domestic and foreign markets. The report covers the period 1988 through 1992.

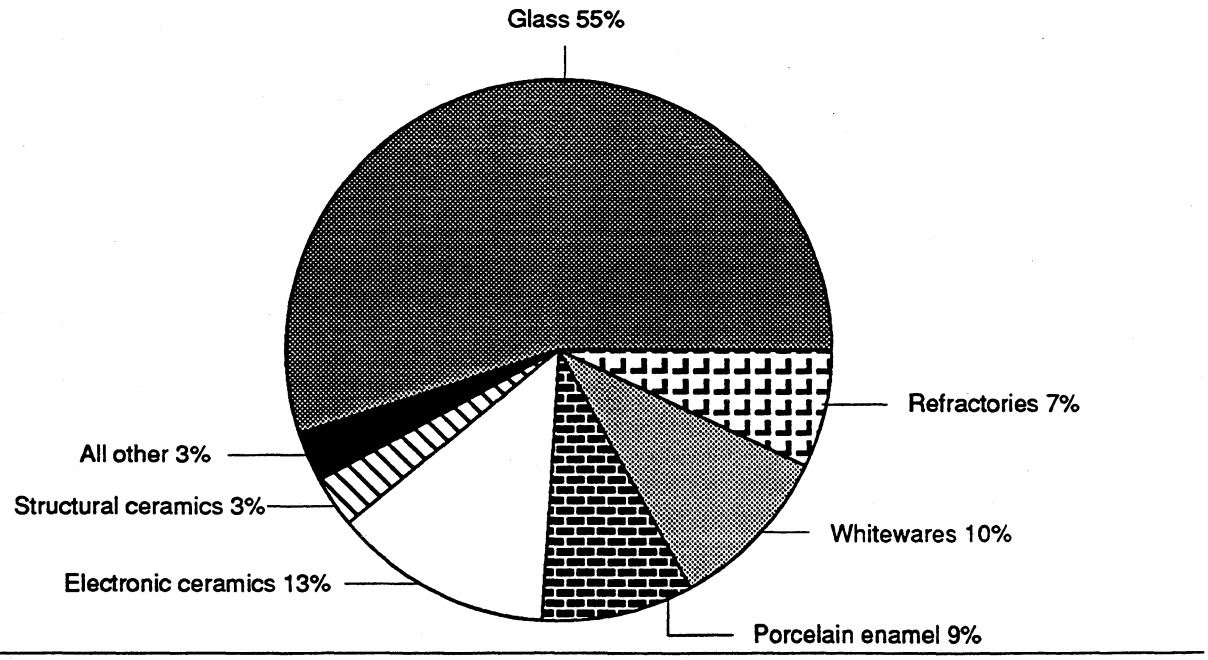
The manufacturing process for refractories depends on the particular combination of chemical compounds and minerals selected to produce the required thermal stability, corrosion resistance, thermal expansion, and other qualities. There are three basic forms of refractories—bricks and shapes, crucibles, and monolithics.

Bricks and shapes are the principal forms of refractory items produced in the United States, accounting for nearly 40 percent of all shipments. These are preformed products used to build straight walls and curved designs, such as arches. To form bricks or shapes, the raw materials are mixed with water and/or other binders, pressed or molded into a desired shape[1] and fired in a kiln so as to form a ceramic or chemical bond (figure 3).

Crucibles, the oldest known refractory forms, are ceramic pots or receptacles for use in melting metals. The chemical composition of a crucible depends on the chemistry of the metal melted in the crucible; all crucibles are formed from refractory materials with relatively high thermal conductivity. Advantages of melting metal in a refractory crucible include prevention of metal contamination, reduction of fuel costs and melting times due to more efficient heat transfer, and longer service life resulting in lower maintenance costs.

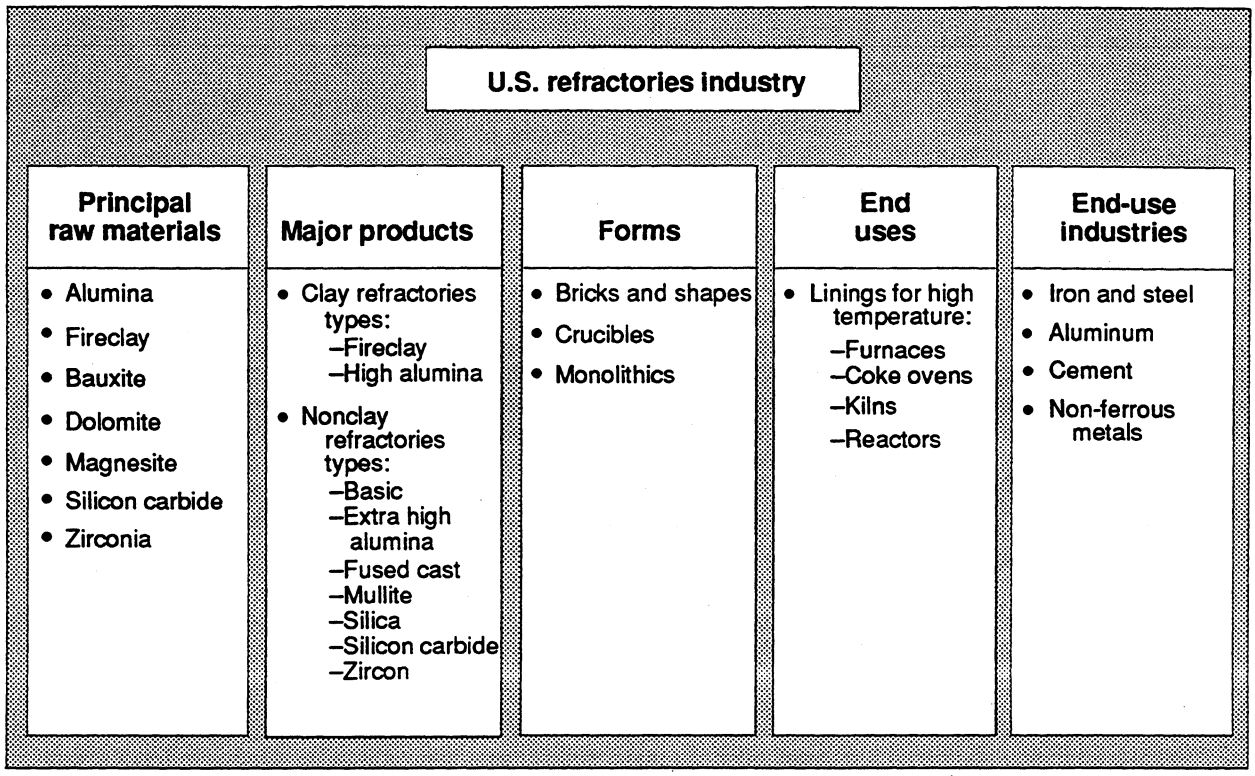
[1] Bricks or shapes can be formed by a variety of methods, including hand molding, air ramming, pressing, extruding, or casting.

