Industry & Trade Summary

Hose, Belting, and Plastic Pipe

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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 hose, belting, and plastic pipe covers the period 1989 through 1993 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 chemicals and textiles sectors.

USITC publication number	*Publication date*	*Title*
Chemicals:		
2458	November 1991	Soaps, Detergents, and Surface–Active Agents
2509	May 1992	Inorganic Acids
2548	August 1992	Paints, Inks, and Related Items
2578	November 1992	Crude Petroleum
2588	December 1992	Major Primary Olefins
2590	February 1993	Polyethylene Resins in Primary Forms
2598	March 1993	Perfumes, Cosmetics, and Toiletries
2736	February 1994	Antibiotics
2739	February 1994	Pneumatic Tires and Tubes
2741	February 1994	Natural Rubber
2743	February 1994	Saturated Polyesters in Primary Forms
2747	March 1994	Fatty Chemicals
2750	March 1994	Pesticide Products and Formulations
2823	October 1994	Primary Aromatics
2826	November 1994	Polypropylene Resins in Primary Forms
2845	March 1995	Polyvinyl Chloride Resins in Primary Forms
2846	December 1994	Medicinal Chemicals, except Antibiotics
2866	March 1995	Hose, Belting, and Plastic Pipe
Chemicals:		
Textiles and apparel:		
2543	August 1992	Nonwoven Fabrics
2580	December 1992	Gloves
2642	June 1993	Yarn
2695	November 1993	Carpets and Rugs
2702	November 1993	Fur Goods
2703	November 1993	Coated Fabrics
2735	February 1994	Knit Fabric
2841	December 1994	Cordage

[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.

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INTRODUCTION

This summary covers products made principally of polymeric[1] materials—plastics and rubber.[2] The specific products included in this report are hose, belting, and pipe. These products are used in numerous industries, generally serving to convey goods or materials. The production of these products requires large volumes of rubber and plastics, and therefore this product grouping represents one of the largest consumers of these raw materials. Based on U.S. Department of Commerce, Bureau of the Census data, there are estimated to be over 500 domestic manufacturers of these products. Total value of shipments for this grouping was approximately $6.9 billion in 1993.[3]

More specifically, the products covered in the report include plastic and rubber tube, pipe, and hose; synthetic sausage casings; plastic pipe fittings; and rubber and plastic conveyor and power drive belts. These products are contained in Standard Industrial Classification (SIC) categories 3052, 3084, and 3089. During 1990-93, the United States was a net exporter to world markets for this category of products. The trade of these commodities, however, is relatively small compared with the size of the domestic market. During 1989-93, exports accounted for an average of 12 percent of shipments, and imports averaged 10 percent of consumption.

The largest subgrouping of this product category, in terms of shipments, is plastic and rubber tube, pipe, and hose, which in 1993 comprised 73 percent of total shipments. Rubber and plastic belting is the next largest subcategory, accounting for approximately 17 percent of shipments, followed by sausage casings, 6 percent, and plastic pipe fittings, 4 percent.

The majority of the products covered in this report are utilized as parts or components for products in larger downstream industries. Although the products are used in a variety of industrial, food, and consumer industries, the two most prominent end-users are the automotive and construction industries. Rubber belts and hoses are mainly used in a large number of automotive applications while plastic pipe is mainly used in building applications. This summary will examine the U.S. industry, major foreign industries, and trade of these commodities during 1989-93.

[1] See app. A for a glossary of industry terms.

[2] Although the products are mainly made of rubber or plastic, they also contain other materials such as textile fiber, metal reinforcers, and glass fiber.

[3] Shipment data estimated by USITC staff based on U.S. Department of Commerce, Bureau of the Census data.

BACKGROUND AND HISTORY

Although some of the products covered in this report can trace their origins back more than a hundred years, most development and large-scale production of these products occurred during this century. Prior to the development of these rubber and plastic-based products, many of the products were made with other materials such as steel and products derived from agricultural and animal sources, e.g., leather. In the early 1900s, the various plastics and synthetic rubber industries either did not exist or were in their infancy. However, by the 1920s, most existed, at least as infant industries. With the onset of World War II, the industries in this sector were tapped for the war effort and significant technological developments and capacity expansions occurred. Most of the growth of the rubber and plastic belt, hose, and pipe industries occurred during the post-World War II period when new and larger manufacturing facilities were built, new and better products were created, and new applications were found.

U.S. INDUSTRY PROFILE

Industry Structure

The U.S. hose, belting, and plastic pipe industry consists of those firms that fabricate these products from polymer materials. The industry is comprised of over 500 firms and serves numerous end-use industries (figure 1). The largest subsector is plastic pipe, followed by rubber hose, belt, and tubing; and sausage casings.

Plastic Pipe and Fittings

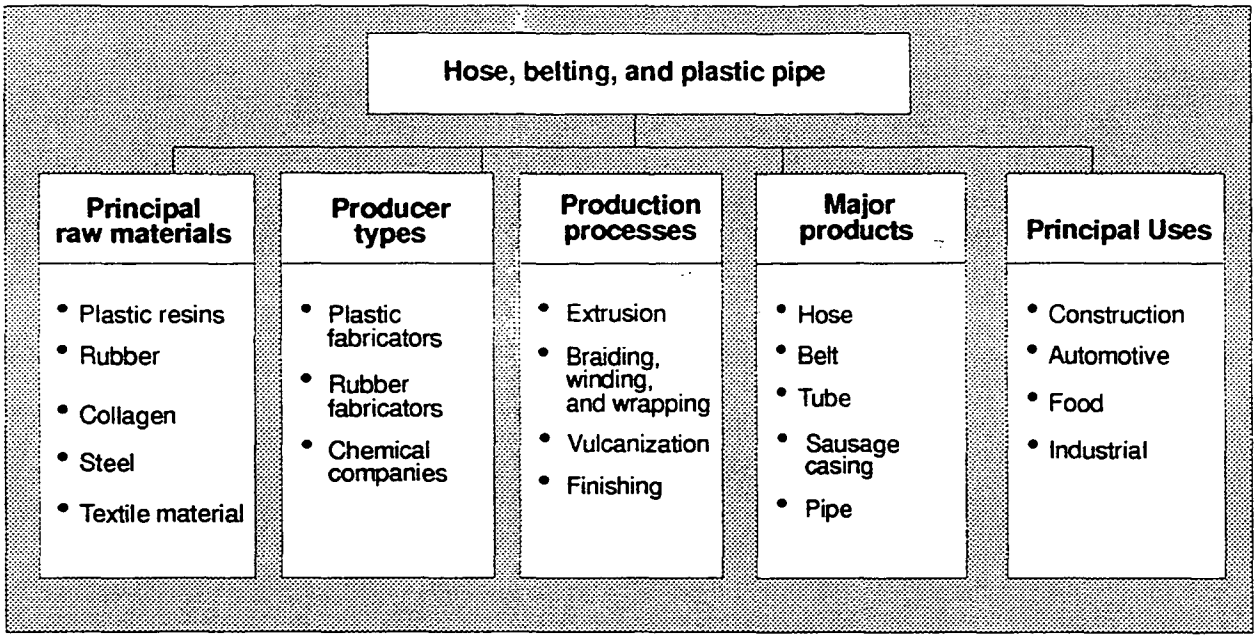
The structure of the U.S. plastic pipe industry is fragmented. Producers vary in size from large multinational firms to small producers; the latter reportedly total over 300.[4] Major U.S. producers include CertainTeed Corp. (McPherson, KS), E.I. du Pont de Nemours and Co. (Wilmington, DE), and Bristol Corp. (Bristol, IN). A few firms are back-integrated[5] to plastics production, but the majority purchase plastic resin[6] from manufacturers or distributors. In addition, a growing number of firms utilize recycled plastic resins as raw materials instead of to raw materials supplied by the petrochemical industry. The technological base of plastic pipe producers also serves to differentiate producers. Many

[4] Refers to firms that are integrated backwards in the production pipeline. Therefore, if the firm produces the raw material plastic in addition to the pipe, it is more vertically integrated compared with other firms that solely produce pipe.

[5] Dr. John J. Breckling, *Study 3201: Plastic and Competitive Pipe* (Leading Edge Reports, 1987), p. III-1.

[6] See app. A.

Figure 1
U.S. hose, belting, and plastic pipe industry: Principal raw materials, producer types, production processes, major products, and principal uses



Source: Compiled by USITC staff from various sources.

companies have focused on serving specific markets that require different levels of sophistication and technology.[7]

Methods of distribution in the plastic pipe industry include direct sales by manufacturers, sales through wholesalers and distributors, and retail sales. The end-use market often determines the method of distribution. For example, supply to municipal water markets is almost exclusively by direct sales, whereas sales to the drain, waste, and vent market typically occurs through distributors.

Rubber Hose, Belt, and Tubing

In 1992, the U.S. hose, tube, and belting industry was comprised of 144 companies with 202 production facilities.[8] Major producers in this category include the Gates Rubber Co. (Denver, CO), Goodyear (Akron, OH), and Dayco (Dayton, OH). Many of these products serve the automotive market, and are sold either directly to the automotive manufacturer (OEM-original equipment manufacturer), or through distributors that service the secondary or replacement market.

