TRENDS IN INTERNATIONAL TRADE IN PRINTED CIRCUIT BOARDS AND BASE MATERIAL LAMINATES

Report to the Subcommittee on Trade of the Committee on Ways and Means of the U.S. House of Representatives on Investigation No. 332-133 Under Section 332 of the Tariff Act of 1930

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UNITED STATES INTERNATIONAL TRADE COMMISSION

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Alfred E. Eckes, Chairman Paula Stern Veronica A. Haggart

Kenneth R. Mason, Secretary to the Commission

This report was prepared principally by Nelson J. Hogge, Machinery and Equipment Division Sharon Thompson, Energy and Chemicals Division

James Tsao, Office of Economics

Office of Industries Norris A. Lynch, Director

Address all communications to Office of the Secretary United States International Trade Commission Washington, D.C. 20436

Preface

On November 16, 1981, the Subcommittee on Trade, Committee on Ways and Means, U.S. House of Representatives, pursuant to section 332 of the Tariff Act of 1930, requested the U.S. International Trade Commission to conduct a study on trends in international trade in printed circuit boards and the base material laminates from which they are produced and the factors affecting the competitiveness of U.S. producers of such products. 1/ The Commission instituted investigation No. 332-133, Trends in International Trade in Printed Circuit Boards and Base Material Laminates, on December 10, 1981. Notice of the institution of the investigation was published in the <u>Federal Register</u> (46 F.R. 62348, Dec. 23, 1981). 2/ A public hearing was held in connection with the investigation in Washington, D.C., on May 5, 1982. Notice of the public hearing was published in the Federal Register (47 F.R. 4166, Jan. 28, 1982). 3/

Information contained in the report was collected from the Commission's questionnaire, fieldwork, statements provided at the public hearing, and from Government and public sources. Questionnaires were sent to the 44 largest domestic establishments producing circuit boards, which accounted for approximately 39 percent of total estimated U.S. production, and to all domestic producers of laminates.

1/ The request from the Subcommittee on Trade, Committee on Ways and Means, is reproduced in app. A.

2/ A copy of the notice of the Commission's investigation as it appeared in the Federal Register is reproduced in app. A.

3/A copy of the notice of the change in the Commission's public hearing as it appeared in the Federal Register is reproduced in app. A.

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Note.--The whole of the Commission's report to the Subcommittee on Trade of the Committee on Ways and Means may not be made public since it contains certain information that would result in the disclosure of the operations of individual concerns. This report is the same as the report to the Subcommittee except that the abovementioned information has been omitted. Such omissions are indicated by asterisks.

Executive Summary

Printed circuit boards are produced from dielectric materials called base material laminates and are used in electronic equipment for interconnecting components. A variety of dielectric materials are used in circuit board production with epoxy-glass materials being the type most often used.

The major findings of the investigation are summarized as follows:

1. U.S. industry

o The United States is the world's largest producer and consumer of printed circuit boards and the base material laminates from which they are made.

Printed circuit boards are produced by about 1,500 firms in the United States. A large number of these firms are small enterprises which support the electronics industry and which have increased in number as the electronics industry has expanded. However, only 19 firms produce laminates in the United States. As demand for laminates has increased, existing laminate producers have been able to expand capacity to serve the needs of the circuit board industry.

Total domestic production of circuit boards increased from an estimated 325 million boards in 1977 to 377 million boards in 1981. During the period, domestic production of base material laminates increased from 148 million square feet to 276 million square feet. Double-sided copper laminates made from epoxy-glass materials were the principal laminates produced. In the period, circuit board producers operated at 71 to 79 percent of capacity compared with 87 to 92 percent for the laminate industry.

During 1977-81, total U.S. shipments of circuit boards were estimated to have increased from \$1.3 billion to \$2.9 billion. Industry sources reported that captive shipments accounted for almost 50 percent of total U.S. shipments.

During the period, shipments of laminates rose from \$228 million to \$452 million, representing an increase of 98 percent. Captive shipments of laminates were insignificant during the period.

Apparent U.S. consumption of circuit boards increased from an estimated \$1.3 billion in 1977 to \$3.0 billion in 1981. The ratio of imports to consumption is estimated to have increased from 1.3 to 5.4 percent of consumption during the period. Apparent U.S. consumption of laminates was valued at \$207 million in 1977, increasing to \$338 million in 1981. Imports of laminates accounted for less than 3 percent of apparent consumption during the period. The growth in apparent consumption of circuit boards and laminates is directly related to the growth of the electronics industry.

o The computer industry is the largest market for printed circuit boards.

The largest domestic market for printed circuit boards is the computer industry which accounts for about 40 percent of U.S. shipments followed by the communications industry with 20 percent and the government/military sector with 13 percent. The largest remaining markets are the consumer and industrial product industries which account for 10 percent and 9 percent of U.S. shipments, respectively. Circuit boards produced from glass-based laminates were largely sold in the computer industry or incorporated into military electronics. Circuit boards produced from glass/paper-based laminates were sold in the consumer and industrial electronics industries. Paper-based laminate boards were reportedly sold almost entirely in the consumer electronics industry.

• Although employment, investment, and research and development increased in the circuit board and laminate industries during 1977-81, profit generally declined.