Figure 1
World ceramic sales, by market segments, 1992



Source: Ceramic Industry Magazine, August 1993.

Figure 2
U.S. refractories industry, principal raw materials, major products, product forms, end-uses, and end-use industries



Source: Compiled by the staff of the U.S. International Trade Commission.

Monolithic (specialty) refractories are unformed products that are dried to form a unified, integral structure after application. These items are shipped in a disaggregated form and mixed on the job site in order to be used as mortars, plastics, ramming mixes, castables, and gunning mixes. Depending on their specific use, monolithic refractories can be applied by either pouring, pumping, troweling, or gunning (spraying). Monolithics offer the advantages of (1) reduced installation time because they can be applied while a furnace is hot, (2) the ability to conform to any size or shape, and (3) the absence of joints, a feature that protects a furnace lining by preventing thermal penetration.

U.S. INDUSTRY PROFILE

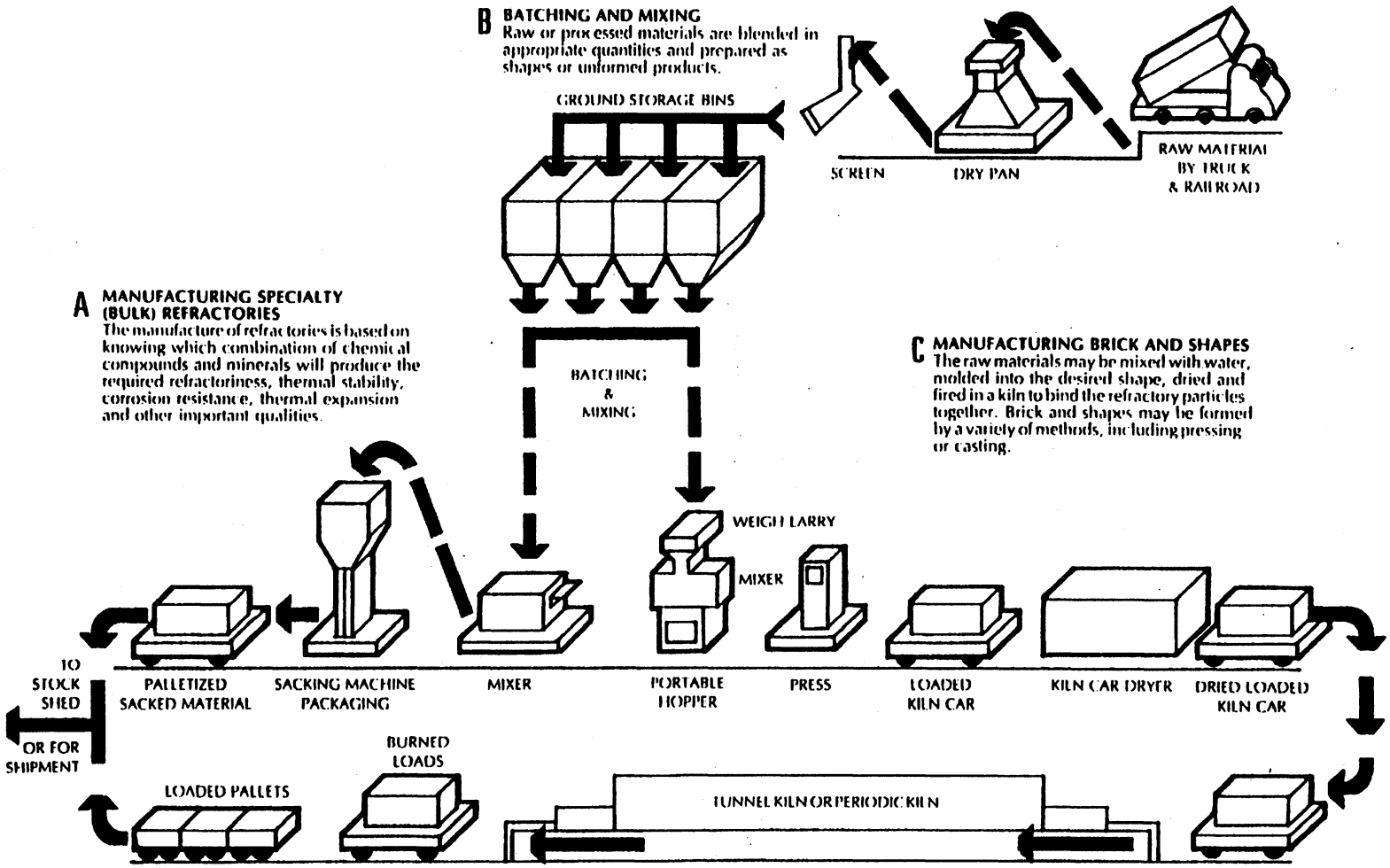
Industry Structure

During the last decade, the U.S. refractories industry has been affected significantly by declining demand for traditional refractories such as bricks and shapes and customer requirements for higher quality, specialty refractories. In response to these factors, the industry restructured operations by reducing overcapacity and employment through mergers with other firms or by divesting into independent entities. At the same time, major diversified refractory firms reduced excess capacity by eliminating lower volume items from their product lines while concentrating on production of a narrower range of products.

As a result of efforts to improve its operating efficiency, the U.S. refractories industry eliminated its most inefficient operations during the 1980s by closing nearly 45 plants. The number of U.S. producers declined from nearly 180 producers in 1988 to about 160 producers in 1992, operating nearly 200 facilities. Refractories production tends to be concentrated in the industrial Midwestern region of the nation, with nearly 35 percent of all establishments located in Ohio and Pennsylvania, to serve more conveniently the important iron and steel industry. Total employment of production workers in the U.S. refractories industry declined from nearly 11,000 in 1988 to fewer than 10,000 in 1992 because of plant closings and increased automation of facilities while average hourly wages for workers averaged nearly $12.50 in 1990, the last year for which such data are available.[2] At the same time, a number of smaller, specialized firms entered the industry to produce monolithic refractories, which gained market share versus bricks and shapes during 1988-92, as end-users sought to reduce their operating costs through the substitution of monolithics.

