Industry & Trade Summary

Radar and Certain Radio Apparatus

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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 radar and certain radio apparatus covers the period 1991 through 1995 and represents one of approximately 250 to 300 individual reports to be produced in this series. Listed below are the individual summary reports published to date on the electronic technology and transportation sectors.

USITC publication number	*Publication date*	*Title*
2430	November 1991	Aircraft, Spacecraft, and Related Equipment
2445	January 1992	Television Receivers and Video Monitors
2505	April 1991	Construction and Mining Equipment
2540	July 1992	Photographic Supplies
2648	July 1993	Measuring, Testing, Controlling, and Analyzing Instruments
2674	September 1993	Medical Goods
2708	December 1992	Semiconductors
2728	February 1994	Capacitors
2730	February 1994	Navigational and Surveying Instruments
2746	March 1994	Aircraft and Reaction Engines, Other Gas Turbines, and Parts
2751	March 1994	Certain Motor-Vehicle Parts and Accessories
2820	October 1994	Telecommunications Equipment

[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.

PREFACE--Continued

USITC publication number	*Publication date*	*Title*
2821	October 1994	Computers, Peripherals, and Computer Components
2822	October 1994	Audio and Video Recording Equipment
2849	January 1995	Motorcycles and Certain Other Vehicles
2850	January 1995	Computer Software and Other Recorded Media
2851	February 1995	Optical Fiber, Cable, and Bundles
2877	May 1995	Television Picture Tubes and Other Cathode-Ray Tubes
2879	May 1995	Unrecorded Media Bundles
2950	March 1996	Office Machines
2954	April 1996	Forklift Trucks, Vehicles, and Parts
3005	November 1996	Radar and Certain Radio Apparatus

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INTRODUCTION

This summary report covers radar apparatus, radio navigational aid apparatus, radio remote-control apparatus, and parts thereof (hereinafter referred to as radar and certain radio apparatus) and examines significant developments that occurred within major global industries producing these products during 1991-95. These developments are discussed in three broad sections of the report covering U.S. and foreign industry profiles, U.S. and foreign trade measures, and the U.S. industry's performance in domestic and foreign markets.

Radar and certain radio apparatus encompass a wide range of high-technology products that are used by the U.S. Department of Defense (DOD), law enforcement offices, airports, weather forecasters, construction operations, homeowners, hobbyists, and operators of commercial and civilian air and marine craft. The manufacture of many of these products involves the use of complex technologies that incorporate optics, opto-electronics, digital electronics, semiconductors, integrated computer systems, and satellite communication systems.[1]

The following discussions focus on radar and certain radio apparatus that are used most widely. Radar, the most popular of these apparatus, is a system used for detecting and locating objects (or the velocity of such objects) by means of reflected radio waves.[2] During the use of radar, radio waves are emitted from a station, returned by reflection from an object, and interpreted at a receiving station (which is usually the emitting station). Radio waves allow the user to determine the distance of the object, the horizontal angular direction (azimuth of the object), and its vertical altitudinal direction relative to the receiving station's position. The advantages of radar include its long-range effectiveness, its precision, and its ability to penetrate darkness and adverse weather conditions.

There are two general types of radar: (1) Pulsed radar and (2) doppler or continuous wave radar. Pulsed radar transmits radio frequency waves in short bursts called pulses.[3] The principal reason for transmitting by pulses is to provide a listening period during which target echoes can be received without interference from the radar transmitter. Pulsed radar provides an effective means of measuring the range of objects. Conversely, doppler radar provides a continuous signal of constant frequency. This signal is reflected at a higher frequency when the object is moving closer to the radar station, and at a lower frequency

[1] U.S. International Trade Commission (USITC) staff interviews with industry representatives, Anaheim, CA, Apr. 1995.

[2] The word "radar" is an acronym for "radio detection and ranging" and applies to both the technique and the equipment used.

[3] Information obtained from USITC staff telephone interview with industry representative, May 1995 and *Encyclopedia Americana,* Vol. 23, p. 115.

when the object is moving away from the radar station. When using doppler radar, the range of objects can be more accurately determined by frequency modulations of the continuous wave.[4]

The most advanced and precise radio navigation system to date is the global positioning system (GPS), which was developed by the DOD as a means of providing U.S. armed forces with the most precise navigation and positioning data available. Since its creation, the GPS has evolved into a wide range of new technologies used in civil, scientific, and commercial applications.[5] This system uses 24 orbiting "Navstar" satellites in 6 orbital planes as reference points from which specifically designed receivers "triangulate" their positions relative to known positions.[6] These satellites continuously transmit precisely timed radio signals to a GPS receiver by using extremely accurate atomic clocks. The receiver calculates distances to the satellites by determining the travel-time to the satellite signals. The GPS receiver then triangulates its position using its known distance from the various satellites and ultimately calculates latitude, longitude, altitude, course, and speed.[7]

In a growing number of applications, the GPS is more effective than traditional radio navigation systems and is complementing or replacing those systems. For example, the VOR/DME[8] radio beacon system, a navigation system widely used in aviation, has an effective range of about 50 to 150 miles line-of-sight from a transmitter. Given the limitations of this system, operators of aircraft are frequently required to make directional adjustments before reaching final destinations.[9] Although the accuracy of the VOR/DME system is adequate for two-dimensional navigation (i.e., longitude and latitude), data regarding altitude, time information, and pinpoint accuracy are not available.[10]

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[4] Ibid.

[5] In 1993, the GPS was recognized by the National Aeronautical Association as the most significant development for safe and efficient navigation and surveillance of air and spacecraft since the introduction of radio navigation.

[6] USITC staff interviews with industry representatives, Anaheim, CA, Apr. 1995.

[7] For a more precise description of the operation of the GPS, see "How GPS Works," *GPS, A Guide to the Next Utility, Trimble Navigation,* 1989, pp. 12-13.

[8] VOR is an abbreviation for "VHF omnirange." The effectiveness of this radio navigation system is limited in mountainous terrain where some interruption of its signal can be expected at lower altitudes. DME, which stands for "distance measuring equipment," provides accurate data with respect to distance from the ground station to which the radio equipment is tuned. For more information regarding these systems, see *Van Sickle's Modern Airmanship,* 1995 edition, pp. 746-747.

[9] USITC staff interview with industry representatives, Sunnyvale, CA, Apr. 1995.

[10] The Federal Aviation Administration (FAA) adopted a policy that established the GPS as the future standard for aviation navigation and initiated the Wide Area Augmentation System (WAAS) Program. With implementation of the WAAS, the GPS will be available as a primary means of navigation within North America for all en route navigation and category I precision approaches by 1998 (based on information obtained from an official of FAA on Oct. 3, 1995).

Radio direction-finders[11] are also devices used for effective navigation. In addition, they are used for plotting the flight of meteorological balloons, locating storm fronts, detecting and locating illicit radio transmitters, and determining the source and characteristics of radio signals for military purposes. These apparatus determine the arrival of emitted radio waves by measuring the alignment of the wavefront. Radio direction-finders generally consist of three component parts: (1) the directional antenna or collector system; (2) the radio receiver that detects the emission from which the directional information will be derived; and (3) the display and indicator system that transforms the output of the two previous components into usable information that is displayed on a meter or a cathode-ray indicator.

Radio remote-control apparatus permit the control or operation of ships, aircraft, rockets, missiles, construction equipment, explosives, and other objects from a distance. The principal components in a remote-control system are the controlling quantity, a transmission medium, and a controlled quantity. In a typical remote-control system, the controlling quantity is the mechanism that controls the operation. The transmission medium is the output (for example, mechanical, electrical, and radio waves) used to obtain the desired functions of the distant object or the controlled quantity.[12]

U.S. shipments and trade of radar and certain radio apparatus reflected periods of depressed market demand during 1991-95, largely caused by reductions in military spending. Annual U.S. shipments fell by 8 percent to $7.8 billion during the 5-year period. U.S. exports remained at about $1.2 billion while imports rose by 5 percent to $522 million, which resulted in a 10-percent decline in the trade surplus to $676 million in these products. Radar used in flight navigation and tracking systems accounted for almost 80 percent of total U.S. producers' shipments and approximately 60 percent of both imports and exports during 1991-95.

[11] Radio direction-finders are sometimes referred to as radio compasses. Despite the name, a radio compass indicates direction with respect to the radio station to which it is tuned rather than the north magnetic pole.

[12] USITC staff interviews with industry representatives, Anaheim, CA, Apr. 1995.

U.S. INDUSTRY PROFILE

Industry Structure

The industry engaged in the production of radar and certain radio apparatus is comprised of firms that range in size from small, family-owned operations specializing in a single product, to large multinational corporations manufacturing a diverse line of products. Although the smaller firms account for a relatively large share of the total number of producers, the larger firms dominate U.S. production and export trade in international markets. Vertical integration within the industry is limited. The majority of producers rely upon domestic or foreign suppliers for certain types of raw and intermediate materials (such as certain computer-related materials) to manufacture products. Figure 1 provides an illustration of the principal types of raw materials used in U.S. production and the major types of producers, products, and consumers.

