

ABRASIVES, MANUFACTURED

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Abrasives play an important role in the fashioning and finishing of numerous products with a wide range of end-use applications. Abrasives are natural or manufactured substances that are used to abrade, clean, etch, grind, polish, scour, or otherwise remove solid material by rubbing action (as in a grinding wheel) or impact (as in pressure blasting). The most important physical properties for abrasives are hardness (scratch hardness), toughness (rigidity), friability, grain shape and size, character of fracture (cleavage), and purity (uniformity). Additional considerations include thermal stability, bonding characteristics, cost, and availability. Manufactured abrasives are made from metals or minerals by heating or chemically treating them to enhance or give them abrasive physical properties. No single property is paramount for any use (Wellborn, 1996, p. 31, 43).

Manufactured abrasives generally dominate high-grade abrasive markets as opposed to natural abrasives because they have superior physical properties and more uniform quality and can be tailored to meet user needs. Consequently, manufactured abrasives typically are characterized by premium prices relative to natural abrasive minerals. Even though manufactured abrasives are more expensive, their durability and efficiency have proven to be more cost effective. Therefore, they are preferred in many industrial applications, such as metal finishing, cutting, and polishing. In the United States, large volumes of abrasives also are used in cutting and finishing wallboard and timber. The abrasives market is mature, and the use of various manufactured abrasive materials is fairly well defined by application (Kendall, 2001, p. 55).

This report includes information on the following abrasives manufactured in the United States: aluminum-zirconium oxide, boron carbide, fused aluminum oxide, metallic shot and grit, and silicon carbide. In some cases, United States production data were combined with Canadian output to protect proprietary information and still provide useful data on the overall Canadian-United States market. Trade data in this report are from the U.S. Census Bureau. Quantities are reported in metric units, unless otherwise noted.

Fused Aluminum Oxide

Legislation and Government Programs.—As of January 1, 2002, the National Defense Stockpile (NDS) maintained by the U.S. Department of Defense (DOD) contained about 16,300 metric tons (t) of fused aluminum oxide abrasive grain valued at \$6.6 million. During 2001, the DOD reported sales of about 99.8 t of NDS aluminum oxide abrasive grain for \$49,500. All of the NDS crude fused aluminum oxide was sold during 2000. Under Federal legislation authorizing the disposal of all NDS aluminum oxide, the DOD plans to continue such sales until all the stockpiled aluminum oxide is sold (Janet Rollins, Market Analyst, Defense National Stockpile Center, oral commun., 2002). All the stockpiled aluminum oxide will be sold before 2004 if the current disposal and sales schedules continue.

Production.—The production data for fused aluminum oxide

in this report were obtained by the U.S. Geological Survey (USGS) from producers in Canada and the United States. The data were collected from three companies that operated six plants and represented the entire Canadian and United States fused aluminum oxide industry (table 1). Two of the companies operated fused aluminum oxide plants in Canada and the United States. Data from the two countries were combined to protect company proprietary information.

In the second half of 2001, Norton Co. permanently shutdown their Worcester, MA, aluminum oxide plant, and during the fourth quarter, workers at Washington Mills Ltd. in Niagara Falls, NY, were on strike.

Estimated production of regular-grade fused aluminum oxide in 2001 was 50,000 t with an estimated value of \$15.1 million. This was a decrease of 44% by weight from the 2000 regular-grade fused aluminum oxide production (table 2). Reporting on the output of high-purity fused aluminum oxide has been discontinued to avoid disclosing company proprietary data.

Consumption.¹—Abrasive-grade fused aluminum oxide has many end uses. Specific applications in 2001 included bonded abrasives (such as abrasive grains that are made to adhere to each other and then are pressed or molded into abrasive tools), coated abrasives (such as abrasive grains glued to a backing of paper or cloth), tumbling media, dry or wet blasting media, polishing/buffing compounds, and antislip additives. In recent years, fused aluminum oxide producers have reported increased demand for micropowder abrasives for industrial and electronic applications that require fine surface finishing. Fused aluminum oxide does not face any significant substitution threats at present [2001], as it is generally a very cost effective abrasive. The total value of fused aluminum oxide abrasive grain consumed in the United States was estimated to be nearly \$62 million in 2001.