[2] Data provided by Refractories Institute.

Figure 3
Refractory manufacturing flow shet



Source: The Refractories Institute

End-users have been able to reduce the costs associated with the idling of a furnace while it is being relined by increasing the use of monolithics, which can be applied while the furnace is still hot.

Industry analysts estimate that nearly 45 percent of U.S. production of refractories is accounted for by 5 large firms producing a wide range of refractory products, and 20 percent of total U.S. production by another 10, more specialized, firms.[3] Most firms in the industry are not vertically integrated and purchase their raw materials from independent sources. The larger U.S. firms tend to be multinational in that they produce and market their goods in a number of overseas markets.

According to *Ceramic Industry*, the tabulation at the bottom of the page shows the estimated 1992 worldwide sales by the leading U.S. producers of refractory products (in million dollars).

During the 1980s, a number of foreign firms entered the U.S. market to purchase assets that were perceived to be selling at a discount to their inherent value. An estimated 20 to 30 percent of U.S. capacity is believed to be foreign owned. The largest U.S. firms owned by foreign interests are The Carborundum Co., (a subsidiary of British Petroleum plc); North American Refractories (owned by Didier-Werke AG of Germany); and Norton Company and Corhart Refractories Company (both owned by Compagnie de Saint-Gobain of France). In 1990 Radex-Heraklith of Austria, a leading European producer, signed an agreement with National Refractories & Minerals Corp. to acquire 50 percent ownership of National Refractories over a 5-year period.

Other significant responses by the industry to the changing demands of end-use industries, particularly of the steel industry, include increased research and development efforts to improve product quality, to reduce product cost and to forge closer ties with end-users in order to develop products that meet the specifications and cost needs of these customers. Adoption by the steel industry of such processes as electric arc furnaces and continuous casting has decreased the total amount of refractories used by the industry but has increased the demand for high-quality, high-value refractories that line these high-temperature furnaces. Improvements in refractory quality, largely resulting from increased availability of high-purity raw materials and from the adoption of modern production techniques, have lengthened the life of furnace and ladle linings dramatically from less than 1,000 heats per furnace vessel 10 years ago to nearly 2,000 heats per vessel at present. The industry hopes to eventually produce linings that last 5,000 heats per vessel.[4] Finally, refractory producers and steelmakers have formed closer working relationships by pooling research and development activities and by sharing their knowledge and experience in the field in an effort to produce refractory products that better serve the needs of the steel industry.[5]

According to refractory industry analysts, nearly 50 percent of the total production cost is accounted for by raw materials, and 20 percent is accounted for by labor. Remaining production costs are allocated among energy[6], transportation, environmental compliance, and other miscellaneous costs. Refractory product costs have been lowered principally through a broadening of raw material sources. In particular, China has emerged as a reliable source of high-purity raw materials such as bauxite, magnesite, and graphite. In addition, numerous technological changes in the handling, crushing/grinding, screening, batching, mixing, pressing, and firing of raw materials have contributed to the competitive manufacture of refractories. Finally, production costs are also being lowered through the adoption of near-net-shape processing techniques that allow manufacturers to produce a final refractory shape requiring little or no costly machining. Customers have also encouraged the transport of premixed refractory materials from the refractory plant directly to the customer's furnace,

[3] "Giants in Refractories," *Ceramic Industry*, Aug. 1993, p. 66-67.

[4] George W. Hess, "Refractories Keep the Melt Shop Up and Running," Iron Age, Mar. 1990, p. 26.

[5] Ibid., p. 25.

[6] Energy costs for manufacturers of refractory bricks and shapes are generally greater than energy costs for manufacturers of monolithic refractories because of the energy-intensive nature of these operations which require the use of forming equipment, dryers and kilns.

Company	Principal products	Estimated 1992 sales worldwide
Carborundum Inc	Refractory bricks, blocks, specialty items	300
Harbison-Walker Refractories Inc	Refractory bricks, blocks, specialty items	209
J.E. Baker Co	Refractory bricks, blocks, specialty items	165
A.P. Green Industries Inc	Refractory bricks, blocks, specialty items	136
National Refractories & Minerals Inc	Refractory bricks, blocks, specialty items	125

thereby eliminating the need to mix these materials at the plant site.[7]

Over the past 20 years, the U.S. refractories industry has been affected by a number of health and environmental regulations. The principal Federal regulations that apply to this industry are included in figure 4. Because industrial refractories typically contain chemically stable materials, they usually do not pose a health hazard. However, certain unusual refractories may contain heavy metals or radioactive oxides, such as silica, asbestos, and beryllium oxide, which may constitute a potential health hazard. OSHA regulations specify the allowable levels of exposure to ingestible and airborne particulate matter.

In addition to Federal regulations, individual states have also passed legislation to restrict hazardous chemical substances, some of which, such as crystalline silica and chromite, are used by the refractories industry. The California Air Toxics Bill requires manufacturers to report air emissions on over 250 chemicals, and many states regulate the transport of out-of-state hazardous wastes, including such refractory wastes as chromium. Although cost figures are not available, industry officials report that the most costly regulations are those related to worker health and safety and to storm-water runoff provisions of the National Conservation and Recovery Act. The industry is now analyzing the potential impact of complying with the 1990 Clean Air Act amendments, to be administered by the individual states, and how best to implement policies that comply with these provisions.

The competitive effects of such regulations on the industry vary. Monolithic refractory producers, for example, have found compliance with the 1990 Clean Air Act generally easier than have producers of bricks and shapes because monolithic producers do little firing or calcining in their production processes. In addition, larger firms, which generally have more resources to devote to environmental compliance than smaller firms, may also have a competitive advantage relative to smaller firms.

Consumer Characteristics and Factors Affecting Demand

Principal end-use markets for refractories include the iron and steel, cement, and nonferrous (principally aluminum) metal industries (figure 5). Because demand for refractory products is heavily consumer driven, developments in end-use markets, particularly in the steel industry, which consumes nearly 50 percent of all refractories produced, tend to influence demand for refractory products strongly (figure 6). During the 1980s, the U.S. steel industry underwent massive rationalization in order to restore competitiveness in a world market characterized by lower demand for steel

[7] To minimize transportation costs, refractory plants are generally located within a 24-hour trucking or rail distance from the site the product is to be consumed. Because water transport costs are typically 5 to 10 percent below other transport modes, some producers who must transport refractories long distances may ship these products when possible. These producers tend to be located in the industrial midwestern region of the United States, where they can take advantage of major river systems.

Figure 4
Principal environmental, health, and safety regulations affecting refractories industry

The National Conservation and Recovery Act (1969) provides for the recovery of mining sites.