Number of Firms, Concentration, and Major U.S. Producers

There were approximately 250 establishments manufacturing radar and certain radio apparatus[13] in the United States during 1995. U.S. producers in California accounted for 21 percent of total establishments, followed by New York (9 percent), Florida (8 percent), and Texas (7 percent). Together, these States accounted for approximately 45 percent of the total number of establishments and about 50 percent of total industry employment during the period.

With respect to U.S. producers of traditional navigation systems, Allied-Signal Inc., Rockwell International, Texas Instruments Inc., Raytheon Co., Lockheed Martin Corp., Honeywell Inc., and Northrop Corp. are among the largest (in terms of sales) in the United States. Major manufacturers of satellite-based GPS systems include Allied-Signal Inc., Rockwell International, E-Systems Inc., and Trimble Navigation. Although these producers are major suppliers to global markets through affiliated international sales and service network systems, only a few of these companies maintain manufacturing facilities abroad. Table 1 provides the sales and locations of major U.S. producers of radar and certain radio apparatus.

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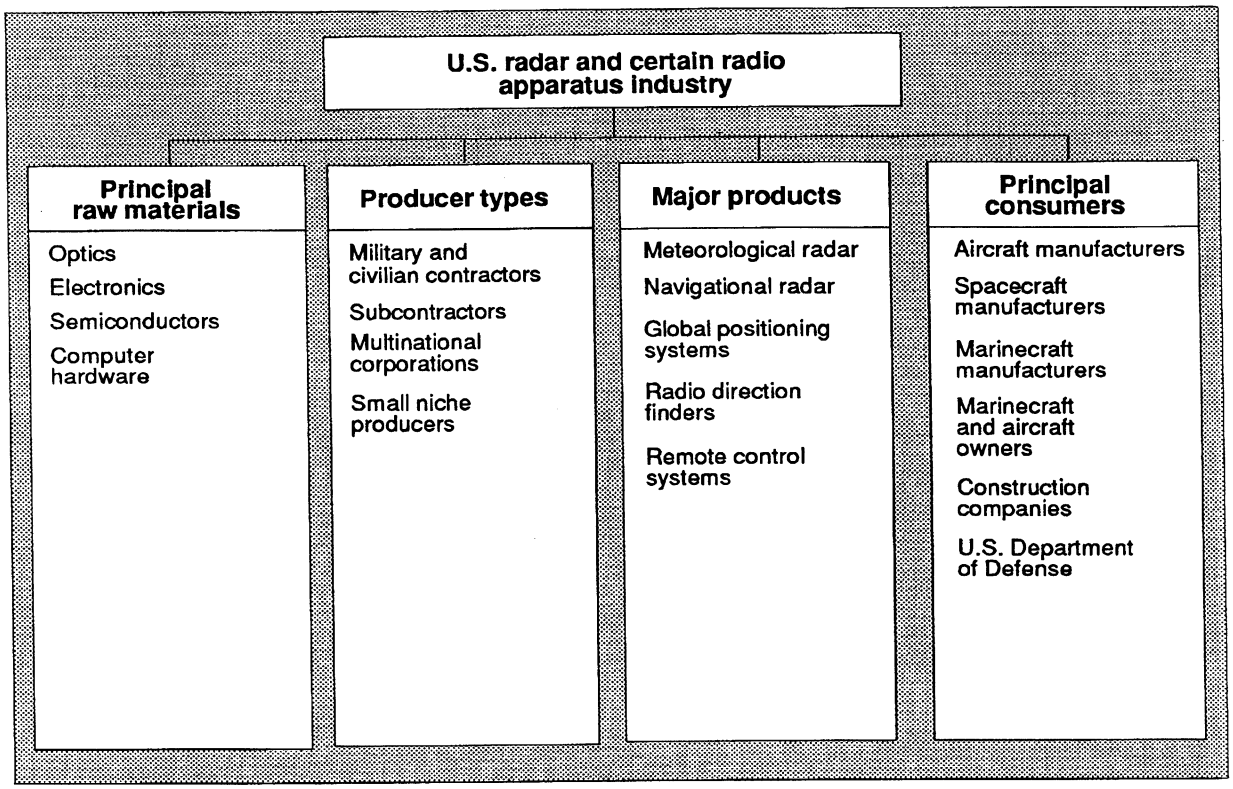
[13] The Standard Industrial Classification (SIC) category applicable to the industry producing radar and certain radio apparatus are 3812, *Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments* and 3829, *Measuring and Controlling Devices, Not Elsewhere Classified.*

Figure 1
Radar and certain radio apparatus: Principal raw materials, product types, major products, and principal consumers



Source: Staff of the U.S. International Trade Commission.

Employment, Wages, and Productivity

The U.S. industry producing radar and certain radio apparatus consisted of approximately 120,000 employees in 1995, which reflects a 10-percent decline from total employment in 1991.[14] The decline in employment was largely generated by reduced product demand, which slowed industry operations, coupled with excess capacity among certain industry manufacturers.[15] Of the total number of workers employed in 1995, approximately 65 percent were highly skilled and employed as software engineers, electronic technicians, computer specialists, and research and program specialists. The remaining workers were

[14] Estimated by the USITC staff from information provided by industry representatives and data published by the U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages, 1993.*

[15] USITC staff interviews with industry representatives, Anaheim, CA, Apr. 1995.

Table 1
Radar and certain radio apparatus: Major producers, sites of producers' headquarters and/or production facilities, and sales

(Million dollars)

Major producers	Sites	Sales [1]
Allied-Signal Inc.	Morristown, NJ	12,817 [2]
Rockwell International	Seal Beach, CA	11,123 [2]
Texas Instruments Inc.	Dallas, TX	10,315 [2]
Raytheon Co.	Lexington, MA	10,012 [2]
Lockheed Martin Corp.	Bethesda, MD	9,874 [2]
Honeywell Inc.	Minneapolis, MN	5,963 [3]
Northrop Corp.	Los Angeles, CA	5,063 [2]
Loral Corp.	New York, NY	4,008 [2]
Litton Industries	Beverly Hills, CA	3,474 [3]
Teledyne Inc.	Los Angeles, CA	2,391 [2]
E-Systems Inc.	Dallas, TX	2,097 [3]
Tracor Inc.	Austin, TX	694 [2]
Trimble Navigation	Sunnyvale, CA	176 [2]

[1] Data may include sales of products other than those included in the summary.
[2] Represent sales for 1994.
[3] Represent sales for 1993.

Source: Compiled from Form 10-Ks submitted by companies to the Securities Exchange Commission.

engaged in assembly, shipping, clerical, and other relatively lower skilled occupations.[16] Since major production facilities are in high production-cost areas of the United States, the average annual wage levels of employees producing radar and certain radio apparatus also were relatively high. The average annual wages of these employees in California (which had the highest of any State in 1993)[17] were $53,832, followed by New Jersey ($51,148), New York ($49,967), and Massachusetts ($45,905).[18] The average annual wage levels of employees producing radar and certain radio apparatus increased from $40,044 in 1990 to $47,200 in 1993, or by 18 percent. The increase in wages coincided with gains realized in labor productivity, which averaged an annual 10-percent increase during 1991-95.[19]

Conditions of Competition

The U.S. radar and certain radio apparatus industry is the world leader in terms of advanced technology, product design, and levels of production. The industry leadership stems from

[16] USITC staff interviews with industry representatives, Sunnyvale, CA, Apr. 1995.
[17] Data for 1994-95 are not available.
[18] U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages, 1993*, SIC 3812, Search and Navigation Equipment.
[19] USITC staff interview with industry representatives, Los Angeles, CA, Apr. 1995.

considerable capital investment expended by U.S. producers on research and product development, coupled with ongoing advancements in semiconductor integration and space communications.[20] The concerted efforts of U.S. Federal agencies (for example, the Department of Transportation (DOT), the FAA, and the DOD) to establish programs designed to improve and maintain effective navigation systems in the United States also has enhanced the global position of the U.S. industry.[21]

Competition is intense within the U.S. industry producing radar and certain radio apparatus.[22] Within most markets U.S. companies encounter competition from both domestic and international producers, both of which have invested heavily in product research and development. Regardless of the product origin, however, a producer's competitiveness is generally influenced by the ease at which products can be used, physical characteristics (including size, weight, and power consumption), product reliability, price, vendor reputation, financial resources, and other factors.