Prices.—The USGS surveyed fused aluminum oxide producers to determine the total value of their production for the year. The survey indicated that the average unit value of regular fused aluminum oxide produced in the United States and Canada during 2001 was \$302 per metric ton at the point of production; the average value of high-purity fused aluminum oxide output was \$530 per ton at the point of production. Prices of abrasive grain produced from these materials and sold to consumers were significantly higher.

The average price of NDS fused aluminum oxide grain sold in 2001 was \$496 per ton.

Average unit values of fused aluminum oxide trade by the United States in 2001 are based on U.S. Census Bureau customs value data. Average unit values of crude fused aluminum oxide imports during the year ranged from \$167 per ton (China) to \$455 per ton (Venezuela). Values of fused aluminum oxide grain imports ranged from \$236 per ton (China) to \$1,396 per

¹In all sections of this report, consumption is defined as apparent consumption, which is domestic production plus imports minus exports plus adjustments for Government and industry stock changes.

ton (Austria). The average value for U.S. exports of fused aluminum oxide during the year was about \$2,937 per ton.

Foreign Trade.—During 2001, imports of crude fused aluminum oxide were received from 11 countries and decreased by 11% to 98,600 t valued at \$29.6 million compared with those of 2000, and imports of ground and refined fused aluminum oxide were received from 21 countries and decreased by 11% to 104,000 t valued at \$49.9 million (table 5). Some of the imported crude fused aluminum oxide was refractory-grade material. China, Venezuela, and Canada supplied 51%, 24%, and 24%, respectively, of the crude imports. Compared with 2000, crude imports from Venezuela and China increased by 45% and 12%, respectively, while imports from Canada decreased by 52%. China, Canada, Austria, Germany, and Brazil provided 55%, 20%, 7%, 7%, and 5%, respectively, of the ground and refined material. Compared with 2000, ground and refined imports from China increased by 31%, while imports from Canada decreased by 48%.

Compared with 2000, exports of all fused aluminum oxides, 2001 exports decreased slightly to 8,950 t, but the value of those exports increased by 12% to \$26.3 million (table 6). Of the exports shipped to 31 countries, 71% went to Canada, Germany, Mexico, and the Netherlands.

Silicon Carbide

Legislation and Government Programs.—The DOD completed sales of its stockpiled silicon carbide in 1999 (Janet Rollins, Market Analyst, Defense National Stockpile Center, oral commun., 2002). The DOD was not expected to replenish the silicon carbide stockpile.

Production.—Two companies produced abrasive-grade silicon carbide in Canada and the United States during 2001 (table 1). These companies also produced similar amounts of metallurgical-grade silicon carbide. Another company in Hopkinsville, KY, produced a small quantity of silicon carbide, primarily intended for use in heat-resistant products rather than abrasives. On June 30, Norton Co. permanently shutdown their Shawinigan, Quebec, silicon carbide plant. Production for Canada and the United States during 2001 was estimated at 40,000 t valued to be \$24 million (table 2).

Consumption.—Abrasive-grade silicon carbide has many end uses. Specific applications in 2001 included antislip abrasives, blasting abrasives, bonded abrasives, coated abrasives, polishing/buffing compounds, tumbling media, and wiresawing abrasives. The total value of silicon carbide consumed in the United States was estimated to be more than \$78 million in 2001.

Prices.—The USGS does not collect price data on the various grades of silicon carbide. Based on information from industry sources and publications, however, the average value of abrasive-grade silicon carbide at the point of manufacture was estimated to be about \$603 per ton in 2001.

During 2001, imports from China accounted for 86% of total U.S. crude silicon carbide imports and had an average value of \$325 per ton; the average value of the remaining 14% of U.S. crude silicon carbide imports was \$585 per ton. The average value of silicon carbide grain imports was \$1,250 per ton; China accounted for 29% of such imports. The average value of total silicon carbide exports in 2001 was approximately \$1,140 per ton.