The Federal Occupational Safety and Health Act (1970) (OSHA) provides the regulatory vehicle for assuring worker safety and health.

The Toxic Substances Control Act (1971) provides for controlling the exposure and use of raw industrial chemicals.

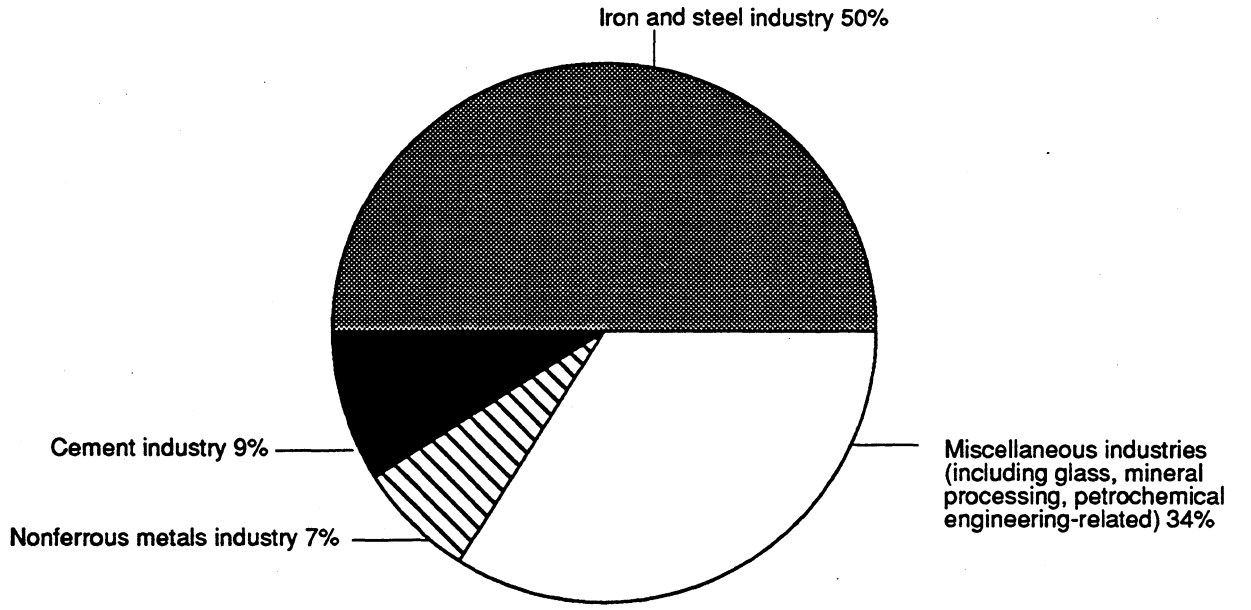
The Clean Air Act (1972) and Amendments (1990) provide for the prevention and control of discharges into the air which may be harmful to public health including limits on substances that contribute to acid rain, global warming, and ozone depletion.

The Mine Safety and Health Act (1974) regulates employee mine safety.

The Resource Conservation and Recovery Act (RCRA) (1976) seeks to control hazardous waste disposal.

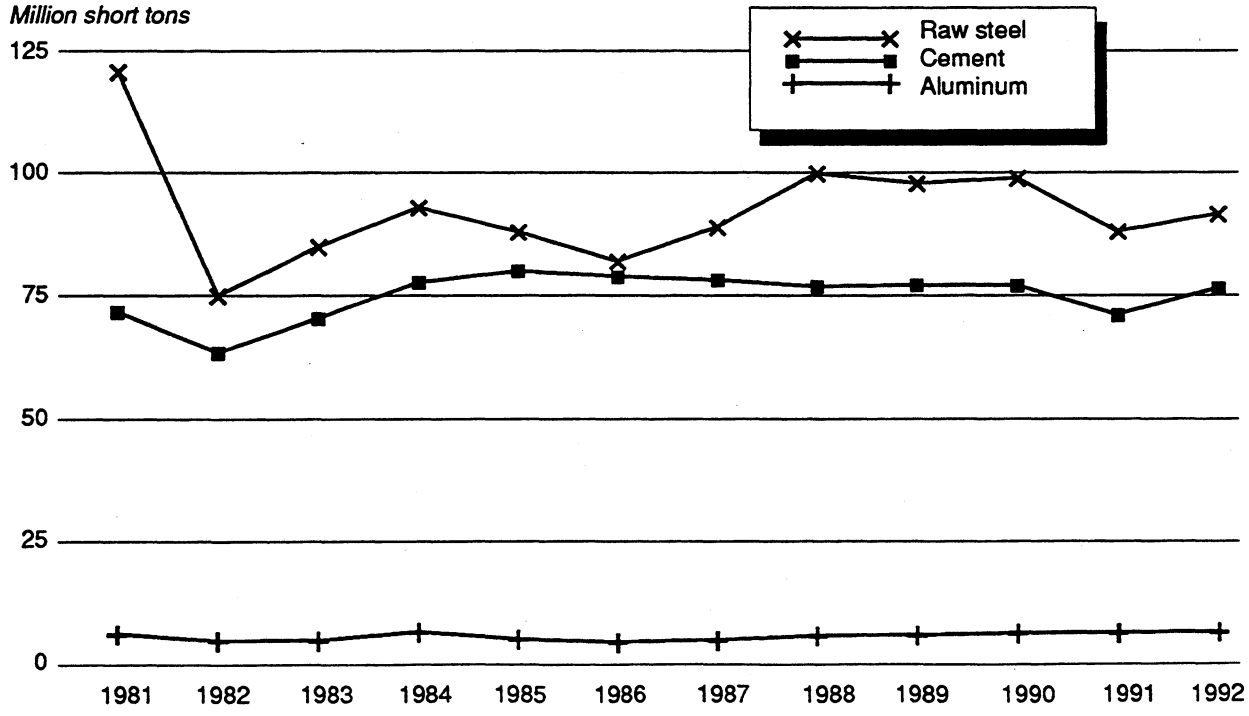
The Superfund Authorization Act (1980) requires cleanup of prior hazardous substances on land and water.

Figure 5
U.S. consumption of refractories, by end-use, 1992



Source: Refractories Institute.