Industry sources estimate that a total of 30,000 production and related workers were employed in the circuit board industry in 1981 and were supported by 8,000 employees in sales, management, and operations. In 1977, about 23,000 production and related workers were employed in the industry and about 6,000 workers were employed in sales, management, and operations. Employment in establishments where laminates are produced increased from 4,464 persons in 1977 to 5,116 persons in 1981. Production and related workers producing laminates increased from 2,101 to 2,758 workers during the same period.

Printed circuit board producers responding to the Commission's questionniares reported an investment of \$373 million was made during 1977-81. About 73 percent of the investment was directed toward the purchase of new machines and equipment, and about 26 percent was directed toward improvement of facilities. Capital investment in the laminate industry during the period was much smaller, increasing from \$1.8 million to \$37.3 million. More than 80 percent of the investment in the laminate industry involved the purchase of new equipment and machinery. The remaining investment largely covered the construction of new buildings or for leasehold improvements.

Circuit board producers responding to the Commission's questionnaires reported that their research and development (R. & D.) expenditures increased from \$16 million to \$33 million during 1977-81. These expenditures represent large firms' share of R. & D. in the circuit board industry. It is believed that these expenditures approximate total R. & D. in the industry since little investment in R. & D. is made by small firms. R. & D. in the laminate industry was limited during the period, rising only from \$1.4 million to \$3.2 million, and was largely directed to the testing of new materials and machines.

Profit before taxes reported by circuit board producers increased from a median of 9.0 percent of sales in 1977 to 12.7 percent in 1980, and then decreased to a median of 7.5 percent in 1981 as competition in the industry increased. Profit was not reported by large captive producers of circuit boards since shipments of these firms are transferred at cost. Profit before taxes in the laminate industry was lower than that in the circuit board industry, decreasing from a median of 8.6 percent of sales in 1977 to a median of 3.0 percent of sales in 1981. Profit before taxes reported by producers

with large market shares was consistently higher than the median during the period.

U.S. firms produce circuit boards and laminates in foreign countries although foreign firms do not produce in the United States.

In 1977-81, printed circuit boards were produced by U.S. firms in Western Europe, Canada, Japan, and the Far East and incorporated into end products which these firms produce in these countries. However, a portion of the boards were exported to the United States for assembly into U.S.-produced end products. Laminates are produced abroad by four U.S. firms, principally in support of captive circuit board production in Europe and Japan. ***.

During 1977-81, a Japanese circuit board producer did establish a fabrication facility in the United States. However, the firm ceased operations in 1981 and sold its assets to a large U.S. producer.

o During 1977-81, prices of printed circuit boards generally decreased whereas prices of laminates increased.

Based on questionnaire responses, the weighted average price of circuit boards decreased from \$13.92 in 1977 to \$12.03 in 1981. Much of the decrease was accounted for by a general decline in the price of multilayer boards. In contrast, the weighted average price of laminates increased from \$1.50 per square foot in 1977 to \$1.78 per square foot in 1981. The average price of epoxy-glass-based laminates (more than 0.031 inch thick with double-sided copper), which accounts for more than 40 percent of domestic shipments, increased from \$2.05 per square foot to \$2.51 per square foot. Overall, laminate prices increased less than 5 percent each year during the period as competition in the industry supplying glass cloth and resins increased.

o During 1978-81, the United States had a negative balance of trade in printed circuit boards and a positive balance of trade in base material laminates.

Total U.S. imports of printed circuit boards increased from \$25 million in 1977 to \$162 million in 1981. Canada and Japan were the largest suppliers accounting for about 50 percent of imported value during the period. Much of the trade during 1977-81 was accounted for by U.S. producers of office machines and computers along with U.S. producers of toys, games, and other consumer electronic products, which imported circuit boards for incorporation into their domestic products. U.S. imports of laminates during the period reached a peak of *** million in 1979 having increased significantly over imports valued at *** in 1977. In 1981, imports of laminates decreased to ***percent of the 1979 level. Taiwan and Japan accounted for essentially all U.S. imports of laminates during the period. U.S. exports of circuit boards increased from \$40 million in 1978 to \$125 million in 1981. 1/ The principal export destinations were Mexico and Canada. Circuit boards exported to Mexico went primarily to U.S. assembly plants located there. Exports of laminates increased steadily during 1977-81, rising from \$23 million to \$67 million. Principal foreign markets for laminates were those in Western Europe and Canada.

The U.S. negative balance of trade in printed circuit boards decreased from \$5 million in 1978 to \$3.8 million in 1979. Due to a surge in imports by *** the negative trade balance in 1981 increased to \$37 million, or about 9 times what it is was in 1979. The balance of trade in laminates on the other hand remained positive during 1977-81, increasing from *** million in 1977 to *** million in 1981.

2. Japanese industry

o The Japanese circuit board industry is more vertically integrated than the U.S. industry and is growing at a faster rate.

Principal producers of circuit boards in Japan are the large endproduct firms which produce circuit boards for internal use. Circuit board shipments of these firms grew at a 25-percent annual rate during 1977-81, increasing from \$425 million to \$1.1 billion. A large share of circuit boards produced in Japan is incorporated into end products for export. 2/

During 1977-81, shipments of laminates produced in Japan are estimated to have increased from \$64 million to \$158 million. Although the product mix is unknown, a relatively larger quantity of paper-based laminates is produced in Japan than in the United States. Japan is also a larger producer of singlesided boards which are principally incorporated into consumer electronic products. It is believed that Japan has a positive balance of trade in both printed circuit boards and laminates in 1977-81. A large share of circuit boards imported into the United States from Japan is accounted for by ***.