Sausage Casings

Major U.S. producers of synthetic sausage casings include Teepak Inc. (Chicago, IL), Union Carbide Corp. (Danbury, CT), and Devro, a subsidiary of Johnson & Johnson (New Brunswick, NJ). Teepak and Union Carbide are predominantly involved in the production of cellulose and thermoplastic casings, while Devro is the dominant producer of collagen casings. Major domestic manufacturers of synthetic sausage casings also have foreign operations.

Product Categories

Plastic Pipe and Fittings

Product description

Plastic pipe is a cylindrically formed product made from numerous types of plastic resins that is used to convey liquids, gases, or slurries. Plastic materials used in pipe production are categorized into two main types—thermoplastics and thermosets. Thermoplastics are capable of being reshaped or reformed when re-exposed to heat after initial forming; alternatively, thermosets can only be formed or cured once. Major thermoplastics used in pipe applications include polyvinyl chloride (PVC), polyethylene, polypropylene, acrylonitrile-butadiene-styrene (ABS), and polybutylene. Thermosetting plastic pipe typically

[7] Breckling, *Study 3201*, p. I-11.
[8] U.S. Department of Commerce, Bureau of the Census, *1992 Census of Manufactures: Rubber Products* (Washington, DC: GPO, 1994), p. 30A-1.

utilizes polyester, epoxy, and vinyl ester-type plastic materials. In addition, thermosetting plastics typically utilize non-plastic reinforcing agents[9] in the construction of pipe. When compared with traditional piping materials,[10] plastic has been described as ideal for piping applications because it is lightweight, provides resistance to corrosion and chemicals, and is flexible in form. As measured by volume, PVC is the dominant polymer used in pipe applications (table 1).

Plastic pipe is an important and growing part of the U.S. pipe industry. When measured in linear feet, plastic pipe dominates the U.S. market over all other types of pipe materials. Plastic pipe accounted for approximately 28 percent of the U.S. pipe market in terms of value during 1993.[11] The growth rate of plastic pipe demand has outpaced the growth rates of all other piping materials in recent years. During the last 10-year period, demand for plastic pipe grew at an average annual rate of 8 percent. According to one source, the growth of the plastic pipe industry is predicted to continue and will average 4.2 percent per year through 1996.[12]

Methods of production

Thermoplastic pipe is typically produced by extrusion—a process that allows for the production of continuously shaped products. Plastic raw materials[13], usually in pellet form, are fed into the extrusion equipment where they are heated to a melt phase. A screw, twin screw, or ram mechanism propels the molten polymer through the barrel of the apparatus and then through a die.[14] The die, essentially an orifice, determines the size, shape, and thickness of the pipe. In contrast to piping, fittings are processed by another common plastics processing method, injection molding. This processing method utilizes a ram or screw mechanism to inject the molten polymer in a mold.[15] Injection molding allows for the production of products with complex shapes and/or dimensions.

Production of pipe[16] from thermosetting materials involves a different set of processing methods. Because thermosetting pipes typically require more than one raw material, production is generally more complex than production of thermoplastic pipe. The four main processes are filament winding, centrifugal casting, contact molding, and compression molding.[17] Filament winding, by far the most popular processing method for thermosetting pipe, utilizes a core (often called a mandrel) upon which a filament is wrapped or wound until the specific width is reached. Before and after filament winding, the core is coated with resin to provide structure and resistance to chemical and environmental degradation. After final coating and polymer cure,[18] the core is removed.[19]

The centrifugal casting method requires the use of a rotating cylinder that contains the polymer and the

[9] For example, these reinforcers include textile filaments and fiberglass.

[10] Traditional piping materials include clay, iron, steel, concrete, asbestos cement, and copper.

[11] "BCC: The U.S. Competitive Pipe Industry," *Business Communications Company, Inc. New Release,* Apr. 8, 1994, p. 1.

[12] Heather Helper, "Flowing with the Times," *American City & County,* Mar. 1994, pp. 36-40.

[13] In addition to the plastic raw material, various chemical additives are often added to the mix. These include colorants, antioxidants, flame retardants, plasticizers, heat stabilizers, fillers and extenders, antistatic agents, and lubricants.

[14] Lloyd R. Whittington, *Whittington's Dictionary of Plastics* (Westport, CT: Technomic, 1978), p. 128.

[15] Ibid., p. 170.

[16] Fittings made from thermosetting materials are also made by these processing methods.

[17] David A. Chasis, *Plastic Piping Systems,* 2d ed. (New York: Industrial Press Inc., 1988), p. 7.

[18] See app. A.

[19] Chasis, *Plastic Piping Systems,* p. 8.

Table 1
U.S. plastic pipe[1] in building markets: Plastic resin consumed, by type, 1989-93

(1,000 metric tons)

Type	1989	1990	1991	1992	1993
ABS[2]	70	66	54	63	68
Epoxy	7	7	7	7	7
High density polyethylene	220	250	305	287	298
Low density polyethylene	61	69	61	73	74
Polypropylene	16	15	11	13	11
Polystyrene	14	19	27	26	26
Polyvinyl chloride	1,440	1,554	1,505	1,975	2,037
Reinforced polyester	72	63	57	55	55
Total	1,900	2,043	2,027	2,499	2,576

[1] Includes fittings and conduit.

[2] Acrylonitrile-butadiene-styrene resins.

Source: "U.S. Resin Sales by Process and Market," *Modern Plastics,* Jan. 1993-94.

reinforcing agent. As the cylinder turns, the polymer material coats the inside of the cylinder, thereby producing the pipe.[20] The contact molding process begins with the placement of reinforcing materials on a mold followed by application of a plastic resin. The process is repeated manually, layer by layer, until the desired thickness is reached.[21] Although contact molding requires few pieces of production equipment, it is the most labor-intensive process. Compression molding of thermosetting pipe requires use of two form-fitting molds. Polymer material is inserted in the mold and pressure is exerted to form the product.[22]

End uses

The variety of plastic materials used for pipe production enables plastic pipe to meet a range of quality and technical specifications and thus allows its use in almost all piping applications. Major categories of usage include drain/waste/vent (DWV), water distribution, irrigation, crude petroleum and gas service, industrial, and chemical. The DWV, water distribution, and irrigation categories are the largest markets for plastic pipe. Major industries utilizing plastic pipe include construction, agricultural, energy, and manufacturing.

Rubber Hose, Belt, and Tubing

These rubber products represent the second largest manufactured rubber industry segment after tires and inner tubes. Although these products are mainly comprised of natural and synthetic rubber[23], they also contain a variety of reinforcing materials such as textile fabrics, plastic materials, fiberglass, and steel or metal wire.

Product description

As shown in figure 2, belting is usually described by the industry segment where it is used (automotive or industrial) and by type (power drive or conveyor). Power drive belts derive their name from the power transmission system they comprise and conveyor belts from the movement or conveyance of materials. The power transmission system is made up of the belt and pulley (also called sheaves). Power transmission belts have four main components—a tensile member, base material, cover, and adhesion materials.[24] There are also four basic types or shapes of belts that are described by the industry. V-belts, the most prominent type of belt, have a "V"-shaped cross section that gives it good adherence to the sheaves. Flat belts are rectangular in cross section and can be cordless (do not contain a tensile layer) or corded. Synchronous belts, also called timing belts, have a notched inside surface. Because this type of belt contains notches or teeth, it is manufactured to precise specifications to fit the pulley apparatus. The last type of belt, round, is cylindrical in cross-section and is the least commonly used belt today.

Rubber hose and tube is a category of products that is also described by the industry it serves. Common types of hoses include automotive, which are used principally in the automotive sector, and hydraulic, which are used in a variety of industrial applications. Rubber hose and tube has the same cylindrical shape as plastic pipe but it generally has more features such as odd shapes and bends to fit between automotive parts. These products are also commonly reinforced with textile fibers to give strength and stability. U.S. shipments of rubber hose, by type, are shown in figure 3.