During 1991-95, the U.S. radar and certain radio apparatus industry was faced with rising production costs, global recessionary conditions, and sustained competition from foreign products.[23] The industry also contended with continuing downsizing and subsequent reductions in spending by the DOD (figure 2), which largely reflected the ensuing effects of the conclusion of the Cold War era. The industry responded to these challenges through a continuation of innovative product improvements, shifts in marketing strategies, and substantial capital investment domestically and abroad.[24]

Although the industry experienced periods of depressed demand, certain segments of the industry (especially segments catering to nongovernment demand) expanded capacity and product-lines to accommodate higher volume manufacturing. This expansion was especially noticeable with respect to the segment of the industry manufacturing GPS products, as popularity and demand for these relatively new and highly effective navigation apparatus increased. Expansion also was significant in the radio remote-control segment of the industry, whose products evolved into an array of new and effective apparatus for commercial and home use.

Innovations and product diversity within the radar and certain radio apparatus industry are occurring at an increasing rate, as U.S. producers become more cognizant of new technologies that affect products, markets, and customers.[25] For example, several producers of traditional navigational apparatus have broadened their product lines to include both

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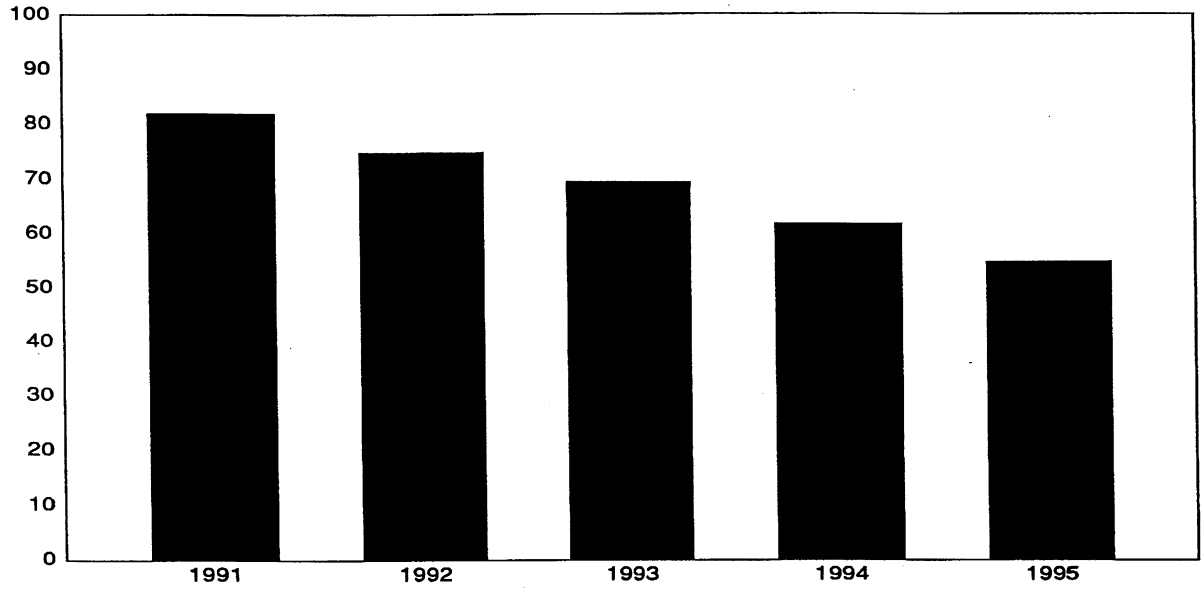
[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] USITC staff interviews with industry representatives, Long Beach, CA, Apr. 1995.
[24] Ibid.
[25] "Why Leica Has Again Been More Successful," *6 Leica Life, The Magazine of Leica*, Sept. 1994, p. 5.

Figure 2
Radar and certain radio apparatus: Total procurement expenditures of the U.S. Department of Defense, 1991-95

Billion dollars



Source: Compiled from data provided by the U.S. Department of Commerce, Bureau of the Census.

remote-control products and GPS products. These and similar production adjustments have strengthened certain producers' competitiveness in the domestic and international markets.[26]

Marketing and Distribution

U.S. producers of radar and certain radio apparatus have established regional sales offices in the United States and foreign countries through which dealers, distributors, and other authorized representatives make products available to consumers. In the United States, these affiliated representatives are supplemented and supported by the company's direct work force. Several major producers depend heavily upon sales established through contracts with the DOD and other U.S. Federal agencies. Although U.S.-affiliated dealers and distributors abroad generally carry one or more product lines, selling by these dealers may be limited to a particular country or portion of a country. Dealers and distributors may provide product maintenance (including warranty and nonwarranty repairs) through company personnel or

[26] USITC staff interviews with industry representatives, Long Beach, CA, Apr. 1995.

factory-trained third party representatives. These companies also may grant exclusive rights to selected representatives as a means of marketing certain products within a particular country.[27]

Trade fairs have become one of the most effective strategies used by U.S. producers to enhance marketing and distribution efforts in the United States and abroad. These occasions provide opportunities to display and demonstrate products before prospective purchasers, which may ultimately lead to sales arrangements.

Research and Development Expenditures

Research and development programs are essential for companies engaged in manufacturing radar and certain radio apparatus. Due to the highly technical nature of these products and their relatively quick obsolescence, the ratio of research and development expenditures to revenues remains large, as producers seek to maintain state-of-art technology to enhance market position.[28] The importance of research and product development is reflected in the $12 billion capital outlay by the DOD to perfect the GPS.[29] Although U.S. producers' capital expenditures for all types of search and navigation equipment declined from $830 million in 1991 to $812 million in 1992,[30] capital expenditures for GPS products reportedly remained relatively stable during the period. New capital expenditures for search and navigation equipment during 1993-95 are not available; however, industry representatives state that research and development expenditures increased to an estimated $850 million during most of the latter 3-year period.[31]

New Technologies

GPS product innovations represented some of the most significant technological developments within the radar and certain radio apparatus industry during 1991-95. One development that garnered substantial attention is the in-vehicle or mobile navigation system. This system utilizes advanced GPS technology for precise automotive navigation, which includes detailed digital moving maps and a "yellow pages directory" of instantly accessible travel information concerning restaurants, hotels, entertainment, and shopping.[32] With respect to developments in aviation, several major U.S. airlines, the Air Transport Association, United Parcel Service, and the FAA have staged major demonstrations of GPS

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[27] USITC staff telephone interview with industry representative, May 1995.

[28] USITC staff interviews with industry representatives, Los Angeles, CA, Apr. 1995.

[29] "GPS - A Global Navigation System Everyone Can Use," *GPS, A Guide to the Next Utility, Trimble Navigation*, 1989, p. 7.

[30] U.S. Department of Commerce, *1992 Census of Manufactures*.

[31] USITC staff telephone interview with industry representative, May 1995.

[32] "The Art of In-Vehicle Navigation," *Supplement to Engineering News-Record*, Nov. 28, 1994, p. 6.

automatic landings or zero-visibility landing systems (including touchdowns) for aircraft.[33] In addition, the use of GPS is thought by many to be the best and least expensive way to design a fool-proof air collision avoidance system. The accuracy of GPS technology also enhances the navigation and tracking of remote-controlled aircraft used for reconnaissance and delivery of payloads.

With respect to innovations regarding radar, Collins Avionics received FAA certification for its weather radar with forward-looking windshear detection.[34] This system issues visual and aural alerts of windshear events up to 90 seconds ahead of the aircraft. Flight demonstrations also are being conducted to perfect an Autonomous Precision Approach and Landing System (APALS) that allows aircraft landings without the aid of a ground navigation system. The APALS system provides precision approach guidance by correlating radar data received within the aircraft with radar landmark data stored on board the aircraft.[35] In another technical development, the National Aeronautics and Space Administration has asked the National Academy of Sciences to recommend the next step in developing a space-based radar monitor of the earth.[36] The Academy is aiming to determine the potential for combining international efforts into a joint project to orbit a highly capable space radar system.[37] The Massachusetts Institute of Technology has developed an unmanned radar-equipped aerial vehicle that is capable of differentiating between moving trucks, tanks, and helicopters in inclement weather.

Another important product innovation involves a hand-held remote controlled apparatus used to control large and powerful cranes from the floor of the workplace.[38] The use of this system provides a new measure of safety to the worker on the floor by eliminating accidents caused by the misinterpretation of hand signals delivered from the floor to the cab of the crane.

Pricing

U.S. producers of radar and certain radio apparatus publish price lists that offer various discounts to purchasers, depending on the size of the order and the payment terms. Advertising promotions and price concessions, which have been a standard practice in the domestic industry, are being offered on a more frequent basis in light of increasing domestic and foreign competition.[39] The prices of these navigational products vary, depending on effective range of products, accuracy, style, finish, raw material quality, warranties offered, and other factors. In assessing the impact of domestic and foreign competition on prices, a

[33] *Aviation Week & Space Technology*, Oct. 10, 1994, pp. 28-29.

[34] "Radar With Windshear Warning is Certified by Collins Avionics," *Aviation International News*, Aug. 1, 1995, p. 48.

[35] *Aviation Week & Space Technology*, Oct. 17, 1994, p. 51.

[36] Ibid, pp. 57-58.

[37] Ibid.