3. West European industry

o The circuit board industry in Western Europe is smaller than the industries in the United States and Japan and is growing at a slower rate.

The circuit board industry in Western Europe is distributed over 15 countries, with large electronic firms being the principal producers. The United Kingdom and West Germany have the largest producers, accounting for 50 percent of European shipments in 1981. France and Italy accounted for 16 percent and 14 percent, respectively. Shipments of circuit boards in Western Europe increased from \$419 million in 1977 to \$936 million in 1981. Such shipments increased about 20 percent each year during the period. Shipments of laminates by West European firms are estimated to have increased from \$67 million to \$150 million during the period. Data are not available on the share of shipments accounted for by each European country. Western Europe is a net importer of both printed circuit boards and base material laminates.

4. Canadian industry

o The Canadian industry is integrated with the U.S. industry.

The largest producers of circuit boards in Canada are reportedly ***.

U.S. imports of circuit boards from Canada are largely accounted for by these two firms. Canada has no producers of base material laminates and relies on outside sources, principally the United States, for laminates needed in circuit board production. Canada is a net exporter of printed circuit boards.

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Introduction

The United States is the world's largest producer and consumer of printed circuit boards and base material laminates. The circuit board and laminate industries in the United States are related to the activities of U.S. multinational concerns and are integrated with the industry in Canada. The U.S. industries are larger than the combined industries in Western Europe and Japan. During 1977-81, the U.S. industries showed a lower growth rate than the Japanese industries, but a higher growth rate than the European industries. Although producers in Western Europe and Japan are more vertically integrated than those in United States, the markets in Western Europe and the United States are more similar. The relatively larger consumer electronics market in Japan makes that market different.

The world market growth rate for circuit boards and laminates depends on the growth rate for electronic products. Countries showing high growth rates in the production of electronic products will show high growth rates in the production of circuit boards and the laminates from which they are produced. This is due to the fact that in the fabrication of circuit boards, close liaison is required between the producers of the end products and circuit boards. During fabrication, problems can arise over the quality of the circuit-board artwork, drawing tolerances, circuit-design changes, or changes in board materials.

The technology and equipment used in producing circuit boards are generally available to foreign and domestic producers although much of the technology was developed in the United States. As a result, no significant competitive advantage is reportedly held by foreign or domestic producers, except in cases of special dielectrics or processes. Technology used in circuit board production is usually made available through producers of equipment and chemicals.

Description and Uses

The development of the printed circuit board grew out of a need in the electronics industry for a reliable and cost-effective way to interconnect electronic components. Prior to its development, components installed in electronic equipment were connected between insulated standoffs, or on terminal boards mounted to the equipment chassis. These methods of component mounting required excessive chassis space and costly point-to-point handwiring and soldering. A high level of rework would often occur from improper connections or from the omission of discrete wires. Further, interconnection of components mounted to the chassis did not provide for ease of rework made necessary when equipment failed. Circuit boards are produced from a variety of dielectric materials which are largely glass based with copper foil attached.

Printed circuit boards

The fabrication of a printed circuit board is divided into three phases. In the initial phase, the locations of the components and the interconnections of the circuits are established. The printed circuit pattern is then laid out on a grid with the intended placement of components and electrical connections checked for accuracy. From this established layout, an enlarged artwork master is produced by laying strips of opaque tape on a sheet of transparent film. The enlarged master can also be produced from a computer-aided layout. A grid layout and an artwork master are required for each circuit board side, and precise registration between the layouts is required when two or more artwork masters are needed.

In the second phase of development, the enlarged masters are photographed and reduced to the appropriate dimensions of the finished board. Step and repeat patterns of the reduced artwork are made when warranted by the volume of production. The reduced masters are used to produce templates (or computer tapes) for drilling the boards and to create the circuit pattern on the base material laminate.

The final stage in the development of the printed circuit board is the board manufacture. After the appropriate copper-clad laminate is selected and coated with a photo-sensitive resist (either dry film or spin-coated), it is exposed through the reduced master creating the circuit image on the copper surface of the laminate. The image is developed out and an alloy of lead-tin is electroplated on the exposed circuit pattern. The alloy plating increases the solderability of the circuit board conductors and serves as an acid-resist when the excess copper on the laminate is etched away (subtractive process). Holes are drilled in the locations where components are to be inserted and the board is profiled to the finished dimensions.

When the number of components on a printed circuit board is sufficiently increased, more circuit layers are required to make the necessary crossover connections. In producing boards with two (or more) circuit layers, the fabrication sequences are changed. Holes required for component mounting are drilled and plated through prior to the creation of the circuit image. The plated-through holes provide circuit continuity from one side of the board to the other. Multilayer boards using 12 to 15 layers of circuitry are now produced for certain types of equipment using high-density interconnections in close areas.

An alternate method for producing circuit boards is called the additive process. In this process, the first two development phases are identical to those described earlier. In the manufacturing phase, a specially treated unclad laminate is required which is sensitized with an electroless, conductive salt. The circuit image is then created on the laminate, and the conductors are hard-copper plated directly to the laminate. Following the copper-plating operation, an alloy of tin-lead is electroplated over the copper. The circuit board is then drilled and profiled to size. Using the additive process, acid etching is not required since there is no excess copper to remove. The disadvantages of the process include the need for a special base laminate and the chance of unacceptable circuit adhesion. Printed circuit boards are used in virtually all electronic equipment including computers, consumer products, and military products. Printed circuit boards are also used to interconnect other printed circuit boards.