Figure 6
U.S. raw steel, cement, and aluminum metal production, 1981-92



Source: American Iron and Steel Institute, U.S. Bureau of Mines.

products and excess production capacity. The U.S. steel industry closed its most inefficient facilities and modernized remaining plants; more than 450 steel-related facilities were closed during the 1980s as annual production capacity declined from 160 to 110 million short tons. Moreover, the industry developed and installed technologies that use fewer refractories per ton of steel. For example, the transition from the open hearth steel-melting process to the basic oxygen furnace (BOF), which reduced the amount of time required to produce a ton of steel, also substantially reduced the need for refractory materials from an estimated 250 pounds to between 10 and 15 pounds per ton of steel produced.

Rationalization in the U.S. cement industry also reduced the number of plants and kilns significantly, while the remaining producers require more sophisticated, higher cost refractories. Demand by primary aluminum smelters, which have been significant consumers of refractories, has also decreased as the aluminum industry has promoted the recycling of primary aluminum in an effort to reduce energy consumption and decrease costs.

Declines in demand for commodity-grade refractories, such as bricks and shapes, have been replaced by rising demand for monolithic refractories (up from 18 percent of total consumption in 1971 to 30 percent in 1991) as the use of these refractories has achieved cost savings for end-users through reductions in installation time.[8] Although price is an important factor in explaining changes in demand for refractory products in general, monolithic refractory products are less price sensitive than commodity-type refractories because they tend to be application-specific and more influenced by technical considerations.

FOREIGN INDUSTRY PROFILE

Although U.S. refractory manufacturers still rank among the lowest cost producers of quality refractory products in the world, benefitting from access to low-cost sources of raw materials and U.S. leadership in refractory process technology, foreign competitors have emerged over the past decade. Expanded raw material sources, major research efforts to develop both more efficient processing techniques and refractory products that meet stringent end-use specifications, and purchases of U.S. firms during the 1980s have helped foreign, mostly Western European and Japanese, firms compete with U.S. refractory producers. This increased global production, coupled with a decline in global demand, has added to world overcapacity among refractory producers. In response to overcapacity, world producers have been forced to rationalize their operations through acquisition, merger, and plant closings. Remaining producers have concentrated their operations to produce a higher proportion of specialty, monolithic refractories and high-performance, high-alumina bricks and shapes for use in modern higher temperature steel furnaces.[9]

Total world sales of refractories equaled nearly $5.8 billion in 1992. The tabulation at the bottom of the page shows the estimated 1992 sales by the leading foreign producers of refractories, published in *Ceramic Industry* (in million dollars).

Germany was the largest producer and consumer of refractory products in Western Europe and the principal foreign supplier of refractory products to the United States in 1992. Iron and steel industries, both domestic and foreign, consume almost 50 percent of German refractory production while exports account for 40 percent of production.[10] Didier-Werke AG, which is a leader in the development of low-cost techniques for producing refractories, is the principal German manufacturer of refractories. Didier has eight domestic facilities with a combined annual capacity of nearly 300,000 short tons and foreign operations in France, Belgium, Spain, Canada, and the United States (Didier owns North American Refractories Co. in the United States). Wulfrath Refractories, another major

[8] Edmund S. Wright, "Manufacturing Trends in the U.S. Refractories Industry," *Ceramic Bulletin,* July 1990, p. 1163. Data for 1991 were supplied by The Refractories Institute.

[9] Dr. Colin Richmond, "Refractories in Europe: Coping with Change," *Ceramic Industry,* Sept. 1990, p. 47.

[10] Karen Harries-Rees, "Refractory Majors Plagued by Overcapacity," *Industrial Minerals,* Sept. 1992, p. 24.

Country Company	Estimated 1992 sales	Principal markets
Germany:		
Didier–Werke AG	713	Steel, glass, cement
Wulfrath Refractories	19	Steel
United Kingdom:		
Burmah Castrol	450	Steel
Hepworth plc	200	Steel, cement, glass
Morgan Crucible	310	Steel
Japan:		
Shinagawa Refractories	483	Steel
Krosaki Corp	300	Steel
Asahi Glass Co. Ltd	248	Glass
France:		
Compagnie de Saint–Gobain	416	Steel, glass, cement
Austria:		
Radex–Heraklith Group	560	Steel, glass, cement

German producer of refractory products, also operates facilities in Poland, Luxembourg, and the United States. Nearly 90 percent of Wulfrath's production is consumed by the iron and steel industry, both domestic and foreign. The German industry relies heavily on low-cost imports of refractory raw materials, primarily from China and Australia, to remain competitive in worldwide refractories markets.[11]

The United Kingdom has traditionally maintained a strong presence in the world refractories market, exporting nearly 60 percent of its output in 1991. Iron and steel industries, both domestic and foreign, consume over 50 percent of British output. During the last 5 years, British producers have reported a large decline in sales of firebrick and high-alumina products because of diminished demand by the British steel industry and because of weak overseas markets. To remain cost competitive in world markets, the British industry relies on imports for nearly 90 percent of its raw material requirements.[12]

Production in France is dominated by Compagnie de Saint-Gobain, a diversified ceramics producer operating in 35 countries and maintaining a strong presence in the U.S. market where it owns two of the leading U.S. producers. Saint-Gobain became a major participant in the world refractories market during the 1980s through the global acquisition of specialized and technologically sophisticated ceramics companies.[13]

Although the Japanese refractories industry has grown considerably since the 1950s because of rapid growth in domestic end-use industries, Japanese refractories production fell by 11 percent between 1989 and 1992 because of declining production by Japanese steelmakers, which consume almost 70 percent of Japanese refractory production.[14] Monolithic refractories account for nearly 50 percent of total refractories produced by Japanese manufacturers, while Japan imports nearly 80 percent of refractories raw materials used.[15] As in many other industrial nations, technological changes in the steel industry have forced Japanese refractories manufacturers to produce smaller volumes of higher quality materials. Japanese refractory-making technology, already considered to be very advanced, is expected to further improve as the Japanese steel industry experiments with direct iron ore smelting and scrap smelting in electric-arc furnaces. Both processes impose more severe conditions on refractory products than do traditional reduction techniques and will require the development of newer, more corrosion-resistant refractory materials. The Japanese presence in the U.S. refractories market is concentrated in the production of products for the steel industry. Principal exporters to the United States include Asahi Glass Co. and TYK Corp. Shinagawa Refractories Co., Japan's leading refractories producer, has sold some of its technology to U.S. refractories manufacturers.[16]

[11] Ibid.

[12] Ibid., p. 27.

[13] Officials of Norton Co., discussion with ITC staff, June, 1993.

[14] Data supplied by Japan Refractories Association.

[15] Ibid.

[16] George W. Hess, "Refractories Keep the Melt Shop Up and Running," *Iron Age,* Mar. 1990, p. 26.