[38] *Material Handling Engineering*, Apr. 1995, pp. 74-76.

[39] Information obtained from industry representative, Aug. 23, 1995.

major producer of GPS products asserted that prices of certain GPS products declined substantially due to these industry competitive pressures.[40] Other producers of these products also have alluded to declining prices and have expressed that reductions in prices are likely to continue as competition within the GPS industry grows.[41]

Globalization

U.S. producers of the radar and certain radio apparatus industry are strengthening their marketing and export capabilities by expanding sales and distribution operations in selected countries, especially in light of reduced spending by the DOD. Examples of these expansions are reflected in the operations of the following major U.S. producers of radar and certain radio apparatus: Trimble Navigation (a leading manufacturer of GPS products with 36 percent of the $420 million world market in 1994) opened sales and distribution offices in Japan and Singapore in 1993, and additional offices in the People's Republic of China, Russia, and Egypt in 1994. In addition to its seven regional sales offices in the United States, Trimble also has offices in Europe, Australia, and New Zealand.[42] Being a major producer of radar and other navigation products, Texas Instruments Inc. established a joint venture with Kobe Steel of Nishiwaki, Japan, to produce semiconductors. Allied-Signal Aerospace entered a joint venture with Shimadzu Corp. of Japan's Mitsubishi Group. As a major manufacturer of precision equipment, Shimadzu will become the primary partner for overseeing the manufacture and marketing of Allied's aviation and aerospace equipment in Japan. The joint business venture was prompted by poor business performance in aviation and related industries resulting from cuts in the post Cold War defense budget and the slump in U.S. and international airline industries.[43]

In recent years Russia has sought modern avionics equipment employing Western technology. Several Russian avionics research and development centers have sought alliances with U.S. companies in international cooperative programs. In 1994, Allied-Signal, Inc. entered a joint venture with the National Institute of Airborne Equipment in Russia. Under this business venture, Allied will provide avionics to the commercial air-transport market. Under separate business ventures, Honeywell Inc., Litton Industries, and Rockwell Collins entered into agreements with Russian firms. Both Honeywell Inc. and Litton Industries will supply inertial reference units, whereas Rockwell Collins will provide digital flight management systems.[44]

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[40] *Annual Report Pursuant to the Securities Exchange Act of 1934 (Form 10-K),* Trimble Navigation Limited, Dec. 31, 1994, p. 19.

[41] USITC staff interview with industry representatives, Sunnyvale, CA, Apr. 1995.

[42] *Annual Report Pursuant to the Securities Exchange Act of 1934 (Form 10-K),* Trimble Navigation Limited, Dec. 31, 1994, p. 19.

[43] *Pacific Rim Economic Review,* July 13, 1994, p. 3.

[44] "Russia - Avionics Market Profile," U.S. Department of Commerce, *International Trade Administration, Market Research Reports (ITA),* June 2, 1995.

Government Programs

The *Institute of Navigation Corporate Membership Directory* lists several U.S. Government agencies that have implemented programs designed to oversee and enhance radio navigation systems. The DOT directs formulation of U.S. policy and planning for air, land, marine, and space navigation systems provided by the Federal Government. The DOT program manager (in conjunction with an advisor of the United States Coast Guard) coordinates radio navigation activities with the DOD, the Coast Guard, the FAA, the Maritime Administration, the Saint Lawrence Seaway Development Corporation, the Federal Highway Administration, the Federal Railroad Administration, the Federal Transit Administration, and the National Highway Traffic Safety Administration.

As creator of the GPS, the DOD is aware of tactical advantages hostile forces may gain by using the system's precise navigation data. Therefore, the DOD has implemented an operational program known as "selective availability," which allows the DOD to degrade the accuracy of GPS signals. Under this program, the accuracy of signals can be degraded to such an extent that the most precise signals emitted from the satellite can be read only by using specially designed GPS receivers. The degraded signals or "standard positioning service," which is available to any worldwide user on a continuous basis, have a horizonal positioning accuracy of 100 meters. The unaltered signals or "precise positioning service," which is reserved for U.S. and allied military and government users, provide a horizonal positioning accuracy of 21 meters.[45]

Mergers and Acquisitions

The radar and certain radio apparatus industry is undergoing a period of restructuring as the DOD downsizes and reduces spending. To a large extent, the restructuring of the industry has taken the form of mergers and acquisitions. A few examples of the mergers and acquisitions include the following: Prior to its merger with Lockheed, Martin Marietta Corp. acquired General Electric's defense electronics operations, which made Martin Marietta the world's largest supplier of radar and satellite technology. Hughes Aircraft broadened its product and marketing base by acquiring the Tomahawk missile operations from General Dynamics. Allied-Signal Inc. acquired Sundstrand Data Control in 1993. Sundstrand manufactures a variety of avionics products for data management, ground hazard avoidance,

[45] The President of the United States has approved a comprehensive national policy on the future management and use of the GPS and related U.S. Government augmentations. The policy stipulates that "selective availability" will be discontinued within a decade in a manner that allows adequate time and resources for military forces to prepare fully for operations without "selective availability." See "U.S. Global Positioning Policy," *The White House Fact Sheet*, Mar. 29, 1996.

general aviation communications, and navigation and instrumentation.[46] On December 28, 1994, Orbital Sciences Corp. acquired the Magellan Corp. in a transaction described as a "pooling of interests." As a result of this transaction, Orbital now manufactures, markets, and sells satellite-based navigation equipment for worldwide consumer and industrial markets and has expanded its GPS satellite-based navigation applications.[47]

Consumer Characteristics and Factors Affecting Demand

Radar and certain radio apparatus are generally sold to the following types of consumers: The DOD (aircraft, ships, guided missiles, weapons systems, and other military applications); original equipment manufacturers (automotive, aircraft, boat, and ship manufacturers); law enforcement agencies; weather forecasters; and wholesale and retail outlets. Since the DOD is the largest consumer of radar and certain radio apparatus, the extent to which these products are used in military applications has a significant impact on product demand.[48] The $27 billion reduction in procurement by the DOD during 1991-95 lessened demand for radar and certain radio apparatus during the period. In an effort to alleviate the effects of the reduced spending, an Advanced Research Project Agency program (ARPA) was designed by the DOD to integrate leading edge navigational technologies into the civilian or commercial sectors. Although this program has served to reduce the impact of budget restraints on DOD contractors, U.S. producers of radar and certain radio apparatus also are increasing promotional efforts designed to increase civilian consumers' demand for boats, aircraft, and other products utilizing navigational equipment.

FOREIGN INDUSTRY PROFILE

The world's largest producers of radar and certain radio apparatus (outside of the United States) are in France, Germany, the United Kingdom, and Japan. Other major producers are in Canada, Italy, Norway, Switzerland, and Korea. Although production of navigation apparatus in each of these countries is dominated by a few large producers whose output generally includes several different navigational products, there are numerous smaller companies that usually specialize in a single product or manufacture navigational apparatus for a specific customer's specifications.[49] Depressed demand conditions that were experienced by these foreign producers during 1991-95 reflected conditions that also existed

[46] Allied-Signal Inc., *Annual Report (Form 10-K)*, Dec. 31, 1994.

[47] Orbital Sciences Corp., *Annual Report (Form 10-K)*, Dec. 31, 1994.

[48] U.S. industry representatives estimated that sales to the DOD represented about 75 percent of total U.S. sales of radar and certain radio apparatus in 1995.

[49] USITC staff telephone interview with industry representative, July 28, 1995.

in the United States during the period.[50] In addition to these adverse demand conditions, new forms of organization and management are being introduced by foreign producers to enhance automation and manufacture products faster, less expensively, and more efficiently.[51] This has encouraged stronger competition within the industry.

U.S. producers' technological leadership and strict adherence to quality standards are universally recognized.[52] Therefore, the preponderance of competition encountered by foreign producers stems primarily from products made in the United States. In addition, the dollar's depreciation during most of 1991-95 relative to currencies in the EU resulted in U.S.-made products being less expensive to European consumers.[53]

Major foreign producers continue to expand export efforts in Europe, Asia, South America, and other regions/countries with developing avionics or aerospace industries. In addition, the intense competition has resulted in restructuring and consolidation of companies. For example, the French company Thompson-CSF acquired Wilcox Electric from U.S.-owned Northrop Corp. to increase sales of air traffic control equipment.[54] Thompson-CSF also teamed with Siemens Plessey Systems (a German company) to participate in the Eurocontrol Program, which is a 54-nation European organization attempting to harmonize air-traffic-control standards.[55] The Japanese firm Furuno is a principal competitor in France, accounting for 30 percent of the market for electronic navigation instruments. Sixty-five percent of Furuno's production originates in Japan; the remaining 35 percent is imported from Italy, Norway, and the United States.[56] The French-British Matra Marconi Space Co. (FBMM) has acquired British Aerospace Systems, making FBMM Europe's largest space company with annual sales of about US$1.1 billion.[57]

Reduced spending by the military also encouraged foreign manufacturers to diversify increasingly into commercial activities during 1991-95. However, this marketing strategy resulted in greater pressure being put on the commercial sector, which also was suffering the adverse effects of reduced consumer demand.