Foreign Trade.—In 2001, the United States imported crude

silicon carbide from 10 countries and imported ground or refined silicon carbide from 19 countries. Imports of crude silicon carbide decreased by 34% during the year to 106,000 t valued at \$38.6 million (table 5). Imports of silicon carbide in ground or refined form decreased by 6% to 26,600 t valued at \$33.3 million. China accounted for 86% of the crude silicon carbide imports and 29% of the ground or refined silicon carbide. A large part of the Chinese imports, however, reportedly included metallurgical-grade material.

During 2001, the United States exported crude silicon carbide to 21 countries and exported refined or ground silicon carbide to 33 countries. The total value of crude silicon carbide exports for 2001 increased by 4% to \$2.90 million from the total value for 2000 (table 6). Compared with 2000 exports of refined or ground silicon carbide, 2001 exports increased by about 12% to 9,830 t valued at \$8.02 million. Approximately 38% of the crude exports went to Japan, and about 83% of the refined or ground material was shipped to Canada.

Aluminum-Zirconium Oxide

During 2001, fused aluminum-zirconium oxide for abrasive applications (such as resin-bonded grinding wheels) was produced at one plant belonging to Norton Co. in the United States and two plants in Canada, one belonging to Norton Co. and one belonging to Washington Mills Electro Minerals Corp. The USGS does not publish aluminum-zirconium oxide production data received from the producers to avoid disclosing company proprietary information.

Boron Carbide

Only one firm, Washington Mills, was a commercial producer of boron carbide in the United States during 2001. Boron carbide was used for grinding and lapping operations previously possible only with diamond dust; it also was molded to form highly wear-resistant products, such as pressure blast nozzle liners and extrusion dies.

Domestic production data for boron carbide are not reported to avoid disclosing company proprietary information. The following 2001 trade information on boron carbide, however, was available: the United States imported 282 t of boron carbide valued at \$6.87 million from 5 countries, primarily Germany, China, and Japan, and exported 32.4 t valued at \$685,000 to 18 nations (U.S. International Trade Commission, 2001²).

Metallic Abrasives

Production.—Data on U.S. production and shipments of metallic abrasives were based on a survey of domestic producers conducted by the USGS. Survey data were collected from 12 companies operating 14 plants in the United States and accounted for all the domestic industry (table 3).

Steel shot and grit account for almost all of the metallic abrasives produced domestically (table 4). U.S. production of steel shot and grit in 2001 decreased by 17% compared with that of 2000; the average value was \$440 per ton. Six companies reported production of cut wire shot in 2001, and most of that was cut from carbon steel wire and stainless steel wire. Other products reported included shot cut from

²A reference that includes a section twist (§) is found in the Internet Reference Cited section.

aluminum, copper, and zinc wire.

Consumption.—Metal abrasives are used primarily as loose particles propelled at high velocities for blast cleaning or to improve the properties of metal surfaces; approximately 75% of the abrasives are employed in cleaning operations. Principal consumers include foundries, machine tool industries, and metalworking plants, particularly those supporting the automotive and aircraft industries, and steel manufacturers.

During 2001, total sales of all steel shot and grit by U.S. producers decreased by 16% compared with shipments in the preceding year, and the average value was \$449 per ton sold or used.

Prices.—The USGS compiles survey data on the value of production and shipments, but it does not collect price data. Values of production and shipments reported by metallic abrasive producers in 2001 are listed in table 4. Average values of steel shot and grit ranged from \$0.35 to \$0.47 per kilogram in 2001. Average values of cut wire shot in 2001 ranged from \$4.74 to \$5.85 per kilogram for aluminum wire shot and from \$1.97 to \$4.41 per kilogram for stainless steel wire shot.

Average unit values for metallic abrasives traded by the United States during 2001 were as follows: exports, \$0.65 per kilogram, and imports, \$0.60 per kilogram.

Foreign Trade.—During 2001, the United States imported metallic abrasives from 16 countries and exported metallic abrasives to 36 countries. Domestic imports decreased by 44% in 2001 to 18,700 t valued at \$11.3 million (table 5). About 41% of the imports came from Canada; most of the remaining imports, in decreasing order, were shipped from the Japan, South Africa, and Germany.

U.S. exports of metallic abrasives decreased by 22% during the year to 22,600 t valued at \$14.7 million (table 6). Most of the exports went to Canada; most of the remainder, in decreasing order, was shipped to Mexico, the United Kingdom, and Japan.