Base material laminates

Base material laminates used in the production of printed circuit boards are usually called copper-clad laminates. These base material laminates are made from dielectric materials which are produced as laminations or extrusions. However, as previously mentioned, the laminates used in the additive process are not copper-clad, but have surfaces which are specially treated for good adhesion during hard-copper electroplating.

The three principal product grades of base material laminates are (1) woven-glass-cloth based impregnated with epoxy resin, (2) nonwoven-glass/paper based impregnated with polyester resin, and (3) paper-based phenolic. Other dielectric materials are also used depending on the application, such as a need for resistance to high temperature or a need for a low dielectric constant.

Woven-glass-cloth-based materials are usually fire retardant and are easily machined, pierced, or sheared at room temperature. These materials maintain good dimensional stability over changes in temperature and are subject to minimal warping and moisture absorption. The laminates are produced in various thicknesses, but the largest share is produced to a nominal thickness of 0.0625 inch. Printed circuit boards produced from woven-glasscloth-based laminates are used in military electronics, computers, and industrial-grade electronic equipment where high reliability is important. Circuit conductors on printed circuit boards produced from less-stable laminates could rupture (open circuit) from warping or could become intermittent. Fire retardant materials are used to prevent laminate combustion during severe heat rises in the equipment.

Glass/paper-based laminates are used in applications where reliability and environmental conditions are less stringent. Printed circuit boards made from these laminates are found in numerous commercial products and in consumer products such as automobiles. Paper-based laminates, on the other hand, are relatively low-grade materials which warp easily and are often preheated to prevent crazing or chipping during shearing, drilling, or punching operations. Printed circuit boards produced from paper-based laminates are found in consumer products and in inexpensive toys and games.

Customs Treatment

Import classification procedures for printed circuit boards and base material laminates are generally different in the United States from those in the European Community (EC), Japan, and Canada. Further, rates of duty applied to imports of printed circuit boards and base material laminates in the United States are generally lower than rates of duty applied in those countries.

U.S. customs treatment

Printed circuit boards.--Printed circuit boards are classified under item 685.90 of the Tariff Schedules of the United States (TSUS) as articles for making, breaking, protecting, or connecting electrical circuits (see table on the following page). Printed circuit boards classified under item 685.90 are limited to unassembled boards, i.e., without components thereon. Printed circuit boards imported with components affixed or assembled are classified as parts of end products for which they are dedicated. Printed circuit boards, which are imported from Canada and designated as original motor-vehicle equipment, are classified under item 685.91.

The rate of duty applied to imports of printed circuit boards under item 685.90 is determined by the trading status of the country of exportation. Circuit boards, which are imported from countries afforded most-favored-nation treatment (MFN), are dutiable at a rate of 7.3 percent ad valorem (col. 1 in the TSUS). Circuit boards, imported from countries with MFN status and which have been designated as least developed developing countries (LDDC's), are dutiable at a rate of 5.3 percent ad valorem. Printed circuit boards that are imported from certain countries which the President has designated as being under Communist control or domination and have entered under item 685.90 are dutiable at a rate of 35 percent ad valorem (col. 2 of the TSUS).

TSUS item 685.90 has been designated as an eligible article for duty-free treatment under the Generalized System of Preferences (GSP). Eligibility under the GSP is subject to certain competitive-need limitations as set forth in title V of the Trade Act of 1974. 1/ Printed circuit boards imported from Canada under item 685.91 and designated as original motor-vehicle equipment also enter free of duty.

1/ Duty-free imports entered under a TSUS item from a beneficiary developing country are limited to a percentage of the U.S. gross national product and to 50 percent of the appraised value of imports. Eligibility also requires at least 35 percent of the appraised value of the TSUS item eligible under GSP be added in the beneficiary developing countries.

		4			
TSUS	Description		Rate of du	ty	
No.	Description	Col. 1 <u>1</u> /	LDDC <u>2</u> /	Col. 2 $3/$:	GSP <u>4</u> /
: 685.90 : : : :	Articles for making, breaking, protecting, and connecting elec- trical circuits (printed circuit boards).	7.3% ad val.	: 5.3% ad : : val. : : : :	: 35% ad : val. : :	А.
685.91 : : : : : : : : : :	Articles for making, breaking, protecting, : and connecting elec- trical circuits (printed circuit boards), if Canadian article and original motor-vehicle equip- ment.	Free			
774.55 : : : : : : : : : : : : : : : : : : :	Articles not specially provided for of rubbers or plastics (base material laminates). Articles not specially provided for of rubbers or plastics (base material laminates), if Canadian article and original motor- vehicle equipment.	7.3% ad val. Free	: 5.3% ad : val. :	80% ad : val. : : : : : : :	Α.

1/ The rates of duty in rate of duty column numbered 1 are most-favorednation (MFN) rates and are applicable to imported products from all countries except those Communist countries and areas enumerated in general headnote 3(f) of the TSUS. However, such rates would not apply to products of developing countries which are granted preferential tariff treatment under the Generalized System of Preferences (GSP) or under the "LDDC" rate of duty column.