With respect to new product innovations abroad, GPS products have been developed to such an extent that foreign civilian and military consumers are searching for products that are more compact and have good quality/price ratios.[58] In France, Germany, Italy, and Japan, new markets utilizing the GPS have emerged. One such market involves the on-board automotive navigation system, which relies upon satellites for the geographical locations of

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[50] Ibid.
[51] Ibid.
[52] Ibid.
[53] Ibid.
[54] "Search and Navigation Equipment," U.S. Department of Commerce, *U.S. Industrial Outlook 1994*, (Washington, DC: GPO, 1994) Chapter 30, p. 23.
[55] Ibid.
[56] "France - Navigation Instruments for Pleasure Boats," *U.S. Department of Commerce, ITA, Market Research Reports,* Dec. 26, 1994.
[57] *Aviation Week & Space Technology*, July 25, 1994, p. 26.
[58] "France - Navigation Instruments for Pleasure Boats," *U.S. Department of Commerce, ITA Market Research Reports,* Dec. 26, 1994.

vehicles and directs the driver to a pre-selected destination by use of an onboard computer.[59] The GPS also has mapping capabilities that provide the driver with information regarding one-way streets, traffic congestion, and road construction. The cost of GPS products varies among countries, depending on the level of sophistication. In France, for example, the cost of installing an on-board automotive system may range between US$500 and US$4,000.[60]

With respect to Canada and Mexico, the economic factors that adversely affected demand in the United States and other countries during 1991-95, were also experienced in these countries. In Canada, total aerospace sales declined by about 6 percent during 1991-92 (from US$2.06 billion to US$1.94 billion).[61] According to Canadian industry and government officials, aerospace sales did not experience significant growth during 1993-95.[62] In 1992, radar and certain radio apparatus accounted for approximately 55 percent of the US$2 billion aerospace market in Canada.[63] Of the eight large firms that currently dominate the Canadian aerospace industry, four are U.S. subsidiaries.[64] Both U.S. and Canadian firms sell primarily to the Federal Government (i.e., Canada's Department of Defense and Transport).

For U.S. producers of radar and certain radio apparatus, the border between the United States and Canada is transparent, i.e., there are no obvious barriers confronting products of U.S. origin. Access to Canada's procurement for aerospace products is guaranteed to U.S. producers by the General Agreement on Tariffs and Trade (GATT) and the North American Free-Trade Agreement (NAFTA), as well as several other agreements.[65] In general, Canada has adopted the same standards for products used in commercial and military aviation as those adopted by the United States.[66]

Mexico has no indigenous aerospace industry; therefore, it is dependent on foreign producers (including U.S. producers) for radar and certain radio apparatus.[67] Mexico is already an important export market for U.S. producers. The NAFTA is expected to have a beneficial impact on trade between the United States and Mexico in these products, since tariffs and other barriers to trade within these countries will be eliminated.

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[59] Information obtained from industry representatives, Apr. 1995.

[60] Ibid.

[61] Sales data for 1993-95 are not available.

[62] "Canada - Avionics and Airport Ground Equipment," *U.S. Department of Commerce, ITA, Market Research Reports*, June 2, 1995.

[63] Ibid.

[64] Ibid.

[65] "Canada - Avionics and Airport Ground Equipment," *U.S. Department of Commerce, ITA, Market Research Reports,* June 2, 1995.

[66] Ibid.

[67] "The Aerospace Industry In Mexico," *U.S. Department of Commerce, ITA, Market Research Report*, June 2, 1995.

U.S. TRADE MEASURES

Tariff Measures

Table 2 shows column-1 rates of duty, as of January 1, 1996, for the articles included in this summary (including both general and special rates of duty) and U.S. exports and imports for 1995.[68] The criteria used to classify the articles are set forth in the *General Rules of Interpretation of the Harmonized Tariff Schedule of the United States (HTS).*

The NAFTA, as implemented by the North American Free-Trade Agreement Implementation Act (Public Law 103-182, approved Dec. 8, 1993), provided for the elimination of U.S. duties, effective January 1, 1994, on radar and certain radio apparatus imported from Mexico. Mexico also eliminated duties on these apparatus from the United States on January 1, 1994. The summary apparatus also are eligible for duty-free treatment under the Generalized System of Preferences (GSP), the Caribbean Basin Economic Recovery Act (CBERA), United States-Israel Free-Trade Implementation Act of 1985, and the Andean Trade Preference Act (ATPA). In addition, navigational apparatus are eligible for duty-free treatment under the Agreement on Trade in Civil Aircraft.

The current column 1-general rate of duty for radar and certain radio apparatus ranges from 2.9 percent to 4.9 percent. Approximately 5 percent of total U.S. imports entered the United States duty-free under the combined programs mentioned above.

Nontariff Measures

There are no known nontariff measures imposed by the United States that significantly influence trade of radar and certain radio apparatus.

[68] See app. A for an explanation of tariff and trade agreement terms.

Table 2
Radar and certain radio apparatus: *Harmonized Tariff Schedule* subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1996; U.S. exports, 1995; and U.S. imports, 1995

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1996 General	Special[1]	U.S. exports, 1995	U.S. imports, 1995
				----*Thousand dollars*----	
8526.10.00	Radar apparatus	2.9%	Free (A,C,CA, E,IL,J,MX)	333,437	74,261
8526.91.00	Radio navigational aid apparatus	2.9%	Free (A,C,CA,E,IL,J,MX)	214,500	125,161
8526.92.00	Radio remote control apparatus	4.9%	Free (A,C,CA,E,IL,J,MX)	66,367	110,037
8529.10.40	Antennas and antenna reflectors, and parts suitable for use therewith, all the foregoing for radar, radio navigational aid and radio remote control	3.9%	Free (A,C,CA,E,IL,J,MX)	117,910	131,405
8529.90.16	Radar, radio navigational aid or radio remote control printed circuit assemblies and subassemblies, consisting of two or more parts or pieces fastened or joined together	4.2%	Free (A,C,CA,E,IL,J,MX)	172,429[2]	27,482
8529.90.19	Other printed circuit assemblies for radar, radio navigational aid or radio remote control	4.2%	Free (A,CA,E,IL,J,MX)	69,903[2]	6,751
8529.90.26	Transceiver assemblies for the apparatus of subheading 8526.10, other than printed circuit assemblies	4.2%	Free (A,C,CA,E,IL,J,MX)	[3]	4,142
8529.90.73	Parts of printed circuit assemblies, of radar, radio navigational aid or radio remote control apparatus	4.2%	Free (A,CA,E,IL,J,MX)	46,602[2]	5,283
8529.90.95	Radar, radio navigational aid or radio remote control assemblies and subassemblies, consisting of two or more parts or pieces fastened or joined together	4.2%	Free (A,C,CA,E,IL,J,MX)	116,508[2]	8,705
8529.90.97	Other parts of radar, radio navigational aid or radio remote control apparatus, nesi	4.2%	Free (A,CA,E,IL,J,MX)	60,582[2]	28,858

[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 or A*); Automotive Products Trade Act (B); Agreement on Trade in Civil Aircraft (C); North American Free-Trade Agreement, goods of Canada (CA) and Mexico (MX); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL); and Andean Trade Preference Act (J).
[2] Based on USITC staff estimates of Schedule B number 8529.90.47.
[3] Less than $500.

Source: USITC, *Harmonized Tariff Schedule of the United States* (1996). Exports and imports compiled from official statistics of the U.S. Department of Commerce.

U.S. Government Trade-Related Investigations

On February 21, 1996, a complaint was filed with the USITC on behalf of Trimble Navigation of Sunnyvale, California alleging that certain global positioning system receivers manufactured by NovAtel Communications Ltd. of Canada were being imported into the United States in violation of section 337 of the Tariff Act of 1930. The complaint requested that the Commission institute an investigation and, after the investigation, issue a permanent exclusion order and a permanent cease and desist order. In response, the Commission instituted investigation No. 337-TA-386, *Certain Global Positioning System Coarse Acquisition Code Receivers And Products Containing Same*, to determine whether there is a violation of subsection (a)(1)(B) of section 337, and whether there exists an industry in the United States as required by subsection (a)(2) of section 337. The investigation was terminated in August 1996 on the basis of a settlement agreement.

FOREIGN TRADE MEASURES

Tariff Measures

The principal trading partners of the United States impose rates of duty on radar and certain radio apparatus that are generally higher than U.S. rates levied on comparable products. The differences in these rates of duty are shown in the tabulation below:

Country/region	1995 ad valorem tariff rate[1]
	Percent
United States	2.9-4.9
Korea	8.0
China	3-9
Japan	Free-5.2
Canada	9.2-9.5
Mexico	10-15
European Union	Free-5.7

[1] With the exception of the United States, tariff rates for 1996 are not available for the countries shown.