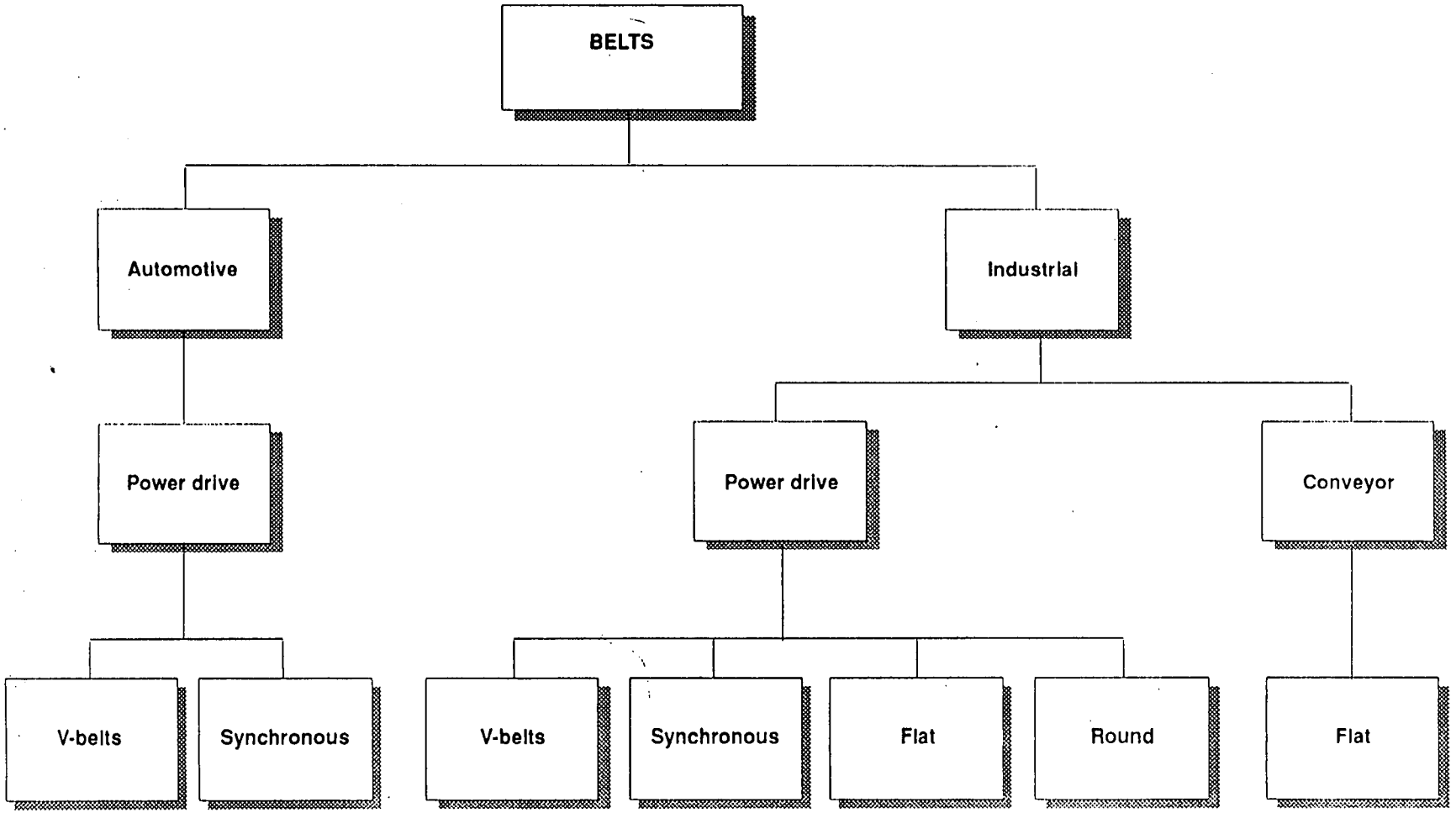
Methods of production

Because there is a wide variety of rubber hoses and tubes, each with various properties, production can be complex. Production methods vary by the end use of the hose as well as by the level of technology employed. However, the hose construction technology involves the following seven key steps: mixing, machining the inside coat, wrapping an insertion inside, machining the outside coat, wrapping the hose, vulcanization,[25] and attaching couplings.[26] In the first step, raw material rubber is mixed with other compounds or chemicals that provide desirable properties to the resulting rubber product. The second and third steps involve the extrusion of the inside coat on a form or mandrel, followed by the braiding or weaving of textile material around this first layer. After braiding, the hose again passes through an extrusion step to apply the outside layer of rubber. The hose is then wrapped or sheathed with a textile or polymer material before it undergoes vulcanization in a vulcanizing chamber. After the vulcanization or cure, the hose is unwrapped and the mandrel is removed. Necessary finishing steps and the attachment of couplings are done at this stage before final shipment.

The production of belting involves four basic steps—parts manufacture, assembly or building, vulcanization, and finishing and packaging.[27] In the

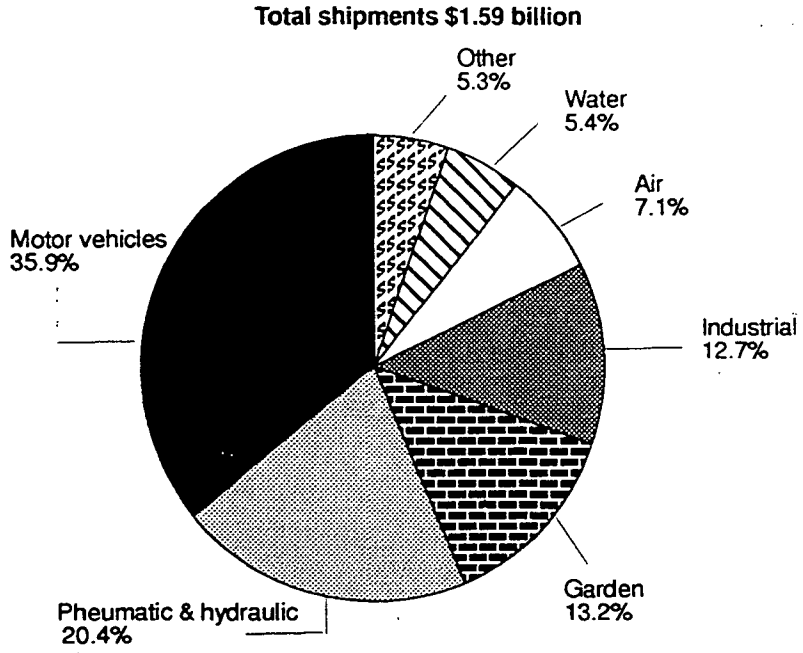
[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Although these products use practically all types of rubber, the most commonly used rubbers include neoprene and styrene-butadiene.
[24] The Gates Rubber Company, *Belt Power Transmission* (Scranton, PA: International Correspondence Schools, 1970), p. 23.
[25] See app. A.
[26] *Industrial Market & Energy Management Guide* (Washington: American Consulting Engineers Council, 1985), p. II-16.
[27] U.S. International Trade Commission, *Industrial Belts from Israel, Italy, Japan, Singapore, South Korea, Taiwan, the United Kingdom, and West Germany* (investigation Nos. 701-TA-293 (final) and 731-TA-412 through 419 (final)), USITC publication 2194, May 1989, p. a-5.

Figure 2
Types of belting



Source: Compiled by USITC staff from various sources.

Figure 3
Hose: U.S. shipments, by type, 1992



Source: "Rubber Products," 1992 *Census of Manufactures* (Washington: GPO, 1994) pp. 3-4.

first stage of belt production the rubber material is prepared by following a recipe of the appropriate rubber materials and chemical additives to include in the mixture. This rubber mixture is then layered to the proper thickness, usually by calendering.[28] The preparation of the tensile material also takes place at this stage. Tensile cord is usually coated with latex or adhesive in order to obtain better bonding qualities. The second stage of production involves building the component parts; tensile layer and rubber pieces are assembled together usually by the aid of adhesives or other bonding agents. The assembled belts are then vulcanized or cured. Finally, the belts undergo trimming and finishing operations, are inspected, and prepared for shipment. A key difference in the production of these rubber products compared with plastics products is that production requires vulcanization.

End uses

The two major end-use industry segments for these products are automotive and industrial. However, the majority of rubber hose, belting, and tube is used in automotive applications. Common applications for tube and hose are in fuel lines, cooling systems, power steering, air conditioning, and brakes. Automotive belting applications include use in power transmission drives, cooling fans, and air conditioner compressors.

Other than automotive applications, power drive belts are used in many industrial applications such as office machines, sewing machines, appliances, and paper mill machines. Major industry segments that use conveyor belts are mining, iron and steel, and food and agriculture. Hose and tube are also used in industrial, agricultural, and consumer industries. Typical applications include use in irrigation, water blast cleaning, and food processing.

Sausage Casings

Product description

A small percentage of the products covered in this summary are sausage casings that are used to shape, contain, and protect meat for fresh, cooked, or dry sausage production. There are four main types of sausage casings—natural, reconstituted collagen, regenerated cellulose, and thermoplastic; but only cellulose, thermoplastic, and hardened reconstituted collagen casings are classifiable in Harmonized Tariff Schedule (HTS) heading 3917, and thus are included in this report.[29] The sausage industry generally delineates sausage casings as natural or synthetic, and also sometimes as edible or non-edible. Natural casings are derived from the intestinal guts of animals and are edible. Generally the small and large intestines

[28] See app. A.

[29] Natural sausage casings are classifiable in HTS heading 0504 and according to recent U.S. Customs rulings, non-hardened reconstituted collagen casings are classifiable in HTS heading 3504.

are obtained from hog, sheep, and cattle for use as natural casings.[30] The second type of casings, reconstituted collagen casings, are prepared by reconstituting the protein substance (collagen) from an animal source. This type of casing is neither entirely natural nor entirely synthetic, but it is edible.