Outlook

Abrasives markets closely follow economic and technologic trends and are greatly influenced by activity in the manufacturing sector in the United States. This is particularly true of manufacturing activities in the automotive, housing, aerospace, and furniture industries. In the United States, during most of 2001, the abrasives market was very tough specifically in the automotive and housing sectors. The slowdown in auto manufacturing and sales in addition to a downturn in housing construction during 2001 had a noticeable impact (Kendall, 2001, p. 55). The aerospace sector, which held up reasonably well during the first half of 2001, experienced a slump after the events of September 11. Cheaper imports and higher domestic costs will continue to challenge U.S. producers of fused aluminum oxide and silicon carbide. Competition from developing nations, especially China, will probably lead to further decreases in domestic output. China has become a dominant force in both fused aluminum oxide and silicon carbide in recent years. This has changed the makeup of the manufactured abrasives market. Lower priced Chinese exports have displaced and will continue to displace manufactured abrasive producers in Europe and North America (Gasser, 2002, p. 39). The traditional suppliers among the Western industrialized nations are expected to continue consolidating and contracting.

Metal abrasives markets will continue to be influenced by improved technology in industries that use metallic abrasives. For example, better metal casting methods that achieve near-finish surfaces will reduce demand for some abrasives. Lesser quantities of metallic abrasives will be needed in foundries where new chemical cleaning and finishing techniques are employed.

Emerging suppliers of fused aluminum oxide and silicon carbide in China, Eastern Europe, India, the Republic of Korea, and South America will continue to increase their prominence in world markets. Further success for these suppliers, particularly in such major markets as Japan, the United States, and Western Europe, will depend on their ability to provide higher grades of material and levels of supply reliability while maintaining lower prices. Energy costs, furnace size, quality-control systems, and the availability of essential mineral inputs will be the dominant factors influencing the competitive stance of these suppliers (O'Driscoll, 1997; Zhilun, 1997; Lunghofer and Wolfe, 1998).

The housing construction sector in North America will remain a significant indirect influence on demand for manufactured abrasives. This is due to the large volumes of manufactured abrasives that are used in cutting and finishing wallboard and timber. The aerospace and automotive manufacturing sectors also will continue to be significant indirect influences on demand for manufactured abrasives used by metalworking operations supporting those sectors. Substitution by plastics and new lighter weight designs of automobiles and planes will likely decrease metals consumption and are important factors to be considered in long-range demand forecasts for manufactured abrasives.

References Cited

- Gasser, Peter, 2002, China versus the rest to continue?—Abrasive trends: *Industrial Minerals*, no. 412, January, p. 39-43.
- Kendall, Tom, 2001, Fused alumina—Grinding out a living: *Industrial Minerals*, no. 408, September, p. 35-55.
- Lunghofer, E.P., and Wolfe, L.A., 1998, Fused minerals—Where are they heading?: *Industrial Minerals*, no. 364, September, p. 19-25.
- O'Driscoll, Mike, 1997, Silicon carbide—Supply sector showdown: *Industrial Minerals*, no. 352, January, p. 19-27.
- Wellborn, W.W., 1996, Abrasives—Synthetics cut natural products down to size: *Industrial Minerals*, no. 347, August, p. 31-45.
- Zhilun, Yuan, 1997, Chinese bauxite and fused alumina—Exports spark EC debate: *Industrial Minerals*, no. 360, September, p. 93-99.

Internet Reference Cited

- U.S. International Trade Commission, 2001, HTS-2849901000—Customs value by customs value for all countries, accessed June 20, 2002, via http://dataweb.usitc.gov/scripts/user_set.asp.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Abrasives. Ch. in *United States Mineral Resources*, Professional Paper 820, 1973.
- Abrasives, Manufactured. Ch. in *Mineral Commodity Summaries*, annual.
- Abrasives, Manufactured. *Mineral Industry Surveys*, quarterly.

Other

- Abrasives, Industry & Trade Summary. U.S. International Trade Commission, May 1995.
- Industrial Minerals* (monthly).
- European Abrasives Directory 1997-98*.