Source: Bulletin International, Douanes, International Customs Tariffs Bureau.

Nontariff Measures

Although radar and certain radio apparatus manufactured in the United States maintain a high degree of demand and a long tradition of acceptance in global markets, there are several nontariff measures that are of concern to U.S. manufacturers. Members of the EU provide subsidies and other forms of assistance to their shipbuilding and repair industry,[69] which is a major consumer of radar and certain radio apparatus. This assistance has been in the form of subsidized restructuring of the EU shipbuilding industry, direct subsidies for operations and investment, indirect subsidies, home credit schemes, subsidized export credits, and practices associated with public ownership of shipyards.[70] U.S. industry representatives maintain that these subsidies create advantages for foreign firms by unfairly limiting the use of U.S.-made radar and certain radio apparatus in foreign shipping vessels.[71] Korea, Finland, Norway, and Japan reportedly provide subsidies and other forms of assistance to their shipbuilding industries.[72] Japan also provides various incentives to facilitate development of its aerospace industry, including government interest rate subsidies and preferential loans for the development and research of aircraft and engines.[73]

U.S. MARKET

Consumption

The United States is the world's largest market for radar and certain radio apparatus, however, reductions in spending by the DOD and other consumers curtailed U.S. demand for these products during 1991-95. U.S. apparent consumption totaled $7.1 billion in 1995, which was 8 percent less than consumption during 1991 (figure 3). U.S. imports accounted for roughly 6 percent of consumption throughout most of the 5-year period.

[69] "1996 National Trade Estimate Report on Foreign Trade Barriers," *Office of the United States Trade Representative,* p. 114.

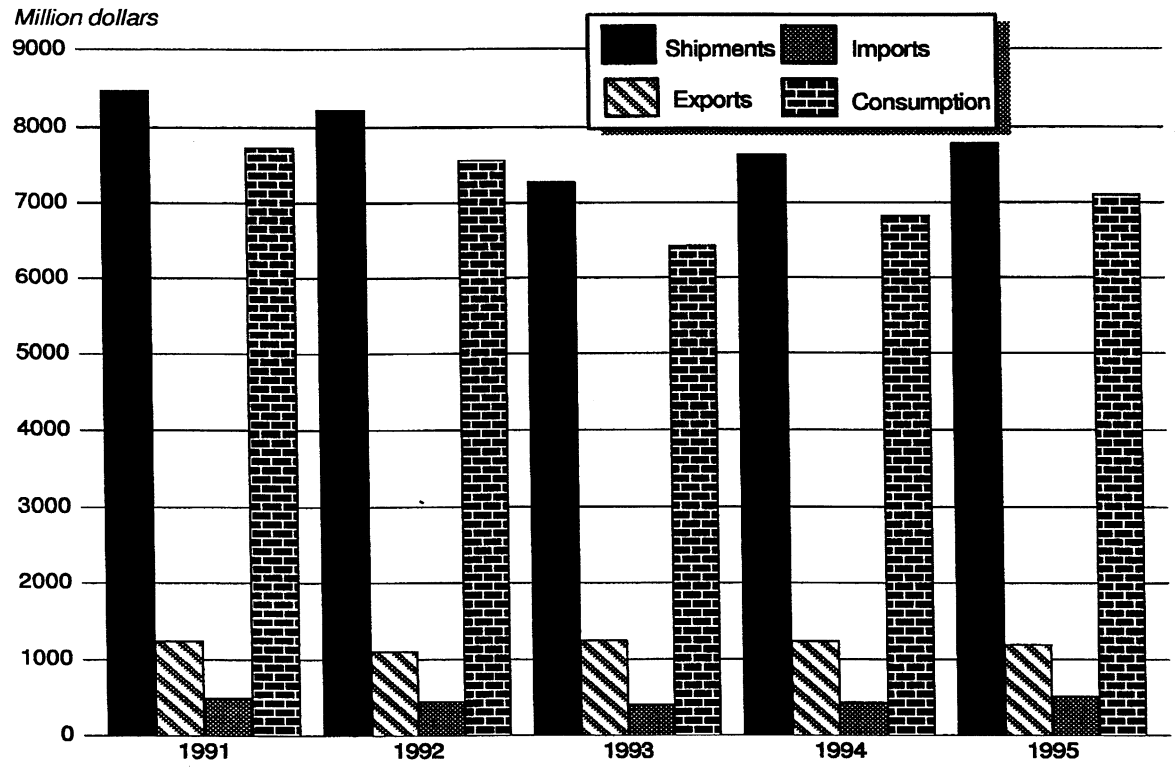
[70] Ibid.

[71] USITC staff telephone interview with industry representative, Aug. 9, 1995.

[72] Ibid.

[73] "1996 National Trade Estimate Report on Foreign Trade Barriers," *Office of the United States Trade Representative,* p. 198.

Figure 3
Radar and certain radio apparatus: U.S. producers' shipments, imports, exports, and apparent consumption, 1991-95



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

Approximately 80 percent of the navigational apparatus consumed during 1991-95 consisted of various types of navigational radar and tracking systems. U.S. consumption of radar and certain radio apparatus is largely influenced by demand for civilian and defense-related air and marine-craft.

Production

U.S. shipments of radar and certain radio apparatus fell by 14 percent to $7.3 billion during 1991-95, before increasing by 17 percent to $7.8 billion in 1995 (table 3). The increase in the value of shipments in 1995 largely reflected an increase in demand for the relatively higher-valued radar navigational apparatus and an increase in the production of GPS products. Approximately 80 percent of shipments during the 5-year period consisted of radar equipment used in flight navigation and tracking systems.

Table 3
Radar and certain radio apparatus: U.S. shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1991-95

Year	U.S. shipments[1]	U.S. exports	U.S. imports	Apparent U.S. consumption[1]	Ratio of imports to consumption[1]
	Million dollars				*Percent*
1991	8,479	1,244	496	7,731	6.4
1992	8,229	1,110	446	7,565	5.9
1993	7,275	1,248	408	6,435	6.3
1994	7,639	1,242	438	6,835	6.4
1995	7,786	1,198	522	7,110	7.3

[1] Estimated by the USITC staff from official statistics of the Bureau of the Census, U.S. Department of Commerce, Current Industrial Reports, MA38B, annual series.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Imports

Total U.S. imports fell by 18 percent to $408 million during 1991-93, before increasing by 28 percent to $522 million during 1993-95 (table 4). Canada was the largest supplier of radar and certain radio apparatus to the U.S. market during most of the 5-year period (representing 24 percent of total imports in 1995), followed by Japan (17 percent), Taiwan and Israel (13 percent each), and Singapore (7 percent) (figure 4). Radar used in flight navigation and tracking applications represented approximately 65 percent of total U.S. imports during 1995.

U.S. imports entering the United States under the production sharing provision[74] subheading 9802.00.80 of the *HTS* totaled $20 million in 1995, and accounted for 4 percent of total U.S. imports. Mexico and Canada were the largest suppliers of imports entering under this special subheading. In 1995, these two countries collectively accounted for approximately 90 percent of both total imports and products imported under the production sharing subheading.

[74] Under subheading 9802.00.80 of the *HTS*, U.S. firms pay no duty on the value of U.S.-made components contained in the assembled navigational products when they are imported into the United States after being assembled abroad.

Table 4
Radar and certain radio apparatus: U.S. imports for consumption, by principal sources, 1991-95

(1,000 dollars)