Regenerated cellulose casings represent one of the highest volume casings used in the United States. Because these casings are synthetic and non-edible, the sausage made using these casings is typically peeled before entering commerce. The final type of casing is thermoplastic, which utilizes this type of plastic material as the casing. Because thermoplastic casings are highly impermeable, they are often used to extend the shelf-life of sausage.[31] The most common plastic material used for this type of casing is polyvinyl alcohol.

Besides being made of different materials, natural and synthetic casings have different properties that allow their use in separate markets. Artificial casings, when compared with natural casings, are more uniform in size and properties, generally not edible, and possess better strength and tear properties. Therefore, synthetic casings are typically used in high-volume applications where automated machinery is employed in the production process. For example, synthetic casings are generally used for hot-dog production. Alternatively, specialty meats found in delicatessens typically have natural casings.

Methods of production and end uses

Production of reconstituted collagen casings begins with the isolation of collagen, typically from cattle hides. The collagen is treated with chemicals to obtain a gel-like substance that is extruded into a tubular form. After washing and drying, the casing is typically shirred[32] before use by a sausage producer.

The production of regenerated cellulose sausage casings begins with a source of cellulose, typically wood pulp, flax, or cotton linters.[33] The cellulose undergoes a number of chemical treatments to break down and then reform the cellulose. The material is then extruded into an acidic liquid or bath, washed, plasticized, dried, and shirred.[34] Production of thermoplastic casings is similar to the above-mentioned processes except that the raw material, in this case plastic, does not have to be isolated or reconstituted. The plastic is extruded through a die to obtain the tubular shape. Sausage casings are used exclusively in the production of sausage, or of similarly processed meats.

[30] Sausage casings were typically made from natural materials until the 1920s, when synthetic casings were developed and became popular. Endel Karmas, *Sausage Casing Technology* (Park Ridge, NJ: Noyes Data Corporation, 1974), p. 1.

[31] Frank Gerrard, *Sausage and Small Goods Production*, 6th ed. (London: Northwood Publications, 1976), pp. 69-70.

[32] See app. A.

[33] Gerrard, *Sausage and Small Goods*, p. 146.

[34] Ibid

Consumer Characteristics and Factors Affecting Demand

Plastic Pipe and Fittings

Plastic pipe competes against other types of pipe (e.g. copper, steel, etc...) and competes internally (PVC versus ABS) for pipe markets. To some degree, the application, standards, and building codes determine what type of pipe will be used and therefore limit competition among materials. Where options exist, there is often intense competition among pipe suppliers based on a combination of factors, including price, ease and cost of installation, and repair and maintenance. Many analyses have been conducted on the competitive factors affecting the pipe industry. These studies have determined that, on an installed basis, PVC pipe is the most cost-competitive material (see table 2 for price history of PVC pipe).[35]

Rubber Hose, Belt, and Tubing

The level of automobile production has the largest effect on the demand for rubber hose, belting, and tubing. Production of U.S. automobiles initially declined during 1989-91, but then recorded positive growth levels in 1992 and 1993.[36] The production of hose, belt, and tubing mirrored this trend. There are essentially no substitute products for rubber hose, belt, and tubing in automotive and industrial applications.

Sausage Casings

The demand for synthetic sausage casings is driven by the demand for sausage products. During 1987-92, the value of sausage shipments increased by $421 million, or by 6 percent.[37] Substitutability of other types of sausage casings, such as natural casings for synthetic casings is minimal because natural casings are not suitable for highly automated factory production of certain sausages and because supply is limited.

[35] Nancy L. Lindley and Joe C. Floyd, "Piping Systems: How Installation Costs Stack Up," *Chemical Engineering*, Jan. 1993, pp. 94-100.

[36] The Economist Intelligence Unit, "World Rubber Trends and Outlook," *Rubber Trends*, 2nd Quarter 1994, p. 7.

[37] U.S. Department of Commerce, Bureau of the Census, *1992 Census of Manufactures: Meat Products* (Washington, DC: GPO, 1994), pp. 20A-15 and 20A-16; and U.S. Department of Commerce, Bureau of the Census, *1987 Census of Manufactures: Meat Products* (Washington, DC: GPO, 1988), pp. 20A-15 and 20A-16.

Table 2
Plastic pipe: U.S. prices, by type, 1989-93

(dollars per foot)

Type[1]	1989		1990		1991		1992		1993	
	mid[2]	end[2]	mid	end	mid	end	mid	end	mid	end
PE, underdrain 4"	0.54	0.53	0.49	0.49	0.50	0.50	0.46	0.44	0.46	0.45
PVC, sewer, 4"	.87	.87	.77	.83	.75	.73	.75	.74	.77	.80
PVC, sewer, 8"	3.14	3.16	2.85	2.98	2.63	2.61	2.44	2.56	2.68	2.81
PVC, water, 6"	3.47	3.46	3.15	3.28	2.70	2.63	2.73	2.75	2.89	2.81
PVC, water, 8"	5.97	5.84	5.41	5.57	4.49	4.36	4.19	4.28	4.49	4.55
PVC, water, 12"	12.45	11.94	11.67	11.95	9.42	9.70	9.37	9.40	9.88	9.87

[1] PE is an abbreviation for polyethylene and PVC for polyvinyl chloride.
[2] Mid refers to the mid-year period and end refers to the end of the year.

Note.—Prices reported refer to a 20-city average spot price for delivered pipe.

Source: "Materials Prices," *ENR*, various issues 1989-93.

Associated Factors: Standards and Codes

Nearly all of the products covered in this report are subject to various industry standards, building codes, and government regulations at national and international levels. The pipe industry is heavily influenced by standards and building codes which dictate what is required or permitted in certain areas. In the United States, there are numerous organizations that provide standards to the pipe industry to guarantee a minimal level of quality and safety. No one organization is predominant; some organizations provide standards for numerous products whereas others limit their scope specifically to pipe, plastic pipe, or pipe for certain applications. Organizations specifically involved in standardization of plastic pipe are listed in table 3. In addition to safety and quality aspects, standards provide information to the consumer or builder about the specifications or limitations of a pipe for a given application.

In addition to standards, many building codes specify what type of pipe can be used in certain jurisdictions. Typically, cities or local governments write codes for their own situation or circumstance, but these codes are usually based on one or more model codes. The organizations and their respective model codes are also listed in table 3.

The impact of these standards and codes can often determine the market size and penetration of certain types of pipe. Recently, several counties, cities, and even states, have imposed restrictions[38] on the use of polybutylene pipe in household plumbing applications because of reported ruptures and failures of the pipe.[39] Numerous lawsuits have ensued against a polybutylene raw material producer and pipe fabricator that allege the product was defective.[40] The resulting ban on the use of polybutylene pipe in certain jurisdictions is likely to reduce its demand in the future.

Rubber products such as hose and belting are also subject to a variety of industry standards and guidelines. The production of these products is guided by the Society of Automotive Engineers specifications as well as by guidelines and standards provided by the Rubber Manufacturers Association. The end user typically requires that these products conform to some industry standard.

FOREIGN INDUSTRY PROFILE

Major foreign producers of hose, belting, and pipe are located principally in Japan and in Western Europe. There is little statistical data for West European production but the dominant producing countries are Germany, France, the United Kingdom, and Italy. Rubber hose and belting has faced weak demand in Western Europe during recent years because of the corresponding weakness of the automotive sector. West European manufacturers of rubber products include some of the major tire producers, such as Michelin, and also a number of small and medium-sized firms that generally serve niche markets. Small and medium-sized firms also dominate the plastics products sector, which includes production of plastic pipe and fittings.

The growth and decline of Japan's hose, belting, and plastic pipe sector is primarily dependent on the automobile industry. The majority of hose and belting is used in automobile applications, but the plastic pipe sector serves many of the same markets as in the United States, most notably construction. As shown in table 4, Japanese production of products made of plastics increased during the past 5-year period at and

[38] Some jurisdictions have banned the use of polybutylene pipe.
[39] Ronald Begley, "Polybutylene Pipe Faces a Ban, Lawsuits," *Chemical Week*, May 25, 1994, p. 12.
[40] David B. Rosenbaum, "Pipe Makers Appeal Award," ENR, May 3, 1993, pp. 10-11.

Table 3
Plastic pipe: Organizations providing standards and codes to the industry

Organization
Standards
American National Standards Institute
American Petroleum Institute
American Society for Testing and Materials
American Water Works Association
International Association of Plumbing and Mechanical Officials
International Electrical Manufacturers Association
National Fire Protection Association
National Sanitation Foundation
National Swimming Pool Institute
Sprinkler Irrigation Association
Underwriters Laboratories
U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Defense
Codes
Building Officials and Code Administers (BOCA)- BOCA Basic Plumbing Code
National Association of Plumbing, Heating, Cooling Contractors- National Standard Plumbing Code
Southern Building Code Congress- Southern Standard Plumbing Code
International Association of Plumbing and Mechanical Officials- Uniform Plumbing Code

Source: Dr. Peter J. Mooney, *Business Opportunity Report: The Competitive Pipe Industry,* (Norwalk, CT: Business Communications Co., Inc., 1988), pp. 128-134.