TABLE 1
CRUDE ARTIFICIAL ABRASIVES MANUFACTURERS IN 2001

Company	Plant location	Product
The Exolon-Esk Co.	Hennepin, IL	Silicon carbide.
Do.	Thorold, Ontario, Canada	Fused aluminum oxide (regular).
Norton Co.	Huntsville, AL	Fused aluminum oxide (high-purity) and aluminum-zirconium oxide.
Do.	Worcester, MA	General abrasive processing.
Do.	Chippewa, Ontario, Canada	Fused aluminum oxide (regular) and aluminum-zirconium oxide.
Do.	Shawinigan, Quebec, Canada	Silicon carbide.
Washington Mills Electro Minerals Corp.	Niagara Falls, Ontario, Canada	Fused aluminum oxide (regular) and aluminum-zirconium oxide.
Do.	Niagara Falls, NY	Fused aluminum oxide (high-purity) and boron carbide.
Washington Mills Ltd.	do.	Fused aluminum oxide (regular).

TABLE 2
PRODUCTION OF CRUDE SILICON CARBIDE AND FUSED ALUMINUM OXIDE IN THE UNITED STATES AND CANADA 1/

Product	2000			2001		
	Quantity e/ 2/ 3/ (metric tons)	Value e/ 2/ (thousands)	Yearend stocks (metric tons)	Quantity e/ 2/ 3/ (metric tons)	Value e/ 2/ (thousands)	Yearend stocks (metric tons)
Aluminum oxide, regular, abrasives 4/	90,000	\$29,400	W	50,000	\$15,100	W
Silicon carbide 5/	45,000	26,300	W	40,000	24,000	W

e/ Estimated. W Withheld to avoid disclosing company proprietary data.

1/ Data are rounded to no more than three significant digits.

2/ Owing to rounding, data do not match total quarterly Mineral Industry Surveys estimated data.

3/ Quantities are rounded to the nearest 5,000 tons to avoid disclosing proprietary data.

4/ Regular grade normally accounts for about 85% of total output, and high-purity material accounts for the remainder.

5/ Approximately one-half of the quantity and value consists of material for metallurgical and other nonabrasive applications.

TABLE 3
U.S. PRODUCERS OF METALLIC ABRASIVES, 2001

Plant location	Plant location	Product (shot and/or grit)
Chesapeake Specialty Products, Inc.	Baltimore, MD	Steel.
Ervin Industries, Inc.	Adrian, MI	Do.
Do.	Butler, PA	Do.
Do.	do.	Do.
Frohn North America, Inc.	Austell, GA	Cut wire.
Marwas Steel Co.	Scottsdale, PA	Do.
Metaltec Steel Abrasives Co.	Canton, MI	Steel.
National Metal Abrasive Inc.	Wadsworth, OH	Do.
Peerless Metal Powders & Abrasive Co., Inc.	Detroit, MI	Do.
Pellets, Inc.	Tonawanda, NY	Cut wire.
The Platt Brothers, Inc.	Waterbury, CT	Do.
Premier Shot Co.	Cleveland, OH	Do.
U.S. Filter Abrasive Materials, Inc.	Hillsdale, MI	Do.
Wheelabrator Abrasives, Inc.	Bedford, VA	Steel.

TABLE 4
PRODUCTION AND SHIPMENTS FOR METALLIC ABRASIVES IN THE
UNITED STATES, BY PRODUCT 1/

Product	Production		Shipments 2/	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
2000:				
Steel shot and grit	266,000	\$118,000	270,000	\$121,000
Cut wire shot and other e/	2,140	7,120	2,130	7,120
Total	269,000	125,000	272,000	128,000
2001:				
Steel shot and grit	222,000	97,400	226,000	102,000
Cut wire shot and other e/	1,310	4,380	1,320	4,460
Total	223,000	102,000	228,000	106,000

e/ Estimated.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Includes reported exports.