U.S. TRADE MEASURES

Tariff Measures

According to Column 1 of the 1993 tariff rates, refractory items are either duty-free, 4.9 percent ad valorem, or eligible for duty-free treatment under special trade provisions (See appendix for an explanation of rate of duty columns and relevant page of Harmonized Tariff Schedule). Current U.S. rates of duty are provided in table 1. They are not considered a limiting factor in the entry of foreign refractories in this market. There are currently no known U.S. nontariff measures that affect trade in refractories.

Nontariff Measures

The Commission is unaware of any statutory investigation that has been instituted in the United States during the past 5 years involving imports of refractory products.

FOREIGN TRADE MEASURES

In 1993, foreign ad valorem tariff rates for refractories range from 3.8 percent to 8 percent for the EC, from duty-free to 6.8 per cent for Canada, while Mexican tariff rates on nearly all U.S. refractory products equal 15 percent.[17] U.S. exports to Japan are assessed ad valorem duty rates, ranging from duty-free to 5.2 percent, in addition to a 3 percent consumption tax assessed on the import value. Foreign tariffs are not generally considered by U.S. manufacturers to be a significant factor in limiting U.S. exports of refractories. The Commission is unaware of any nontariff barriers that affect U.S. exports of refractories.

U.S. MARKET

Consumption

Reflecting slow growth and the results of industry restructuring in end-use markets, apparent U.S. consumption of refractories remained between $1.8 and $1.9 billion during 1988 and 1992 (table 2). As the world's largest producer of refractory products, the United States is generally self-sufficient in such production. Imports accounted for 9 percent of total refractories consumption in 1992, up from 7 percent of total consumption in 1988.

[17] Under the United States-Canada Free-Trade Agreement (CFTA), tariff rates on nearly 27 percent of 1992 U.S. refractory exports to Canada will be eliminated, effective January 1, 1994 while nearly all remaining refractory exports to Canada shall continue to receive duty-free treatment (See appendix for explanation of CFTA). Under the proposed North American Free-Trade Agreement (NAFTA), tariff duties on nearly 90 percent of 1992 U.S. refractory exports to Mexico will be removed in five equal annual stages beginning January 1, 1994 and will be duty-free, effective January 1, 1998. Remaining exports will either be duty-free, effective January 1, 1994 or shall have their duties removed in 10 equal annual stages beginning on January 1, 1994.

Table 1
Refractories: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1993; U.S. exports, 1992; and U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]		
				Million dollars	
6901.00.00	Bricks, blocks, tiles and other ceramic goods of siliceous fossil meals	4.9%	Free (CA, E, IL,J)	2,478	485
6902.10.10	Refractory magnesite bricks, not siliceous, containing over 50% magnesium, calcium, or chromium	Free	-	24,023	44,102
6902.10.50	Refractory, bricks, blocks, tiles and similar goods, not siliceous, containing over 50% magnesium, calcium, or chromium	4.9%	Free (A, CA, E, IL, J)	33,673	5,302
6902.20.10	Refractory bricks containing by weight more than 50% aluminum, of silica or of their mixtures or compounds	Free	-	54,454	19,698
6902.20.50	Refractory blocks, tiles and similar goods, containing over 50% of alumina of silica or of their mixtures or compounds	4.9%	Free (A, CA, E,IL,J)	459	3,690
6902.90.10	Refractory bricks, not of siliceous fossil meals or earths, nesi	Free	-	37,168	13,129
6902.90.50	Refractory bricks, tiles, and similar goods, not of siliceous fossil meals or earths, nesi	4.9%	Free (A, E,IL,J) 2.4% (CA)	8,425	15,389
6903.10.00	Refractory ceramic goods, nesi, not of siliceous fossil meals or earths, containing over 50% graphite or other forms or mixtures of carbons	4.9%	Free (A, E,IL,J) 2.4% (CA)	10,002	3,587
6903.20.00	Refractory ceramic goods nesi, not of siliceous fossil meals or earths, containing over 50% alumina or a mixture or compound alumuna and silica	4.9%	Free (A, CA, E,IL, J)	21,085	19,586
6903.90.00	Refractory ceramic goods nesi, not of siliceous fossil meals or earths, nesi	4.9%	Free (A, CA, E,IL, J)	22,676	42,921

[1] Programs under which special tariff treatment may be provided, and the corresponding symbols for such programs as they are indicated in the "Special" subcolumn, are as follows: Generalized System of Preferences (A); Automotive Products Trade Act (B); Agreement on Trade in Civil Aircraft (C); United States-Canada Free-Trade Agreement (CA); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL), and Andean Trade Preference Act (J).

Source: U.S. exports and imports compiled from official statistics of the U.S. Department of Commerce.

Industry analysts anticipate modest future growth in demand for refractories as end-use industries continue the restructuring of their operations. Although both the steel and aluminum industries are expected to continue as major markets for refractory products, near-term growth for steel mill products of only 1 to 2 percent and continued emphasis on the recycling of primary aluminum materials is anticipated.

Shipments

Sluggish demand by end-use industries for refractory bricks and shapes encouraged refractory manufacturers to produce a greater percentage of lower volume but higher quality and higher-value monolithic refractories between 1988-92. During the period, shipments of bricks and shapes declined from 50 percent to 40 percent of total refractories shipments, whereas shipments of monolithic refractories increased from 20 percent to 30 percent. Although the value of U.S. shipments of refractories fluctuated narrowly during 1988-92, remaining at nearly $2 billion for each year, the quantity of refractories produced declined as the industry sold a greater proportion of higher value, longer lasting refractory products (table 2).[18]

Imports

Despite sluggish domestic demand, the value of U.S. imports of refractories increased 28 percent from $131 million in 1988 to $168 million in 1992 as both Japan and Germany made greater efforts to sell to the U.S. market (table 3). Japan and Germany accounted for 24 percent and 20 percent, respectively, of total refractory imports in 1992; Japan, Germany, and Canada were the principal suppliers of imported refractory products during 1988-92. Imported products reflected a product mix similar to products produced domestically. Refractory bricks represented 38 percent of total imports in 1992, with magnesite bricks, used primarily in BOF steel furnaces, accounting for 26 percent of total imports.

Imports of refractory products entering the U.S. duty-free accounted for 51 percent of total imports in 1992. Imports under the CFTA and the GSP accounted for 5 and 4 percent, respectively, of total import value in 1992. Imports under the United States-Israel Free-Trade Agreement and the Caribbean Basin Economic Recovery Act each accounted for less than 1 percent of total imports in 1992.