Table 4
Hose, belting, and plastic pipe: Japan's production of selected products, 1989-93

(metric tons)

Product	1989	1990	1991	1992	1993
Plastic pipe, tube, and hose	580,283	602,126	579,218	591,853	602,794
Plastic fittings	55,540	57,702	57,688	59,612	61,012
Rubber tube and hose	31,142	31,382	32,226	30,312	28,851
Rubber belting	33,841	35,838	36,506	31,494	29,958

Note.—Rubber products are reported in metric tons of virgin rubber.

Sources: *Japan Chemical Annual 1989-94,* (Tokyo: The Chemical Daily Co., Ltd., 1989-93), various pages; and "Production and Sales of Plastics Products," *Plastics Industry News,* Apr. 1993-Mar. 1994, various pages.

average annual rate of 1 percent, while rubber products declined by an average annual rate of 2 percent. Decline in the rubber products sector is attributed to the decline in the production of automobiles during 1991 and 1992. Japan's production of hose, belting, and plastic pipe is mainly consumed by the domestic market. The level of imports and exports remains minimal compared to Japan's total consumption of these products.

U.S. TRADE MEASURES

Tariff Measures

As of Jan. 1, 1994, the U.S. most-favored-nation rate of duty for the imported hose, belting, and plastic pipe covered by this summary ranged from 2.4 percent ad valorem (e.g., for certain belting) to 8 percent ad valorem (e.g., for belting containing certain textile materials) (table 5). Some of these products are eligible for duty-free entry under the Generalized System of Preferences (GSP), the Automotive Products Trade Act, the Agreement on Trade in Civil Aircraft, the Caribbean Basin Economic Recovery Act (CBERA), the United States-Israel Free Trade Area Implementation Act, and the Andean Trade Preference Act. Under the North American Free Trade Agreement (NAFTA), the United States has agreed to phase out duties on hose, belting, and plastic pipe from Canada and Mexico. The staged reductions for goods from Canada began Jan. 1, 1989 under the United States-Canada Free-Trade Agreement (CFTA),[41] and for Mexico, under NAFTA, on Jan. 1, 1994. The respective rates of duty are shown in table 5. Under the GATT Uruguay Round Agreement, the United States has agreed to eliminate or reduce tariff rates, beginning Jan. 1, 1995, on some of the products contained in this grouping.

[41] David B. Rosenbaum, "Pipe Makers Appeal Award," ENR, May 3, 1993, pp. 10-11.

Table 5
Hose, belting, and plastic pipe: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1994; U.S. exports, 1993; and U.S. imports, 1993

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1994 General	Col. 1 rate of duty as of Jan. 1, 1994 Special[1]	U.S. exports, 1993	U.S. import-1993
				Million dollars	
	Tubes, pipes and hoses and fittings therefor (for example, joints, elbows, flanges), of plastics:				
	Artificial guts (sausage casings) of hardened protein or of cellulosic plastics materials:				
3917.10.10	Of cellulosic plastics materials	6.6%	Free (A,CA,E,IL,J,MX)	[2]92	33
3917.10.50	Other	4.2%	Free (A,CA,E,IL,J,MX)	([3])	41
	Tubes, pipes and hoses, rigid:				
3917.21.00	Of polymers of ethylene	3.1%	Free (A,B,C[4],E,IL,J,MX) 1.2% (CA)[5]	35	5
3917.22.00	Of polymers of propylene	3.1%	Free (A,B,C[4],E,IL,J,MX) 1.2% (CA)	3	1
3917.23.00	Of polymers of vinyl chloride	3.1%	Free (A,B,C[4],E,IL,J,MX) 1.2% (CA)[5]	62	25
3917.29.00	Of other plastics	3.1%	Free (A,B,C[4],E,IL,J,MX) 1.2% (CA)[5]	55	17
	Other tubes, pipes and hoses:				
3917.31.00	Flexible tubes, pipes and hoses, having a minimum burst pressure of 27.6 MPa	3.1%	Free (A,B,C[4],E,IL,J,MX) 1.2% (CA)[5]	22	1
3917.32.00	Other, not reinforced or otherwise combined with other materials, without fittings	3.1%	Free (A,B,E,IL,J,MX) 1.2% (CA)[5]	41	50
3917.33.00	Other, not reinforced or otherwise combined with other materials, with fittings	3.1%	Free (A,B,C[4],E,IL,J) 1.2% (CA) 2.7% (MX)	12	8
3917.39.00	Other	3.1%	Free (A,B,C[4],E,IL,J,MX) 1.2% (CA)[5]	59	54
3917.40.00	Fittings	5.3%	Free (A,B,C[4],E,IL,J,MX) 2.1% (CA)[5]	72	57
	Belting and belts, for machinery:				
	Containing textile fibers:				
3926.90.55	V-belts	5.1%	Free (B,E,IL,J) 2% (CA)[5] 4% (MX)	3	1
3926.90.56	Other: With textile components in which vegetable fibers predominate by weight over any other textile fiber	5.1%	Free (A,E,J,MX) 0.5% (IL) 2% (CA)	[6]6	([7])

See footnotes at end of table.

Table 5—*Continued*
Hose, belting, and plastic pipe: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1994; U.S. exports, 1993; and U.S. imports, 1993

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1994 General	Special[1]	U.S. exports, 1993	U.S. imports, 1993
				Million dollars	
3926.90.57	With textile components in which man-made fibers predominate by weight over any other textile fiber	8%	Free (A,E,J,MX) 0.8% (IL) 3.2% (CA)	([3])	11
3926.90.59	Other	2.4%	Free (E,J) 0.2% (IL) 0.9% (CA) 2.1% (MX)	([3])	4
3926.90.60	Other	4.2%	Free (A,E,IL,J,MX) 1.6% (CA)[5]	25	10
	Tubes, pipes and hoses, of vulcanized rubber other than hard rubber, with or without their fittings (for example, joints, elbows, flanges):				
4009.10.00	Not reinforced or otherwise combined with other materials, without fittings	3.1%	Free (A,B,E,IL,J,MX) 1.2% (CA)[5 8]	40	38
4009.20.00	Reinforced or otherwise combined only with metal, without fittings	3.1%	Free (A,B,E,IL,J,MX) 1.2% (CA)[5]	44	15
4009.30.00	Reinforced or otherwise combined only with textile materials, without fittings	3.1%	Free (A,B,E,IL,J,MX) 1.2% (CA)[5]	62	65
4009.40.00	Reinforced or otherwise combined with other materials, without fittings	3.1%	Free (A,B,E,IL,J,MX) 1.2% (CA)	38	13
4009.50.00	With fittings	3.1%	Free (A,B,C,E,IL,J,MX) 1.2% (CA)	87	90
	Conveyor or transmission belts or belting, of vulcanized rubber:				
	Of trapezoidal cross section (V-belts and V-belting):				
4010.10.10	Combined with textile materials	5.1%	Free (B,E,IL,J,MX) 2% (CA)[5]	[9]69	56
4010.10.50	Other	4.2%	Free (A,E,IL,J,MX) 1.6% (CA)[5]	([3])	7
	Other:				
	Of a width exceeding 20 cm:				
	Combined with textile materials:				
4010.91.11	With textile components in which vegetable fibers predominate by weight over any other single textile fiber	5.1%	Free (A,E,J,MX) 0.5% (IL) 2% (CA)	[10]21	5

See footnotes at end of table.

Table 5—*Continued*
Hose, belting, and plastic pipe: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1994; U.S. exports, 1993; and U.S. imports, 1993

HTS subheading	Description	Col. 1 rate of duty as of Jan. 1, 1994 General	Col. 1 rate of duty as of Jan. 1, 1994 Special[1]	U.S. exports, 1993	U.S. imports, 1993
				Million dollars	
4010.91.15	With textile components in which man-made fibers predominate by weight over any other single textile fiber	8%	Free (A,E,J,MX) 0.8% (IL) 3.2% (CA)	(3)	28
4010.91.19	Other	2.4%	Free (E,J) 0.2% (IL) 0.9% (CA) 2.1% (MX)	(3)	3
4010.91.50	Other	4.2%	Free (A,E,IL,J,MX) 1.6% (CA)	(3)	5
	Other:				
	Combined with textile materials:				
4010.99.11	With textile components in which vegetable fibers predominate by weight over any other single textile fiber	5.1%	Free (A,E,J,MX) 0.5% (IL) 2% (CA)[12]	[11]31	2
	Conveyor or transmission belts or belting, of vulcanized rubber:				
	Other:				
	Other:				
	Combined with textile materials:				
4010.99.15	With textile components in which man-made fibers predominate by weight over any other single textile fiber	8%	Free (A,E,J,MX) 0.8% (IL) 3.2% (CA)[12]	(3)	35
4010.99.19	Other	2.4%	Free (E,J) 0.2% (IL) 0.9% (CA)[12] 2.1% (MX)	(3)	3
4010.99.50	Other	4.2%	Free (A,E,IL,J,MX) 1.6% (CA)[12]	(3)	14

[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); Goods of Canada under the terms of the North American Free Trade Agreement (NAFTA) (CA); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL); Andean Trade Preference Act (J); and Goods of Mexico under the terms of the NAFTA (MX).
[2] This figure for U.S. exports is equivalent to aggregate exports reported under HTS subheadings 3917.10.10 and 3917.10.50.
[3] U.S. exports of this item are not separately reported, but are included the figure above.
[4] Applies only to tubes, pipes and hoses having attached fittings.
[5] Under the NAFTA, these items from Canada enter free of duty if intended for use in the repair or maintenance of motor vehicles of heading 8702, 8703, or 8704, or of automobile truck tractors principally designed for the transportation of persons or goods.
[6] This figure for U.S. exports is equivalent to aggregate exports reported under HTS subheadings 3926.90.56, 3926.90.57, and 3926.90.59.