2/ The rates of duty in rate of duty column "LDDC" are preferential rates (reflecting the full U.S. MTN concession rate for a particular item without staging) and are applicable to products of the least developed developing countries designated in general headnote 3(d) of the TSUS which are not granted duty-free treatment under the GSP. If no rate of duty is provided in the "LDDC column for a particular item, the rate of duty provided in column numbered 1 applies. See app. B for scheduled staged rates of duty.

3/ The rates of duty in rate of duty column numbered 2 apply to imported products from those Communist countries and areas enumerated in general headnote 3 (f) of the TSUS. The only Communist countries currently eligible for most-favored-nation treatment (col. 1 rates) are China, Hungary, Poland, Romania, and Yugoslavia.

4/ Articles designated by the President to be eligible for purposes of the GSP pursuant to section 503 of the Trade Act of 1974. The designation "A" signifies that all beneficiary developing countries are eligible for preferential treatment with respect to all articles provided for in the designated TSUS item.

5

<u>Base material laminates.</u>—Base material laminates are classified under TSUS item 774.55 as articles not specially provided for of rubber and plastics. Laminates, which have been imported from Canada and designated as original motor-vehicle equipment, are classified under TSUS item 774.70. The rate of duty applied to imports of base material laminates from MFN countries is 7.3 percent ad valorem, and 5.3 percent ad valorem from LDDC countries. Imports from certain countries designated as being under Communist control are dutiable at a rate of 80 percent ad valorem.

TSUS item 774.55 is an eligible article under the GSP, and imports of laminates from designated beneficiary countries may enter free of duty. Imports of laminates from Canada under item 774.70 as parts of original motorvehicle equipment also enter free of duty.

Foreign customs treatment

Printed circuit boards.--The Customs Cooperation Council Nomenclature (CCCN) is used by the EC and Japan for purposes of import classification. Under the CCCN, MFN imports of printed circuit boards entering the EC are classified under heading 85.19B. MFN imports of circuit boards entering Japan are classified under heading 85.19-280. In contrast to the EC and Japan, alternate rates of duty are applied to printed circuit boards entering Canada depending on the type of equipment for which the circuit boards are dedicated. Printed circuit boards, which are imported into Canada and dedicated for use in radio apparatus, are entered under item 44533-2. Printed circuit boards, which are dedicated for use in other electronic/electrical end products, are entered under item 44533-1. The rates of duty for printed circuit boards are summarized in the following tabulation:

Present rate of duty 1/

European	Community		8.6%	ad	val.
Japan		2/	4.5%	ad	val.
Canada		$\overline{3}/$	9.4%	ad	val.
		<u>4</u> 7	12.8%	ad	val.

1/ Rate currently applicable on imports from the United States on Jan. 1, 1982, except as noted.

2/ Rate of duty effective Apr. 1, 1982.

Market

 $\overline{3}$ / Rate of duty for printed circuit boards dedicated for use in radio apparatus.

4/ Rate of duty for printed circuit boards dedicated for use in other electronic/electrical end products.

Base material laminates.--MFN imports of base material laminates entered into the EC are classified as articles of various plastics material described under heading 39.07. Imports of base material laminates entered into Japan from MFN countries are classified under two separate headings depending on the type of plastics material from which the laminates are made: laminates made from plastics described under headings 39.01-.02 are dutiable at 10.1 percent ad valorem, and laminates made from plastics described under headings 39.03-.06 are dutiable at 7.4 percent. Base material laminates imported into Canada enter under item 93907-1. The following tabulation summarizes the rates of duty of base material laminates imports into these countries (foreign rates of duty):

Present	rate	of	duty	1/

European Community	14.2%	ad	val.
Japan2/ 3/	10.1%	ad	val.
2/4	/ 7.4%	ad	val.
Canada — —	16%	ad	val.

1/ Rate currently applicable on imports from the United States on Jan. 1, 1982, except as noted.

2/ Rate of duty effective Apr. 1, 1982.

Market

 $\overline{3}$ / Rate of duty for base material laminates made from plastics described under headings 39.01-.02.

4/Rate of duty for base material laminates made from plastics described under headings 39.03-.06.

U.S. Industry

U.S. producers

In the United States, the number of printed circuit board producers far exceed the number of base material laminate producers. Circuit board producers are frequently small businesses which are organized to support electronic equipment firms which are not producers of circuit boards. These small businesses have increased in number as the electronics industry has expanded. Large captive circuit board producers are also supported by these small businesses during periods of capacity limitation or for short-run production requirements. Unlike printed circuit board producers, laminate producers have not increased in number, but rather existing firms have expanded their capacities to meet increasing demand. In some instances, large producers of laminates are also producers of printed circuit boards, but except for certain multilayer mass laminations, circuit boards are not generally produced in facilities where laminates are made.

Printed circuit boards.--Because of their small size and ease of entry and exit, it is difficult to determine the number of printed circuit board producers in the United States. However, data on domestic shipments of printed circuit boards were collected by the U.S. Department of Commerce from 206 U.S. firms in 1977 and from an estimated 265 firms in 1981. The criteria used by Commerce, however, limit data collection to firms employing 10 or more workers. In contrast to the U.S. Department of Commerce, the Institute for Interconnecting and Packaging Electronic Circuits (IPC), which represents the industry, reports a membership of 600 circuit board producers, 300 of which are regular members and 300 of which are associated members. Further, the IPC reports that there are between 800 and 1,000 other firms producing circuit boards which are not affiliated with the IPC. Based on IPC reports, the Commission staff estimates that in 1981 there were at least 1,500 firms in the United States producing printed circuit boards. The largest firms were located in New York, California, and Virginia.