FOREIGN MARKETS

Foreign Market Profile

Global sales of refractory products totaled nearly $5.8 billion in 1992; U.S. producers accounted for

[18] Edmund S. Wright, "Manufacturing Trends in the U.S. Refractories Industry," *Ceramic Bulletin,* July 1990, p. 1159.

Table 2
Refractories: U.S. shipments, exports of domestic merchandise, imports for consumption, and apparent consumption, 1988-92

Year	Shipments	Exports	Imports	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1988	1,950	217	131	1,864	7
1989	2,011	210	137	1,938	7
1990	2,003	254	136	1,885	7
1991	1,891	242	161	1,810	9
1992	[1]2,000	238	168	[1]1,930	9

[1] Estimated by the staff of the U.S. International Trade Commission.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 3
Refractories: U.S. imports for consumption, by principal sources, 1988-92
(1,000 dollars)

Source	1988	1989	1990	1991	1992
Canada	30,679	30,842	27,648	24,678	25,134
Germany	22,312	22,257	28,686	39,090	33,614
Japan	32,584	38,625	30,574	38,380	40,673
United Kingdom	15,456	14,042	16,794	16,947	19,321
France	11,580	11,433	8,799	12,054	15,216
Austria	2,321	2,768	5,545	7,911	5,679
Mexico	7,081	7,550	6,783	10,004	12,929
Spain	1,602	1,628	2,340	2,320	1,218
Brazil	440	868	1,259	1,775	1,620
Netherlands	754	167	216	1,652	1,407
All other	5,705	6,928	6,908	5,893	11,079
Total	130,514	137,108	135,552	160,704	167,890

Source: Compiled from official statistics of the U.S. Department of Commerce.

nearly 34 percent of this total. The United States, Europe, and Japan, nations with significant iron and steel, cement, and nonferrous metal industries, are the major world markets for refractory products. Worldwide refractory shipments remained stagnant during the past few years because of sluggish economic conditions that adversely affected demand by the automotive, appliance, and construction sectors, principal steel-consuming industries. In 1991, world crude steel production fell nearly 5 percent from 1990 levels contributing to refractory overcapacity. The persistence of global industry overcapacity, coupled with the technological prowess of many foreign competitors, should continue to put pressure on U.S. exporters. Principal U.S. export markets for refractory products include Canada, Western Europe, and Mexico, where refractory products are principally consumed by the steel and aluminum industries. Because both these industries in Canada and Western Europe are currently being downsized, U.S. exports to these markets are expected to grow only modestly in the near future. Emerging foreign markets for U.S. refractory exporters include India and China and developing countries in Central and South America, where steel production has been increasing by 5 to 15 percent annually.[19] U.S. exports to these markets are presently small, but are growing.

U.S. Exports

The value of U.S. exports of refractories increased by a modest 10 percent from $217 million in 1988 to $238 million in 1992 as end-use markets for many refractory products grew slowly (table 4). Refractory bricks accounted for 48 percent of total exports in 1992, with alumina and various alloy bricks accounting for 30 percent of total exports. U.S. exports accounted for an estimated 12 percent of total U.S. shipments in 1992 compared with 11 percent in 1988. Implementation of the North American Free-Trade Agreement is viewed as likely to lead to somewhat expanded U.S. exports given the elimination, by 2003, of current higher relative tariff rates on U.S. refractory items entering Mexico and Canada.

Canada is the largest market for U.S. exports of refractory products, receiving 39 percent of U.S. exports in 1992. The value of total exports to Canada increased from $76 million in 1989 to $92 million in 1992. U.S. firms also supply Canada with significant amounts of refractories from plants located in Canada. The value of total U.S. exports of refractories to Western Europe accounted for 15 percent of total U.S. exports in 1992, rising from $32 million in 1989 to $35 million in 1992. Mexico is the second largest market for U.S. exports of refractory products, receiving 7 percent of U.S. exports in 1992. The value of total exports to Mexico fluctuated between $16 million and $23 million during 1989-1992. U.S. exports to emerging markets have showed the most rapid growth in recent years, with exports to China increasing from $3 million in 1988 to $8 million in 1992 and exports to India increasing from $1 million in 1988 to $7 million in 1992. Because these nations are presently experiencing economic growth rates of nearly 10 percent per annum, among the highest in the world, they are expected to continue as growing markets for U.S. goods.

Major U.S. multinational refractory producers tend to have sales offices in each of the nations to which they export. Smaller producers generally export either by using agents who represent foreign purchasers or by using a distributor who purchases refractories and resells to the end-user.

U.S. TRADE BALANCE

During 1988-92, the U.S. trade surplus in refractories declined from $85 to $68 million because imports, particularly from newly competitive producers in Germany and Japan, grew faster than exports (table 5). Future trends in trade will depend greatly on the ability of U.S. manufacturers to replace declining or slow-growing markets in Europe, North America, and Japan with emerging markets in Central and South America and Asia.

[19] Karen Harries-Rees, "Refractory Majors Plagued by Overcapacity," *Industrial Minerals,* Sept. 1992, p. 23.

Table 4
Refractories: U.S. exports of domestic merchandise, by principal markets, 1988-92
(1,000 dollars)

Source	1988	1989	1990	1991	1992
Canada	93,011	76,403	102,998	98,255	91,628
Mexico	14,947	16,300	20,256	22,843	16,339
Japan	7,576	9,444	9,518	9,499	12,537
United Kingdom	4,638	8,677	9,578	9,543	9,160
Germany	7,649	9,012	8,743	5,733	7,296
Venezuela	10,835	4,681	4,439	3,703	4,847
France	5,868	9,047	7,168	3,488	4,324
Australia	5,021	10,036	7,644	5,307	6,486
S. Korea	5,199	7,269	7,770	5,699	6,331
China	3,268	4,662	2,421	8,801	8,226
Taiwan	3,289	5,564	4,738	6,400	8,895
Brazil	3,454	6,787	8,060	4,633	4,281
All other	51,958	41,917	60,311	58,280	57,738
Total	216,713	209,799	253,644	242,184	238,088

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 5
Refractories: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1988-92[1]

(Million dollars)