Table 5—*Continued*
Hose, belting, and plastic pipe: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1994; U.S. exports, 1993; and U.S. imports, 1993

[7] Less than $500,000.
[8] Under the NAFTA, flexible closed-cell rubber tubing designed for insulating liquid-cooling or liquid-heating tubes or pipes enters free of duty.
[9] This figure for U.S. exports is equivalent to aggregate exports reported under HTS subheadings 4010.10.10 and 4010.10.50.
[10] This figure for U.S. exports is equivalent to aggregate exports reported under HTS subheadings 4010.91.11, 4010.91.15, 4010.91.19, and 4010.91.50.
[11] This figure for U.S. exports is equivalent to aggregate exports reported under HTS subheadings 4010.99.11, 4010.99.15, 4010.99.19, and 4010.99.50.
[12] Under the NAFTA, motorcycle rear drive belts and belt splice kits enter free of duty.

Source: U.S. exports and imports compiled from official statistics of the U.S. Department of Commerce, and tariff information was obtained from the *Harmonized Tariff Schedule of the United States (1994)*, supplement 1.

Nontariff Measures

There are no known significant domestic nontariff import barriers that restrict the importation of hose, belting, and plastic pipe. However, foreign producers must adhere to U.S. standards and codes if the products are subject to them.

U.S. Government Trade-Related Investigations

During the 1980s, there were 11 trade-related investigations conducted by the U.S. International Trade Commission (Commission) that concerned products covered in this summary. In 1984, the Commission instituted two investigations on certain skinless sausage casings under section 337 of the Tariff Act of 1930. The investigations were conducted following the filing of complaints with the Commission by two U.S. producers, Teepak and Union Carbide. The two complaints named Viscofan, S.A., and Industria Navarra de Conversion de Envolturas Artificiales, S.A., of Spain as respondents. The two investigations were subsequently consolidated. As a result of patent infringement allegations raised in the first complaint,[42] the Commission issued a general exclusion order prohibiting entry into the United States, except under license of the patent holder, of small caliber cellulose skinless sausage casings that infringe certain patent claims. As a result of allegations regarding theft of trade secrets raised in the second complaint,[43] the Commission issued a limited exclusion order against Viscofan, S.A., and Industria Navarra de Conversion de Envolturas Artificiales, S.A., that prohibited entry of the same product into the United States for a period of 10 years, except when under license from Union Carbide, the owner of the trade secret.[44]

During 1988-89, the Commission conducted nine investigations relating to industrial belts, one under the countervailing duty law and eight under the antidumping law. In the investigation under the countervailing duty law, the Commission made a negative determination, finding that an industry in the United States is not materially injured or threatened with material injury by reason of imports of industrial belts from Israel found by the U.S. Department of Commerce to be subsidized by the Government of Israel.[45] In the antidumping investigations, the Commission made affirmative determinations with regard to V-belts from Italy, Japan, and Singapore; synchronous belts from Italy and Japan; and certain other belts from Japan and West Germany, finding that an industry in the United States is materially injured or threatened with material injury by reason of imports of such belts found by the U.S. Department of Commerce to be sold in the United States at less than fair value. The Commission made negative determinations with respect to the remaining belts that were the subject of the antidumping investigations.[46] As a result of the Commission's affirmative determinations, the U.S. Department of Commerce issued antidumping orders under which additional duties in an amount equal to the margin of dumping were imposed (1989) on the imported merchandise subject to the orders.[47]

FOREIGN TRADE MEASURES

Tariff Measures

Major U.S. trading partners of hose, belting, and plastic pipe include Canada, Mexico, Japan, and Germany. Most developed countries impose tariffs at rates similar to U.S. rates, while those of developing countries generally impose higher rates. The tabulation below lists the corresponding 1994 duty rates for major U.S. trading partners (in percent ad valorem):[48]

Nation/Area	Range of duty rates for hose, belting, and plastic pipe
Canada	8.5-17.5 (MFN) 3.4-7 (U.S. 1994 rates under NAFTA)
European Union	Free-12.5
Japan	4.6-7.2
Mexico	10-20 (MFN) Free-18 (U.S. 1994 rates under NAFTA)

Nontariff Measures

There are no specific nontariff barriers identified for the products covered in this report. However, product standards and building codes vary significantly

[42] USITC investigation No. 337-TA-148.

[43] USITC investigation No. 337-TA-169.

[44] U.S. International Trade Commission, *Certain Processes for the Manufacture of Skinless Sausage Casings and Resulting Product* (investigation Nos. 337-TA-148 and 337-TA-169, USITC publication 1624, Dec. 1984.

[45] U.S. International Trade Commission, *Industrial Belts from Israel* (investigation No. 701-TA-293 (final)), USITC publication 2194, May 1989.

[46] U.S. International Trade Commission, *Industrial Belts from Israel, Italy, Japan, Singapore, South Korea, Taiwan, the United Kingdom, and West Germany* (investigation Nos. 731-TA-412 through 731-TA-419 (final)), USITC publication 2194, May 1989.

[47] 54 F.R. 15505, 54 F.R. 15496, 54 F.R. 15489, 54 F.R. 15487, 54 F.R. 15485, 54 F.R. 15483, and 54 F.R. 15481.

[48] Information obtained from country tariff schedules and the U.S. Department of Commerce.

Table 6
Hose, belting, and plastic pipe: U.S. shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1989-93

Year	Shipments	Exports	Imports	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1989	5,808	578	579	5,809	10.0
1990	6,073	670	617	6,020	10.2
1991	6,060	739	589	5,910	10.0
1992	6,498	829	657	6,326	10.4
1993	6,866	880	699	6,685	10.5

Source: Shipment data are obtained from the U.S. Department of Commerce, *Census of Manufactures* and *Annual Survey of Manufactures*; and estimated by USITC staff. Import and export data obtained from official statistics of the U.S. Department of Commerce.

by country and could restrict the free flow of some products such as pipe, belting, and hose.

U.S. MARKET

Consumption

U.S. apparent consumption of hose, belt, and plastic pipe increased by 15 percent during 1989-93 (table 6). The import penetration gradually increased during the period, and in 1993 imports supplied 10.5 percent of consumption. The increase in U.S. consumption was driven by downstream industries, such as the automotive, construction, and industrial sectors, which are the major consumers of hose, belt, and plastic pipe.

Shipments

U.S. shipment data for hose, belt, and plastic pipe are shown in table 6. During this period, U.S. shipments increased from $5.8 billion in 1989 to an estimated $6.9 billion in 1993, or by over 18 percent. U.S. shipments are likely to increase in the future because the automotive industry continues to raise its level of output and the construction industry remains strong as a result of rebuilding following a number of natural disasters in the United States.

Imports

Although the level of imports of hose, belting, and pipe, has increased during the last 5-year period, the United States was a net exporter during the last 4 years (table 7). Imports grew, on average, about 5 percent annually and were equivalent to a small portion, approximately 10 percent of U.S. consumption. The composition of imports differs from the composition of U.S. industry shipments. As shown in the breakdown of total imports in figure 4, the major import category is rubber tube and hose. Together, rubber tube and hose; plastic pipe, tube, and hose; and rubber belting comprise over 75 percent of all imports for this category of products.

U.S. imports of hose, belt, and plastic pipe came mainly from the highly industrialized countries of the world during 1989-93. Major sources of imports during the period were Canada, Japan, and Germany. Together, these countries supplied over 60 percent of all U.S. imports of these products in 1993. Imports from Canada were aided by declining tariffs under the United States-Canada Free-Trade Agreement.

U.S. EXPORTS

U.S. exports of hose, belting, and plastic pipe grew substantially during 1989-93, rising at an average rate of 11 percent per year. As shown in table 8, exports increased by $302 million during the period, from $578 million in 1989 to $880 million in 1993. The growth in exports is attributed to a strengthened competitive position by U.S. producers, the reduction of foreign tariff rates, and the movement towards internationalization of the industry.