Circuit boards were also produced by at least four large U.S. multiproduct firms in West Germany, Japan, Scotland, and the United Kingdom mostly to serve internal demand. These firms produce and market office machines and computers in these countries. Further, circuit boards are produced in Singapore, Hong Kong, and Taiwan by ***.

U.S. firms producing printed circuit boards in foreign countries account for an increasing share of U.S. circuit board imports.

Base material laminates.--Base material laminates were produced by 19 U.S. firms in 1981 with 3 firms operating more than 1 establishment. These 19 firms were supported by a limited number of U.S. producers of glass-cloth and other dielectric materials used in the production of laminates and a number of producers of electrodeposited copper. Four U.S. firms were also producers of laminates in foreign countries. These firms produced laminates in ***

to serve the European markets and in *** to serve the Far East markets. Since 1977, one large domestic producer ceased laminate production and left the industry. The largest producers of laminates were located in Ohio, California, Wisconsin, and New York.

With increased competition in the laminate industry and increased cost pressures on purchased materials, there is some product integration among producers in the industry, although the level of integration is limited. Certain laminate firms have integrated backward by producing resins for glass-cloth impregnation, or by producing electrodeposited copper foil. Other producers have integrated forward into the partial production of multilayer printed circuit boards called mass laminations. In mass laminations, the inner layers of the multilayer boards are produced by the laminator, and the top and bottom circuit surfaces and hole drilling are subsequently completed by the printed circuit board producer. The forward integration requires increased capital investment by the laminator and results in increased competition among printed circuit board producers.

Production

Printed circuit boards are specialty products produced in different shapes and sizes with different etched circuit patterns. The quantity of circuit boards produced is determined by the production of end-use products in which they are incorporated. In contrast, base material laminates are commodity products produced from limited types of dielectric materials and in limited thicknesses. Laminates are usually sold in 3 feet by 4 feet sheets, or cut to panel size at the request of the circuit board producer.

<u>Printed circuit boards</u>.--Producers responding to the Commission's questionnaires reported that their output of circuit boards increased from 111 million boards in 1977 to 146 million boards in 1981. 1/ Circuit board production consisted principally of boards produced from epoxy-glass-based and epoxy-glass/paper-based laminates as shown in the following table.

Printed circuit boards: U.S. production reported by domestic producers, by types, 1977-81

(In thousands of boards)									
Туре	1977	:	1978	:	1979	:	1980	:	1981
Multilayer (3 layers or : more)	5,579	:	5,912	:	6,446	:	6,993	:	8,441
From additive laminates: Other:	0	:	0	:	13	:	30	:	91
Epoxy-glass base: :		:		:		:		:	
less: More than 0.031 inch	275	:	250	:	202	:	82	:	65
thick: :	10 001	:		:		:		:	
Double-sided copper:	18,001 29,344	:	13,935 30,572	:	14,776 39,974	:	14,459 47,562	: :	16,960 48,181
Epoxy-glass/paper base: Other:	26,386 31,483	:	30,780 49,818	:	33,550 44,313	:	41,102 34,966	: :	40,179 32,561
Total:	111,068	:	131,327	:	139,274	:	145,194	:	146,478

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

In their production of circuit boards, U.S. producers responding to questionnaires reported laminate purchases of \$79 million in 1977, increasing to \$176 million in 1981. Laminates purchases by these large circuit board producers amounted to 33 to 39 percent of the value of laminates reportedly sold during the period by laminate producers. Using the difference between the laminates sold to large producers and total laminates sold, it is estimated that total domestic production of printed circuit boards increased from 325 million boards in 1977, to 423 million boards in 1979, decreasing to 377 million boards in 1981, as shown in the following tabulation (in thousands of boards):

Quant	111
1977 324,7	60
1978 337,6	02
1979 423,2	:86
1980 404,4	40
1981 376.5	50

. . .

1/ The Commission's questionnaires were mailed to 44 U.S. establishments believed to be the largest domestic printed circuit board producers. Responses were received from 35 respondents, representing about 39 percent of U.S. estimated shipments.

Base material laminates.--U.S. production of base material laminates, as reported by domestic producers, increased by 86 percent during 1977-81, rising from 148 million square feet in 1977 to 276 million square feet in 1981, as indicated in the following table. Of the laminates produced during this period, thin laminates, used in the production of multilayer boards, showed the largest relative gain, increasing from 16.8 million square feet in 1977 to 41.0 million square feet in 1981. Prepreg, single-ply uncured epoxy sheets used with thin laminates in the production of multilayer printed circuit boards, also showed a significant gain.

Laminates having an epoxy-glass base were the largest types of printed circuit board materials produced, accounting for about 52 percent of production of all types of boards in 1981. Epoxy-glass based laminates account for about 70 percent of laminate production when prepreg uncured epoxy production is not considered. The level of U.S. laminate production reported in response to questionnaires of the U.S. International Trade Commission represents more than 90 percent of U.S. output as estimated by the IPC.