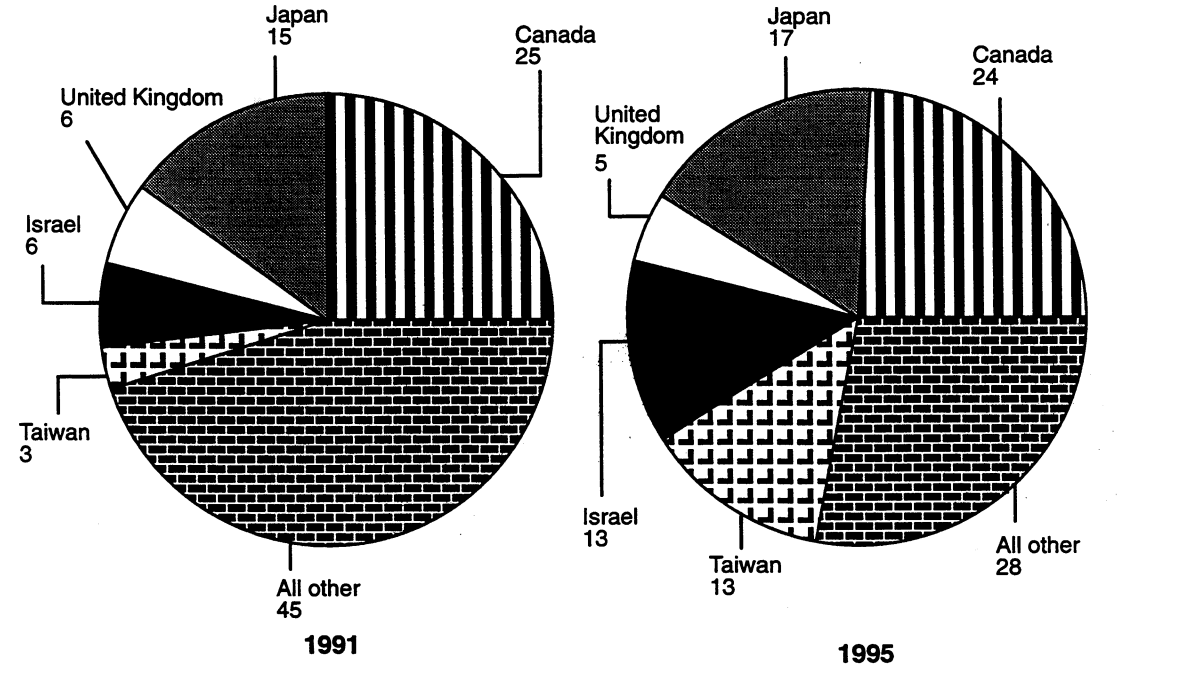
Source	1991	1992	1993	1994	1995
Canada	123,726	118,134	98,510	97,381	126,884
Japan	74,785	75,514	89,797	121,210	89,007
Taiwan	16,194	36,034	36,984	45,640	67,876
Israel	30,410	24,992	23,554	31,726	65,887
Singapore	14,288	18,684	19,955	26,620	36,191
United Kingdom	30,655	37,146	29,064	23,421	29,033
Mexico	28,241	31,079	12,220	13,945	26,218
Sweden	12,317	9,234	9,309	9,259	23,863
China	2,227	7,824	13,346	13,663	14,093
France	19,046	7,547	13,660	9,691	8,486
South Korea	38,354	13,539	8,754	9,411	6,659
Denmark	10,505	7,397	6,046	4,275	5,795
All other	95,736	58,772	47,256	31,510	22,092
Total	496,484	445,894	408,455	437,752	522,085

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

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

Figure 4
Radar and certain radio apparatus: U.S. imports from leading sources, by share of total, 1991 and 1995

(Percent)



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

FOREIGN MARKETS

Foreign Market Profile

The European Union (EU) is the largest foreign market for radar and certain radio apparatus. The slump in civilian demand for navigational products during 1991-95, which coincided with significant reductions in military orders, generated a downturn in EU production. Due to the wide acceptance and reliance on U.S.-made high-quality products, however, the United States continued to be the principal source of EU imports of navigational apparatus. The relationship between EU and U.S. producers in many instances is a mix of cooperation and competition. Collaboration often exists during product research and development. Although U.S. producers generally maintain an edge in advanced technology, product quality, and price competitiveness, intense competition takes place in both civilian and military markets.[75]

Japan is the largest market in Asia for radar and certain radio apparatus. Markets in Korea, Taiwan, and other Asian countries are expected to grow as these countries expand their aerospace navigation systems and update them with high-technology equipment.[76] Since U.S. firms are major world producers and exporters of high-tech navigational products, U.S. producers may benefit through increased export sales to these countries.

The Russian aerospace industry, which is one of the largest in the world, has the potential to become a major global supplier of navigation apparatus.[77] The Russian industry, however, is handicapped by organizational problems and limited access to capital, which have hindered its ability to develop and market many of the high-technology products available from U.S. and EU suppliers.

U.S. Exports

Exports have become increasingly important to U.S. producers of radar and certain radio apparatus, accounting for between 13 percent and 17 percent of producers' annual shipments during 1991-95. However, the depressed demand conditions experienced in the principal export markets during 1991-95 resulted in virtually no growth in U.S. exports, which remained at about $1.2 billion throughout the period (table 5). Although U.S. exports to the United Kingdom, Saudi Arabia, Korea, and Mexico (which accounted for a combined 31

[75] USITC staff telephone interview with industry representative, Aug. 1995.
[76] Ibid.
[77] "Panorama of EU Industry," *European Commission*, 1994, pp. 11-48.

Table 5
Radar and certain radio apparatus: U.S. exports of domestic merchandise, by principal markets, 1991-95

(1,000 dollars)

Market	1991	1992	1993	1994	1995
Japan	208,763	192,176	175,138	181,373	152,483
Saudi Arabia	31,563	5,980	55,747	47,309	123,781
South Korea	62,046	43,164	45,947	70,913	103,724
United Kingdom	89,521	49,274	52,655	87,662	103,387
Canada	106,030	66,898	107,314	60,841	96,962
Germany	51,686	61,116	106,856	68,309	52,554
Taiwan	64,428	67,639	104,358	79,028	46,822
Israel	51,099	66,501	101,268	84,519	42,836
Italy	29,567	22,302	38,760	23,546	42,143
Mexico	23,817	26,137	8,528	14,198	37,171
France	48,865	49,423	40,878	45,968	30,774
Turkey	27,280	38,718	103,285	194,106	27,876
All other	449,360	421,207	307,875	284,375	337,724
Total	1,244,026	1,110,536	1,248,610	1,242,147	1,198,238

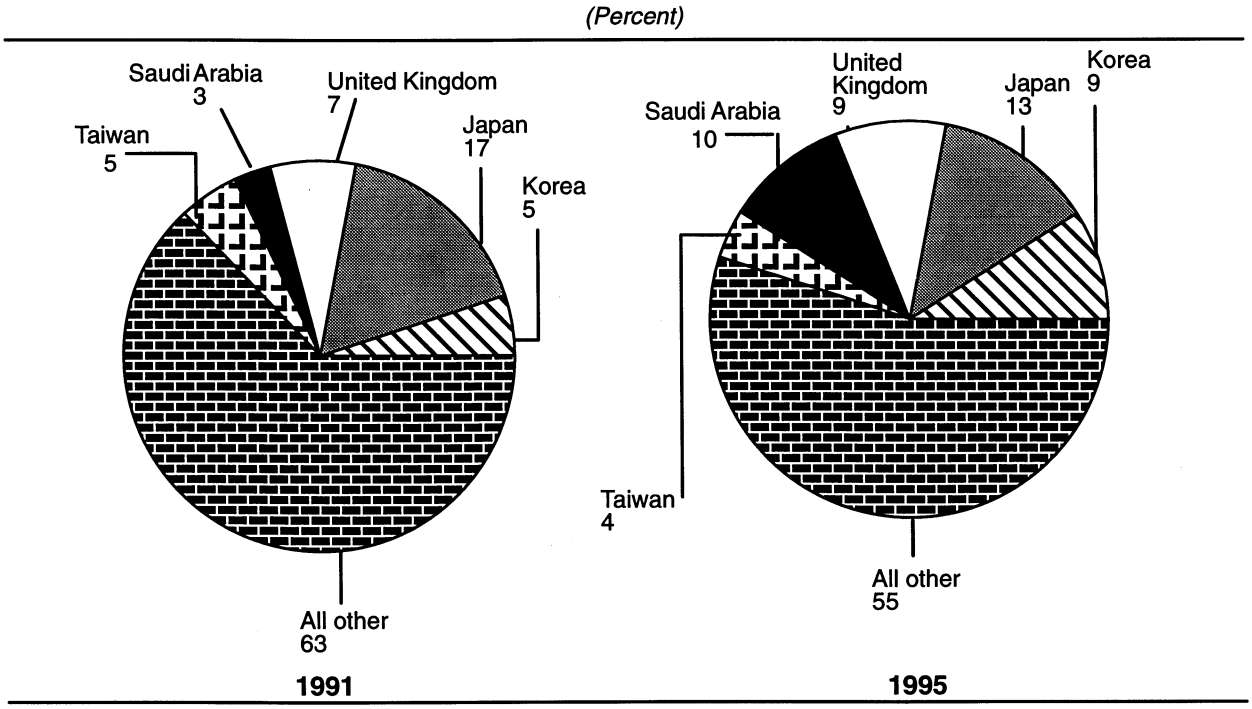
Note.--Because of rounding, figures may not add to the totals shown.
Source: Compiled from official statistics of the U.S. Department of Commerce.

percent of total exports in 1995) recorded increases during the period, the increases were dampened by export declines to Japan, Canada, Taiwan, and Israel (the combined exports to these countries represented 28 percent of total exports in 1995). Exports to Japan, the largest export market in 1995, accounted for 13 percent of total exports, followed by Saudi Arabia (10 percent), Korea (9 percent), and the United Kingdom (8 percent) (figure 5). These exports consisted largely of radar apparatus used in navigational applications.

There are several international developments that should have a positive impact on U.S. producers' exports. These include the modernization of developing countries' aerospace systems, the relaxation of U.S. export control regulations for U.S. exports to the former Soviet Union and countries of Eastern Europe, and the procurement of radar and certain radio apparatus under the NATO infrastructure program initiated in 1993.[78]

[78] U.S. Department of Commerce, *"Search and Navigation Equipment,"* U.S. Industrial Outlook 1994, (Washington, DC: GPO, 1994) p. 30-23.