The quantity of product types exported correlates roughly with the size of the U.S. industry. Leading export categories and percent of total exports of the products covered in this report in 1993 are as follows: plastic pipe, tube, and hose (33 percent); rubber tube and hose (31 percent); rubber belting (14 percent); sausage casings (10 percent); plastic pipe fittings (8 percent); and plastic belting (4 percent). These products were exported to numerous countries, with Canada and Mexico together accounting for 55 percent of 1993 exports. They also were the major growth markets for U.S. exports. U.S. exports to Canada increased by almost 180 percent during the 5-year period, and exports to Mexico increased by 27 percent. The gradual removal of Canadian tariffs beginning in 1989 under the U.S.-Canada Free-Trade Agreement contributed to export growth to that country. The other significant development in export trade during 1989-93

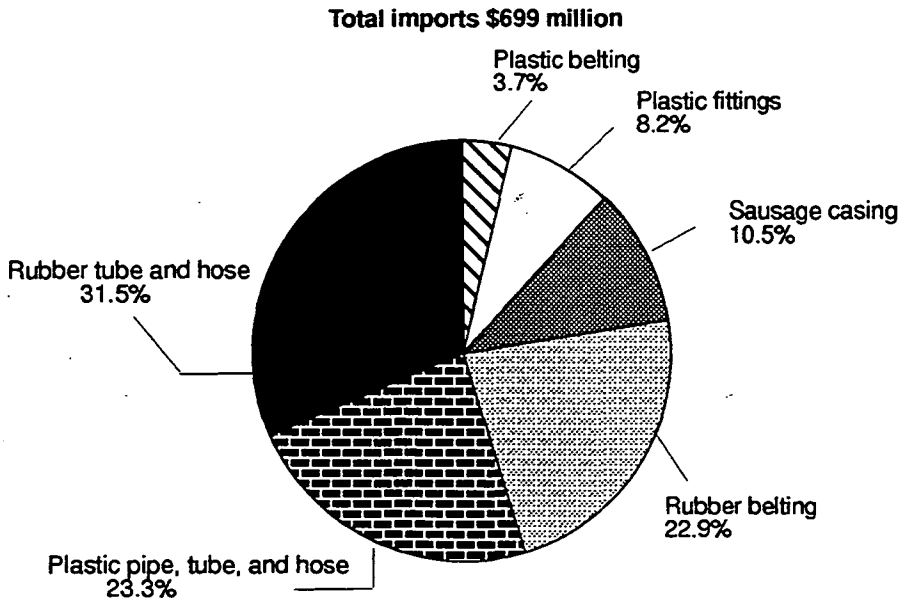
Table 7
Hose, belting, and plastic pipe: U.S. imports for consumption, by principal sources, 1989-93

(1,000 dollars)

Source	1989	1990	1991	1992	1993
Canada	143,560	156,547	145,077	173,483	183,459
Japan	129,460	131,206	125,646	143,781	158,463
Germany	74,048	83,184	83,332	84,807	84,203
Mexico	30,061	41,549	34,419	40,352	44,330
United Kingdom	30,700	29,258	32,262	34,448	32,315
Italy	21,586	18,874	19,337	21,185	26,874
Switzerland	17,386	18,893	16,817	22,506	25,575
Taiwan	29,704	24,823	24,141	26,771	25,199
Republic of Korea	13,846	13,967	12,445	11,623	14,700
Finland	12,741	14,132	16,210	16,469	14,201
All other	76,060	84,187	79,555	81,780	89,747
Total	579,151	616,629	589,241	657,205	699,064

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

Figure 4
Hose, belting, and plastic pipe: Composition of U.S. imports, by type, 1993



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

Table 8
Hose, belting, and plastic pipe: U.S. exports, by principal markets, 1989-93

(1,000 dollars)

Market	1989	1990	1991	1992	1993
Canada	117,698	229,240	247,225	278,748	328,203
Mexico	125,291	118,770	125,132	150,599	159,596
Japan	35,578	38,628	44,197	46,725	42,068
United Kingdom	28,701	25,631	26,768	30,934	33,986
Saudi Arabia	8,497	10,067	18,669	26,154	24,574
Australia	25,753	25,840	22,068	22,691	23,784
Germany	13,645	16,239	16,716	20,111	20,045
France	25,033	17,086	21,282	19,487	17,766
Republic of Korea	15,609	19,450	24,186	18,994	16,192
Venezuela	7,783	6,913	10,944	14,195	16,089
All other	173,936	161,988	181,994	200,581	197,497
Total	577,524	669,853	739,183	829,218	879,800

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

was the 189 percent increase in exports to Saudi Arabia. Exports increased from a small base of $8 million in 1989 to $25 million in 1993.

U.S. TRADE BALANCE

The U.S. trade balance of hose, belting, and plastic pipe shifted significantly from a negative $2 million in 1989 to a positive $181 million in 1993 (table 9). Although both imports and exports increased during the period, the shift in the trade balance was attributed to the faster growth of exports. Significant export growth of rubber tube and hose was the main contributing factor to the shift in the trade balance. Although the product category as a whole had a positive trade balance, not all segments exhibited this trend. As shown in figure 5, rubber belting had a trade balance in 1993 while all other categories had positive balances.

The United States maintained a positive and growing balance of trade during most of 1989-93 with the two largest trading partners, Canada and Mexico. The U.S. trade balance with Canada improved from a negative balance in 1989 to a positive position in 1992 and continued to grow during the remainder of the period, reaching $145 million in 1993.

Table 9
Hose, belting, and plastic pipe: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1989-93[1]

(Million dollars)

Item	1989	1990	1991	1992	1993
U.S. exports of domestic merchandise:					
Canada	118	229	247	279	328
Mexico	125	119	125	151	160
Japan	36	39	44	47	42
Germany	14	16	17	20	20
United Kingdom	29	26	27	31	34
Taiwan	10	11	9	15	12
Italy	10	6	4	5	5
Korea	16	19	24	19	16
Belgium	10	11	13	16	14
France	25	17	21	19	18
All other	186	176	208	228	231
Total	578	670	739	829	880
EU-12	99	89	99	108	107
OPEC	33	22	39	50	51
ASEAN	23	20	23	33	28
CBERA	29	24	28	26	27
Central Europe	(2)	1	1	1	2
U.S. imports for consumption:					
Canada	144	157	145	173	183
Mexico	30	42	34	40	44
Japan	129	131	126	144	158
Germany	74	83	83	85	84
United Kingdom	31	29	32	34	32
Taiwan	30	25	24	27	25
Italy	22	19	19	21	27
Korea	14	14	12	12	15
Belgium	11	14	13	14	13
France	10	11	8	9	10
All other	85	92	92	98	107
Total	579	617	589	657	699
EU-12	169	179	175	186	189
OPEC	2	1	2	2	2
ASEAN	5	6	8	8	10
CBERA	(2)	(2)	(2)	(2)	(2)
Central Europe	2	2	1	1	1
U.S. merchandise trade balance:					
Canada	-26	73	102	105	145
Mexico	95	77	91	110	115
Japan	-94	-93	-81	-97	-116
Germany	-60	-67	-67	-65	-64
United Kingdom	-2	-4	-5	-4	2
Taiwan	-20	-14	-15	-11	-13
Italy	-12	-13	-15	-17	-22
Korea	2	5	12	7	1
Belgium	(3)	-2	(2)	2	1
France	15	6	13	11	8
All other	101	84	116	129	124
Total	-2	53	150	172	181
EU-12	-70	-79	-76	-78	-82
OPEC	31	21	37	48	49
ASEAN	18	14	15	25	19
CBERA	29	24	28	26	27
Central Europe	-2	-1	-1	1	1

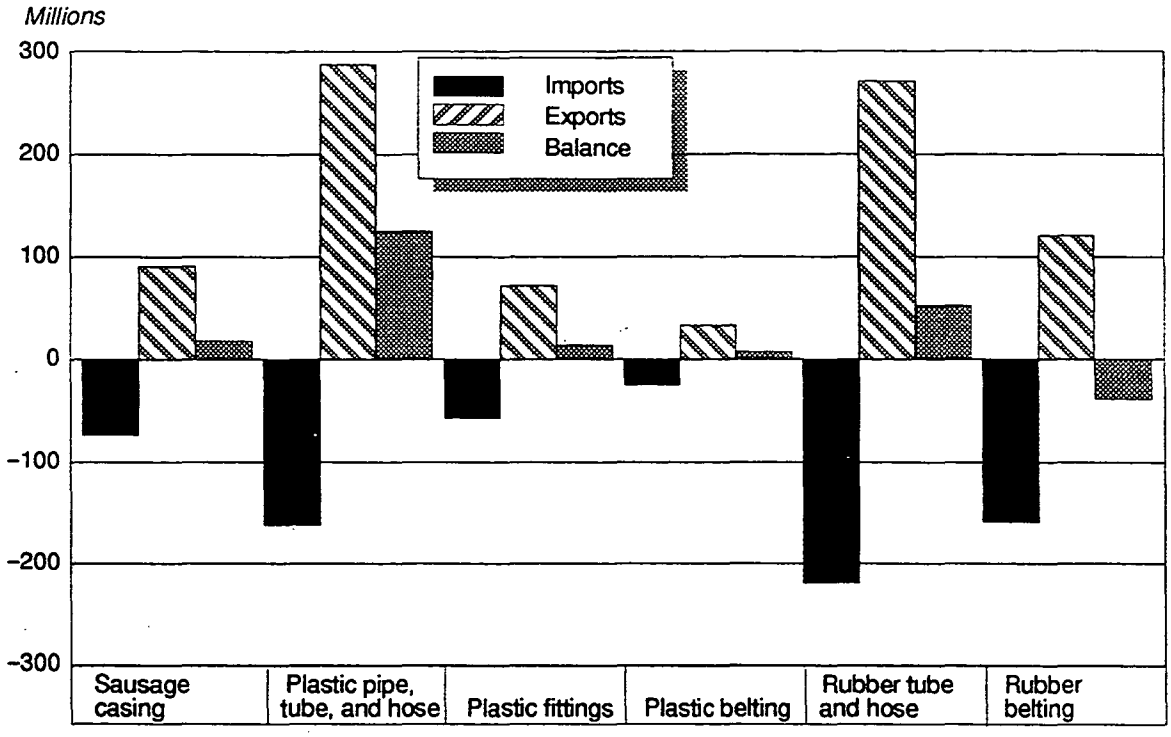
[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export. U.S. trade with East Germany is included in "Germany" but not "Central Europe."