Base	material	laminates:	U.S.	production	reported	Ъy	domestic	producers,
			by	types, 197	7-81			

	Jusanus (<u>, 1</u>	square						
Туре	1977	:	1978	::	1979	:	1980	::	1981
•••••••••••••••••••••••••••••••••••••••		;		:		:		:	
Multilayer: :		:		:		:		:	
Thin laminates of 0.030 :		:		:		:		:	
inch thick or less:	16,761	:	22,383	:	31,586	:	37,811	:	41,012
Prepreg, single-ply :		:		:		:		:	
uncured epoxy:	26,722	:	37,920	:	50,936	:	59,996	:	71,929
Additive:	783	:	1,519	:	1,519	:	1,421	:	1,835
Epoxy-glass base: :		:		:	-	:	-	:	
0.031 inch thick and less:	748	:	826	:	1,269	:	1,148	:	1,230
More than 0.031 inch thick: :		:		:		:		:	
Single-sided copper:	11,878	:	15,145	:	22,017	:	18,742	:	18,544
Double-sided copper:	51,698	:	61,771	:	86,488	:	86,255	:	83,946
Epoxy-glass/paper base:	22,336	:	29,093	:	29,127	:	31,732	:	38,733
Other:	17.180	:	19,668	•	22,474	:	17,927	:	18,908
Total:	148,106	:	188,325	:	245,416	:	255,032	:	276,137
	,	:	•	:		:	•	:	· .
								-	

(In thousands of square feet)

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Capacity

Capacity in the production of laminates and printed circuit boards is not regarded as a rigid measure of the industries' capability to produce. Over time, this capability is affected by the utilization of advanced equipment, and the development of new production materials and processes. Because of these changing production functions, capacity, particularly in the circuit board industry, is reportedly difficult to measure. For example, an official from the trade association appearing at the public hearing reported that, during a period when the circuit board industry was allegedly operating at full capacity, a study conducted by the association showed that the industry was actually operating at 80 percent of capacity. 1/

Printed circuit boards.--Producers responding to the Commission's questionnaires reported production capacity of 156 million boards in 1977, increasing to 192 million boards in 1981. The largest increase was reported for 1978 when capacity expanded by about 16 million boards as shown in the following table.

Printed circuit boards: U.S. capacity reported by domestic producers, by types, 1977-81

(in chousands of boards)											
Туре	1977	:	1978	:	1979	:	1980	:	1981		
: Multilavorazzazzazzazzazzazzazzazzazzazzazzazzazz	0 110	:	0 500	:	10 / 70	:	11 505	:	10.010		
Huitilayer	0,119	:	0,090	:	10,472	:	11,505	:	13,819		
from additive laminates:	58	:	58	:	58	:	60	:	102		
Epoxy-glass base:	50,813	:	49,455	:	59,534	:	68,070	:	77,036		
Epoxy-glass/paper base:	52,301	:	54,193	:	59,188	:	60,688	:	60,688		
Other:	44,423	:	<u>59,024</u>	:	46,027	:	4,441	:	40,452		
Total:	155,714	:]	171,328	:	175,279	:	184,764	:	192,097		
•											

(In thousands of boards)

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The annual ratio of production to capacity (capacity utilization ratio) for questionnaire respondents increased from 71 percent in 1977 to 79 percent in 1979, and then decreased to 76 percent in 1981. These utilization rates, reported in questionnaire responses, are believed to be representative of the industry, including the smaller firms. Using these utilization rates and the industry production estimates cited earlier, (using the ratio of laminates purchased by large circuit board producers to total laminate shipments reported by domestic laminate producers) capacity estimates for the entire industry, during 1977-81, were calculated, as shown in the following tabulation:

Quar	ntity
(1,000)	boards)

1977	455,275
1978	440,432
1979	532,641
1980	514,363
1981	493,825

1/ Transcript of the hearing before the United States International Trade Commission, investigation No. 332-133, p. 52.

During 1977-81, about *** manhours were reported lost in the circuit board industry, resulting in a decrease in production of over *** boards. This loss was principally due to strikes at producers' plants, production line problems, bad weather, and power failures. The largest losses were reported for 1978 and 1981 when producers' estimated capacity of *** boards and *** boards, respectively, could not be utilized.

Base material laminates .-- Producers reported that capacity in the industry increased by 85 percent during 1977-81, rising to over 309 million square feet in 1981, compared with 167 million square feet in 1977, as indicated in the following table. The largest annual increase in capacity occurred in 1979 when almost 50 million square feet were added. High-capacity growth rates were reported for the production of multilayer laminates (thin laminates) and other epoxy-glass laminates.

Base	material	laminates:	U.S.	capacity	reported	by	domestic	producers,
			by	types, 197	7-81			

	(In Lnouse	ina	s or squa	ire	e reer)				
Туре	1977	:	1978	:	1979	:	1980	:	1981
	:	:		:		:		:	
Multilayer	: 48,215	:	62,082	:	85,136	:	106,435	:	121,907
Additive	2,002	:	2,038	:	1,869	:	2,172	:	2,164
Epoxy-glass base	: 74,753	:	98,083	:	119,304	:	117,354	:	124,547
Epoxy-glass/paper base	: 23,280	:	30,649	:	33,500	:	34,500	:	39,900
0ther	: 18,900	:	22,800	:	25,500	:	21,350	:	20,700
Total	: 167,150	:	215,652	:	265,309	:	281,811	:	309,218
									•

(In thousands of anisons

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

During 1977-81, the laminate industry experienced a high level of capacity utilization, ranging between 87 and 92 percent of maximum effective capacity. The utilization rate was reported at 89 percent of capacity in 1981, the same as it was in 1977. The utilization rate, like the production of printed circuit boards, can change over time as new machines and equipment are purchased and larger presses are utilized.