TABLE 5
U.S. IMPORTS OF ALUMINUM OXIDE AND SILICON CARBIDE, BY COUNTRY AND TYPE 1/

Country	2000		2001	
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Crude aluminum oxide:				
Canada	48,800	\$19,700	23,300	\$9,890
China	45,200	8,080	50,700	8,470
Venezuela	16,200	7,240	23,400	10,700
Other	169	117	1,090	209
Total	110,000	35,200	98,600	29,600
Ground and refined aluminum oxide:				
Austria	10,000	13,700	7,110	9,920
Brazil	7,530	5,400	5,050	3,560
Canada	39,900	14,300	20,900	7,280
China	43,500	11,600	56,900	13,400
France	2,890	3,310	1,360	1,780
Germany	8,150	10,400	7,010	8,420
Hungary	614	519	1,340	1,090
Italy	1,860	1,720	1,340	1,260
Russia	46	233	789	532
United Kingdom	676	1,330	454	1,280
Other	1,680 r/	2,140 r/	1,820	1,400
Total	117,000	64,700	104,000	49,900
Crude silicon carbide:				
Canada	15,600	9,280	9,790	5,570
China	133,000	41,500	91,200	29,700
Germany	17	66	111	496
Norway	801	574	381	862
Russia	4,510	2,000	2,890	1,130
Ukraine	1,500	510	1,530	532
Venezuela	251	108	500	289
Other	5,660 r/	2,680 r/	39	48
Total	162,000	56,700	106,000	38,600
Ground and refined silicon carbide:				
Brazil	5,420	3,440	5,240	3,730
China	13,500	8,230	7,760	4,740
Germany	1,930	6,110	2,110	5,890
Japan	1,750	10,400	1,310	6,590
Mexico	382	431	313	329
Norway	2,830	6,980	2,510	7,520
Philippines	138	135	714	517
Russia	1,440	477	3,170	1,430
Ukraine	315	563	2,170	1,430
Venezuela	(3/)	3	1,100	458
Other	612 r/	798 r/	186	661
Total	28,300	37,600	26,600	33,300
Metallic abrasives:				
Canada	22,900	10,300	7,630	3,580
France	2,760	2,690	282	153
Germany	1,560	1,070	1,290	2,210
Italy	720	316	145	139
Japan	451	770	4,690	3,410
Romania	198	200	234	261
South Africa	946	359	3,640	1,210
United Kingdom	2,520	1,090	437	125
Other	1,470 r/	722 r/	362	226
Total	33,500	17,600	18,700	11,300

r/ Revised.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 6
U.S. EXPORTS OF ALUMINUM OXIDE, SILICON CARBIDE, AND METALLIC ABRASIVES,
BY COUNTRY AND TYPE 1/

Country	2000		2001	
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Crude aluminum oxide:				
Canada	2,080	\$2,660	1,590	\$1,870
Germany	2,160	7,390	2,660	7,890
Japan	563	2,410	495	3,330
Korea, Republic of	327	1,300	551	2,060
Mexico	1,680	2,070	1,440	2,140
Netherlands	905	830	699	1,730
United Kingdom	181	2,800	360	3,570
Other	1,130 r/	4,050 r/	1,160	3,720
Total	9,020	23,500	8,950	26,300
Crude silicon carbide:				
Brazil	10	128	9	195
Germany	1	82	20	126
Japan	187	834	236	1,200
Mexico	871	1,290	203	703
United Kingdom	41	161	105	247
Other	97 r/	284 r/	56	423
Total	1,210	2,780	628	2,900
Ground and refined silicon carbide:				
Australia	(3/)	3	639	219
Brazil	9	82	18	194
Canada	7,260	4,660	8,200	5,120
Japan	318	2,160	224	1,080
Mexico	750	737	220	212
United Kingdom	219	302	106	196
Other	254 r/	767 r/	425	996
Total	8,810	8,710	9,830	8,020
Metallic abrasives:				
Canada	16,000	6,750	12,400	5,040
Japan	1,040	531	759	370
Mexico	8,820	7,360	6,380	4,990
Senegal	--	--	32	467
Singapore	127	200	21	298
Taiwan	(3/)	6	210	235
United Kingdom	1,040	1,350	1,560	1,980
Other	1,830 r/	2,440 r/	1,250	1,350
Total	28,900	18,600	22,600	14,700

r/ Revised. -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: U.S. Census Bureau.