[2] Less than $500,000.

[3] Between zero and -$500,000.

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

Figure 5
Hose, belting, and plastic pipe: U.S. imports, exports, and trade balance, by product grouping, 1993



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

APPENDIX A
GLOSSARY OF INDUSTRY TERMS

GLOSSARY OF INDUSTRY TERMS

ABS	Abbreviation for acrylonitrile-butadiene-styrene type thermoplastic resins and made from the monomers acrylonitrile, butadiene, and styrene. The polymer was one of the first engineering-grade polymers and has good impact resistance, heat resistance, and electrical properties.
Antioxidant	A substance incorporated in a material for the purpose of inhibiting undesirable oxidation at normal or elevated temperatures.
Antistatic agent	A chemical substance added to plastics or rubber to prevent the accumulation of electrostatic charges.
Calendering	A process for forming plastics or rubbers, usually sheets and film, by passing the materials through rollers.
Chloroprene	A chlorinated organic chemical that, when polymerized, forms polychloroprene, also known as neoprene.
Colorant	Dyes or pigments that impart color to plastics and rubber.
Cure	A process used to change the properties of thermosetting plastics or rubbers typically by heat and/or catalysts. The resulting thermosetting plastic is usually hardened in form.
Epoxy	A type of thermosetting plastic resin having the characteristic three membered (C-O-C) ring in its chemical structure. The plastic is typically used in composite applications where good thermal and adherence properties are desirable.
Extender	A substance added to the mixture to reduce its unit cost.
Filler	A relatively inert substance added to a plastic or rubber compound to reduce its cost and/or to improve physical properties, particularly hardness, stiffness, and impact strength.
Flame retardant	A material that reduces the tendency of plastics or rubbers to burn.
Lubricant	A type of substance that reduces friction and prevents sticking between two objects. When added to plastics or rubbers during processing, lubricants impart these qualities to the finished product.
Natural rubber	Chemically known as cis-1,4-polyisoprene, natural rubber is extracted from plant material and possesses a high degree of elasticity, a highly polymerized structure, and is vulcanizable.
Neoprene	A type of synthetic rubber distinguished because it contains chloroprene, a chlorinated chemical, as the main constituent. This rubber has good resistance to heat, oil, and environmental factors.
Plasticizer	A substance incorporated in a material (usually plastic) to increase its flexibility, workability, or distensibility.
Polybutylene	A type of thermoplastic resin obtained from the polymerization of butene-1 or butene-2. The material possess good flexibility, toughness, and creep resistance.

GLOSSARY OF INDUSTRY TERMS—Continued

Polyester	This is a name for a family of plastic resins in which the main backbone of the molecule is formed from a condensation reaction of polyfunctional acids and alcohols; they can be thermoplastic or thermosetting.
Polyethylene	A family of thermoplastic resins obtained by polymerizing ethylene gas. Those polymers with densities greater than 0.94 (g/cc) are considered high density, whereas those with densities 0.94 and below are low density.
Polymer	Long-chain molecular compound formed by the chemical union of five or more monomers that is the product of a polymerization reaction.
Polymerization	A chemical reaction in which the molecules of a chemical compound (monomer) are linked together to form large molecules whose molecular weight is a multiple of that of the monomer or monomers.
Polypropylene	One of the major categories of thermoplastic resins produced from the polymerization of propylene. The polymers have good electrical properties and good resistance to oils.
Polyvinyl alcohol	A type of thermoplastic resin that is typically produced from vinyl acetate by methanolysis or hydrolysis. The polymer is water soluble but has good barrier properties which make it suitable for a variety of packaging applications.
Polyvinyl chloride	A polymer made by the polymerization of vinyl chloride with catalysts. The polymer is inherently hard and brittle, but with the addition of plasticizers, it becomes desirably supple and flexible.
Ram	The part of the processing machinery that exerts pressure on the material and pushes it through the cavity.
Resin	The term resin is defined by ASTM (D 883-75a) as a solid or pseudosolid material, often of high molecular weight, that exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. A note added to this ASTM definition explains that in a broad sense, the term is used to designate any polymer that is a basic material for plastics.
Sheave	A grooved-type wheel or pulley part that is connected to a similar one by a power-drive belt.
Shirring	A process that pleats or folds the casing so that it is compressed in a smaller space. This enables the casing to be used efficiently on automated sausage stuffing machinery.
Styrene-butadiene rubber (SBR)	One of the major synthetic rubbers; a copolymer made from styrene and butadiene monomers.
Synthetic rubber	A material exhibiting natural-rubber-like properties--elasticity, vulcanizabilty, and shock absorption; but derived from petrochemical feedstocks.
Thermoplastics	A class of high polymers that in their final condition are capable of being repeatedly resoftened by increases in temperature and hardened by cooling.

GLOSSARY OF INDUSTRY TERMS—Continued

Thermosets	A class of high polymers that, in their final condition as finished articles, are substantially infusible and insoluble.
V-belts	A continuous drive belt that has a rubber-covered layer and is V shaped.
Vulcanization	A process that converts rubber from a predominantly plastic state to an elastic condition by crosslinking the constituent molecules, usually with sulfur. It is also referred to as curing.

Source: *Whittington's Dictionary of Plastics, Modern Plastics Encyclopedia, The Condensed Chemical Dictionary,* and *Dictionary of Rubber*

APPENDIX B
EXPLANATION OF 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 incorporate the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description and have U.S. product subdivisions at the 8-digit level. Chapters 98 and 99 contain special U.S. classifications and temporary rate provisions, respectively.

Duty rates in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates, many of which have been eliminated or are being reduced as concessions resulting from the Uruguay Round of Multilateral Trade Negotiations. Column 1-general duty rates apply to all countries except those enumerated in HTS general note 3(b) (Afghanistan, Azerbaijan, Cuba, Kampuchea, Laos, North Korea, and Vietnam), which are subject to the rates set forth in column 2. Albania, Armenia, Belarus, Bosnia, Bulgaria, the People's Republic of China, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Mongolia, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan are accorded MFN treatment. Specified goods from designated MFN-eligible 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 or in the general notes. If eligibility for special tariff rates is not claimed or established, goods are dutiable at column 1-general rates. The HTS does not enumerate those countries as to which a total or partial embargo has been declared.

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 for 10 years and extended three times thereafter, applies to merchandise imported on or after January 1, 1976 and before the close of July 30, 1995. Indicated by the symbol "A" or "A*" in the special subcolumn, 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 4 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. Indicated by the symbol "E" or "E*" in the special subcolumn, 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 7 to the HTS.

Free rates of duty in the special subcolumn 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 8 to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn 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 as 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 11 to the HTS.

Preferential or free rates of duty in the special subcolumn followed by the symbol "CA" are applicable to eligible goods of Canada, and those followed by the symbol "MX" are applicable to eligible goods of Mexico, under the ***North American Free Trade Agreement***, as provided in general note 12 to the HTS, implemented effective January 1, 1994 by Presidential Proclamation 6641 of December 15, 1993.

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 5) and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 6), ***articles imported from freely associated states*** (general note 10), ***pharmaceutical products*** (general note 13), and ***intermediate chemicals for dyes*** (general note 14).

The ***General Agreement on Tariffs and Trade 1994*** (GATT 1994), annexed to the Agreement Establishing the World Trade Organization, replaces an earlier agreement (the GATT 1947 [61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786]) as the

primary multilateral system of disciplines and principles governing international trade. Signatories' obligations under both the 1994 and 1947 agreements focus upon 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, dispute settlement, and other measures. The results of the Uruguay Round of 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 importing and exporting countries to negotiate bilateral agreements limiting textile and apparel shipments, or for importing countries to take unilateral action in the absence or violation of an agreement. These agreements establish quantitative limits on textiles and apparel of cotton, other vegetable fibers, wool, man-made fibers or silk blends in an effort to prevent or limit 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.

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