Figure 5
Radar and certain radio apparatus: U.S. exports to principal markets, by share of total, 1991 and 1995



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

U.S. TRADE BALANCE

The U.S. trade balance in radar and certain radio apparatus declined during 1991-95, largely because of a lack of significant growth in U.S. exports during the period. The United States had negative trade flows with Canada, Taiwan, Israel, and Singapore (table 6). The negative U.S. bilateral trade balance with Canada (the largest negative trade flow) increased from $18 million to $30 million during the 5-year period. The balance with Israel shifted from a $21-million surplus to a $23-million deficit, that with Singapore shifted from a $15-million surplus to a $23-million deficit, and that with Taiwan shifted from a $48-million surplus to a $21-million deficit. The overall U.S. trade surplus in these products recorded a 10-percent decline over the 5-year period, falling from $748 million in 1991 to $676 million in 1995 (figure 6).

Table 6

Radar and certain radio apparatus: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1991-95[1]

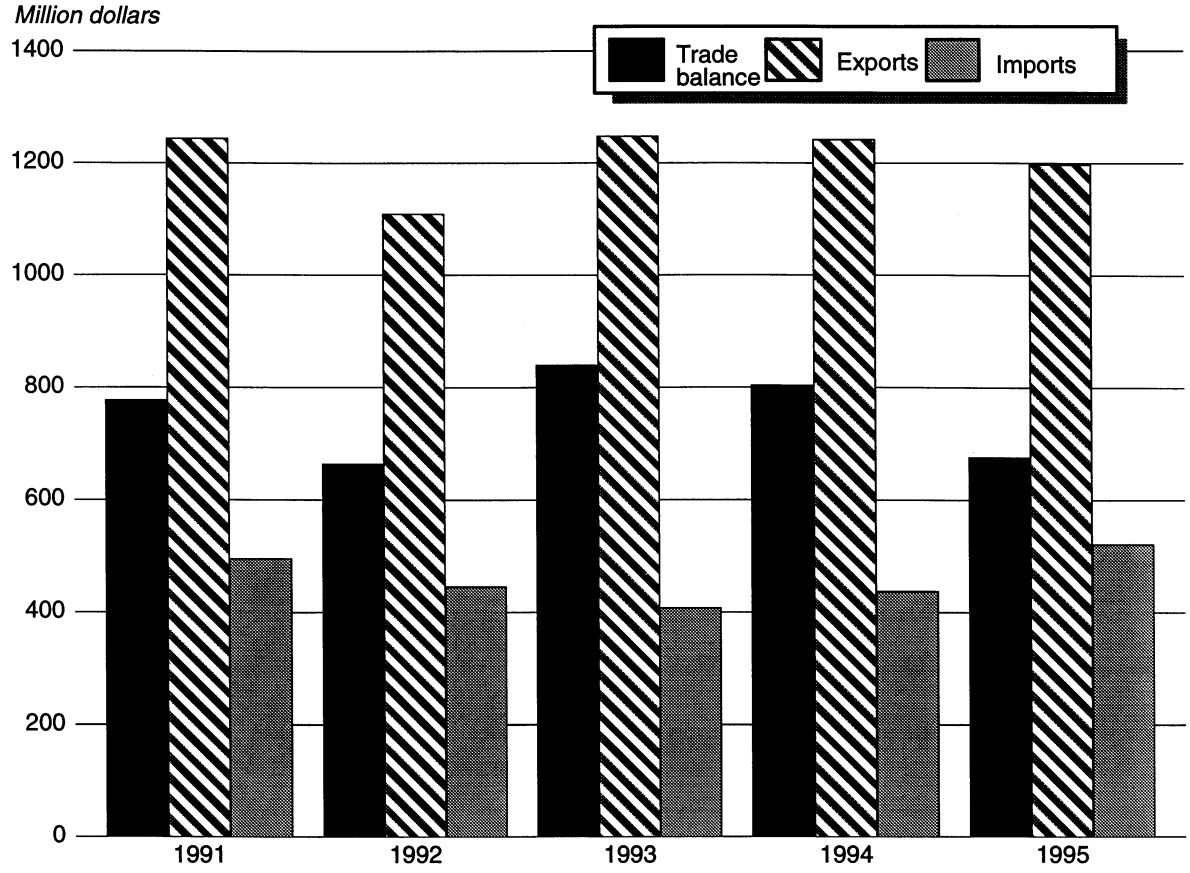
(Million dollars)

Item	1991	1992	1993	1994	1995
U.S. exports of domestic merchandise:					
Japan	209	192	175	181	152
Canada	106	67	107	61	97
United Kingdom	90	49	53	88	103
Saudi Arabia	32	6	56	47	124
Taiwan	64	68	104	79	47
Korea	62	43	46	71	104
Israel	51	67	101	85	43
Mexico	24	26	9	14	37
Germany	52	61	107	68	53
Singapore	29	11	21	56	13
All other	26	521	470	492	426
Total	1,244	1,111	1,249	1,242	1,198
EU-15	350	293	329	280	314
OPEC	59	27	76	72	163
ASEAN	42	30	36	79	41
CBERA	12	12	6	2	6
Eastern Europe	13	51	2	9	21
U.S. imports for consumption:					
Japan	75	76	90	121	89
Canada	124	118	99	97	127
United Kingdom	31	37	29	23	29
Saudi Arabia	0	2	0	0	1
Taiwan	16	36	37	46	68
Korea	38	14	9	9	7
Israel	30	25	24	32	66
Mexico	28	31	12	14	26
Germany	24	14	10	4	5
Singapore	14	19	20	27	36
All other	116	74	80	64	69
Total	496	446	408	438	522
EU-15	150	98	90	62	79
OPEC	0	2	0	0	1
ASEAN	15	19	25	31	38
CBERA	0	1	1	1	0
Eastern Europe	0	0	0	0	0
U.S. merchandise trade balance:					
Japan	134	116	85	60	63
Canada	-18	-51	8	-36	-30
United Kingdom	59	12	24	65	74
Saudi Arabia	32	4	56	47	123
Taiwan	48	32	67	33	-21
Korea	24	29	37	62	97
Isreal	21	42	77	53	-23
Mexico	-4	-5	-3	0	11
Germany	28	47	97	64	48
Singapore	15	-8	1	29	-23
All other	410	447	390	428	357
Total	748	665	841	804	676
EU-15	200	196	239	218	235
OPEC	59	25	76	72	163
ASEAN	27	11	11	48	3
CBERA	12	11	5	1	6
Eastern Europe	11	5	11	9	21

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

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

Figure 6
Radar and certain radio apparatus: U.S. imports, exports, and trade balance, 1991-95



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

APPENDIX A

EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

APPENDIX A
TARIFF AND TRADE AGREEMENT TERMS

In the ***Harmonized Tariff Schedule of the United States*** (HTS), chapters 1 through 97 cover all goods in trade and incorporate in the tariff nomenclature the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description. Subordinate 8-digit product subdivisions, either enacted by Congress or proclaimed by the President, allow more narrowly applicable duty rates; 10-digit administrative statistical reporting numbers provide data of national interest. Chapters 98 and 99 contain special U.S. classifications and temporary rate provisions, respectively. The HTS replaced the *Tariff Schedules of the United States* (TSUS) effective January 1, 1989.

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, Cuba, Kampuchea, Laos, North Korea, and Vietnam), which are subject to the statutory rates set forth in ***column 2***. 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 rate of duty 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.

Although the ***Generalized System of Preferences*** (GSP) expired at the close of July 31, 1995, provisions relating thereto continue to appear in the HTS pending possible Congressional renewal. The GSP afforded 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, applied to merchandise imported on or after January 1, 1976 and before the close of July 31, 1995. Indicated by the symbol "A" or "A*" in the special subcolumn, the GSP provided 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 rates 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 and implemented effective January 1, 1994 by Presidential Proclamation 6641 of December 15, 1993. Goods must originate in the NAFTA region under rules set forth in general note 12(t) and meet other requirements of the note and applicable regulations.

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.

Pursuant to the **Agreement on Textiles and Clothing** (ATC) of the GATT 1994, member countries are phasing out restrictions on imports under the prior "Arrangement Regarding International Trade in Textiles" (known as the **Multifiber Arrangement** (MFA)). Under the MFA, which was a departure from GATT 1947 provisions, importing and exporting countries negotiated bilateral agreements limiting textile and apparel shipments, and importing countries could take unilateral action in the absence or violation of an agreement.

Quantitative limits had been established on imported 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. The ATC establishes notification and safeguard procedures, along with other rules concerning the customs treatment of textile and apparel shipments, and calls for the eventual complete integration of this sector into the GATT 1994 over a ten-year period, or by Jan. 1, 2005.