Item	1988	1989	1990	1991	1992
U.S. exports of domestic merchandise:					
Canada	93	76	103	98	92
Japan	8	9	10	9	13
Germany	8	9	9	6	7
Mexico	15	16	20	23	16
United Kingdom	5	9	10	10	9
France	6	9	7	3	4
China	3	5	2	9	8
Taiwan	3	3	5	6	9
India	1	1	1	4	7
Australia	5	10	8	5	6
All other	70	60	79	68	66
Total	217	210	254	242	238
EC-12	30	35	40	30	30
OPEC	13	7	9	8	8
ASEAN	2	4	5	10	9
CBERA	10	7	8	8	8
Eastern Europe	1	0	0	1	1
U.S. imports for consumption:					
Canada	31	31	28	25	25
Japan	33	39	31	38	41
Germany	22	22	29	39	34
Mexico	7	8	7	10	13
United Kingdom	15	14	17	17	19
France	12	11	9	12	15
China	0	0	0	1	1
Taiwan	0	0	0	0	0
India	0	0	0	0	0
Australia	0	0	0	0	0
All other	10	12	16	18	20
Total	131	137	136	161	168
EC-12	54	53	59	75	75
OPEC	0	0	0	0	1
ASEAN	0	0	0	0	0
CBERA	0	0	0	0	0
Eastern Europe	0	0	0	0	0
U.S. merchandise trade balance:					
Canada	62	45	75	73	67
Japan	-25	-30	-21	-29	-28
Germany	-14	-13	-20	-33	-27
Mexico	8	8	13	13	3
United Kingdom	-10	-5	-7	-7	-10
France	-6	-2	-2	-9	-11
China	3	5	2	8	7
Taiwan	3	6	5	6	9
India	1	1	1	4	7
Australia	5	10	8	5	6
All other	60	48	63	50	46
Total	86	73	118	81	70
EC-12	-24	-18	-19	-45	-45
OPEC	13	7	9	8	7
ASEAN	2	4	5	10	9
CBERA	10	7	8	8	8
Eastern Europe	1	0	0	1	1

[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export. U.S. trade with East Germany is included in "Germany" but not "Eastern Europe."

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce.

APPENDIX A
EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

TARIFF AND TRADE AGREEMENT TERMS

The ***Harmonized Tariff Schedule of the United States*** (HTS) replaced the *Tariff Schedules of the United States* (TSUS) effective January 1, 1989. Chapters 1 through 97 are based upon the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description, with additional U.S. product subdivisions at the 8-digit level. Chapters 98 and 99 contain special U.S. classification provisions and temporary rate provisions, respectively.

Rates of duty in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates; for the most part, they represent the final concession rate from the Tokyo Round of Multilateral Trade Negotiations. Column 1-general duty rates are applicable to imported goods from all countries except those enumerated in general note 3(b) to the HTS, whose products are dutied at the rates set forth in ***column 2***. Goods from Albania, Armenia, Belarus, Bulgaria, the People's Republic of China, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Mongolia, Poland, Russia, Slovakia, and the Ukraine are currently eligible for MFN treatment. Among articles dutiable at column 1-general rates, particular products of enumerated countries may be eligible for reduced rates of duty or for duty-free entry under one or more preferential tariff programs. Such tariff treatment is set forth in the ***special*** subcolumn of HTS column 1. Where eligibility for special tariff treatment is not claimed or established, goods are dutiable at column 1-general rates.

The ***Generalized System of Preferences*** (GSP) affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports. The U.S. GSP, enacted in title V of the Trade Act of 1974 and renewed in the Trade and Tariff Act of 1984, applies to merchandise imported on or after January 1, 1976 and before July 4, 1993. Indicated by the symbol "A" or "A*" in the special subcolumn of column 1, the GSP provides duty-free entry to eligible articles the product of and imported directly from designated beneficiary developing countries, as set forth in general note 3(c)(ii) to the HTS.

The ***Caribbean Basin Economic Recovery Act*** (CBERA) affords nonreciprocal tariff preferences to developing countries in the Caribbean Basin area to aid their economic development and to diversify and expand their production and exports. The CBERA, enacted in title II of Public Law 98-67, implemented by Presidential Proclamation 5133 of November 30, 1983, and amended by the Customs and Trade Act of 1990, applies to merchandise entered, or withdrawn from warehouse for consumption, on or after January 1, 1984; this tariff preference program has no expiration date. Indicated by the symbol "E" or "E*" in the special subcolumn of column 1, the CBERA provides duty-free entry to eligible articles, and reduced-duty treatment to certain other articles, which are the product of and imported directly from designated countries, as set forth in general note 3(c)(v) to the HTS.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "IL" are applicable to products of Israel under the ***United States-Israel Free Trade Area Implementation Act*** of 1985 (IFTA), as provided in general note 3(c)(vi) of the HTS. Where no rate of duty is provided for products of Israel in the special subcolumn for a particular provision, the rate of duty in the general subcolumn of column 1 applies.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "CA" are applicable to eligible goods originating in the territory of Canada under the ***United States-Canada Free-Trade Agreement*** (CFTA), as provided in general note 3(c)(vii) to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn of column 1 followed by the symbol "J" or "J*" in parentheses is afforded to eligible articles the product of designated beneficiary countries under the ***Andean Trade Preference Act*** (ATPA), enacted in title II of Public Law 102-182 and implemented by Presidential Proclamation 6455 of July 2, 1992 (effective July 22, 1992), as set forth in general note 3(c)(ix) to the HTS.

Other special tariff treatment applies to particular ***products of insular possessions*** (general note 3(a)(iv)), goods covered by the ***Automotive Products Trade Act*** (APTA) (general note 3(c)(iii)) and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 3(c)(iv)), and ***articles imported from freely associated states*** (general note 3(c)(viii)).

The ***General Agreement on Tariffs and Trade*** (GATT) (61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786) is the multilateral agreement setting forth basic principles governing international trade among its 111 signatories. The GATT's main obligations relate to most-favored-nation treatment, the maintenance of scheduled concession rates of duty, and national (nondiscriminatory) treatment for imported products; the GATT also provides the legal framework for customs valuation standards, "escape clause" (emergency) actions, antidumping and countervailing duties, and other measures. Results of GATT-sponsored multilateral tariff negotiations are set forth by way of separate schedules of concessions for each participating contracting party, with the U.S. schedule designated as Schedule XX.

Officially known as "The Arrangement Regarding International Trade in Textiles," the ***Multifiber Arrangement*** (MFA) provides a framework for the negotiation of bilateral agreements between importing and producing countries, or for unilateral action by importing countries in the absence of an agreement. These bilateral agreements establish quantitative limits on imports of textiles and apparel, of cotton and other vegetable fibers, wool, man-made fibers and silk blends, in order to prevent market disruption in the importing countries—restrictions that would otherwise be a departure from GATT provisions. The United States has bilateral agreements with many supplying countries, including the four largest suppliers: China, Hong Kong, the Republic of Korea, and Taiwan.