During 1980, nearly *** square feet of laminate production capacity were lost in the industry principally due to a strike at a producer's plant. The strike resulted in a reported loss of more than *** manhours of laminate production. Other than the strike, during 1977-81, about *** square feet of capacity were lost, principally because of bad weather, with an associated loss of about *** manhours.

Profits

Circuit board producers reported higher levels of profit before taxes during 1977-81 than laminate producers. The profit reported by laminate

producers, however, showed less fluctuation than the profit of circuit board producers. Circuit board production is characterized as more labor intensive than laminate production and allows for a greater degree of in-house control over cost. In contrast, laminate production is not as labor intensive as circuit board production. The cost of laminate production is determined largely by the cost of purchased materials. Profit was not reported by captive circuit board producers since their shipments are transferred at cost.

<u>Printed circuit boards.</u>—The median profit before taxes reported by circuit board producers increased from 9.0 percent of sales in 1977 to 12.7 percent of sales in 1980, and then decreased to 7.5 percent in 1981. In 1981, reported profit ranged from a high of 17.9 percent to no realized profit, as compared with a high of 24.1 percent and a loss of 13.1 percent in 1977. Only producers with relatively lower production levels reported losses during the period. The profit before taxes, for the reporting firms which produced printed circuit boards during 1977-81 is summarized in the following table.

		(In	percent	:)					
Profit range	1977	:	1978	:	1979	:	1980	:	1981
	-	:		:		:		:	
High:	24.1	:	27.8	:	20.8	:	16.9	:	17.9
Median:	9.0	:	9.8	:	11.1	:	12.7	:	7.5
Low:	(13.1)	:	(8.4)	:	(3.5)	:	(11.0)	:	0
•		:		:		: '		:	

Printed circuit boards: Profit before taxes, as reported by U.S. producers, 1977-81

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

<u>Base material laminates</u>.--Profit before taxes for laminate producers showed a general deterioration during 1977-81 with the industry median decreasing from 8.6 percent of sales in 1977 to 3.0 percent in 1981. In 1977, profit before taxes ranged from a high of 20.0 percent to a loss of 2.0 percent. In 1981, profit in this industry ranged from a high of 12.1 percent to a loss of 3.9 percent. Profit reported for 1977-81 is summarized in the following table.

Base material laminates: Profit before taxes as reported by U.S. producers, 1977-81

(In percent)									
Profit range	1977	:	1978	:	1979	1980	:	1981	
		:		:	:		:		
High:	20.0	:	15.0	:	18.4 :	15.4	:	12.1	
Median:	8.6	:	6.8	:	8.0 :	5.0	:	3.0	
Low:	(2.0)	:	(1.0)	:	0:	(3.0)	:	(3.9)	
•		•		•					

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The larger laminate producers outperformed the smaller producers during 1977-81, reporting profit before taxes which was consistently higher than the median. The smaller laminate producers reported low and declining profits or losses during the period. The median profit before taxes realized by U.S. producers of electronics in 1981 is estimated at 7.7 percent of sales, higher than profit earned by laminate producers.

Profit in the industry is influenced by the cost of materials which are required in the production of base material laminates. Glass-cloth, epoxy resins, and electrodeposited copper, which are usually purchased by U.S. laminate producers, account for an estimated 70 percent of the direct cost of production; direct labor accounts for the remaining 30 percent. Profit is reduced when laminate producers are unable to pass through material cost increases to their customers. A 10-percent increase in material costs would require more than a 23-percent increase in labor productivity to maintain constant prices.

Employment

Employment in the production of printed circuit boards is higher than in the production of base material laminates. Total employment involved in both the production of printed circuit boards and laminates, as reported by questionnaire respondents, increased from 10,293 workers in 1977 to 15,089 workers in 1981. During 1977-81, workers in the production of laminates accounted for between 18 and 22 percent of this workforce. Circuit board production is more labor intensive, particularly in small firms where a low level of automation is found, or in firms producing multilayer boards where more handling and assembly are required. Base material laminate production, on the other hand, is more capital intensive and requires less labor per unit of sales.

Printed circuit boards.--Average employment in U.S. respondents' establishments producing printed circuit boards increased from 81,128 workers in 1977 to 88,137 workers in 1981 as shown in the following table. Production and related workers employed in the production of all products in these establishments accounted for about 62 percent of total employment. Production and related workers employed in printed circuit boards accounted for 10 to 13 percent of all such workers in these establishments during the period. Of the types of circuit boards produced, multilayer boards and epoxy-glass-based boards accounted for the largest share of employment.

: : : : : 1977 Item 1978 1979 1980 1981 : : : : : Average number employed in : : : : the reporting : establishment(s): All persons-----81,128 : 83.422 : 86,730 : 87,261 : 88,137 Production and related : workers engaged in the production of: All products-----51,121 : 52,419 : 53,400 : 53,974 : 55,167 Printed circuit : boards: : : Multilaver : : (3 layers or : more)-----: 3,314 : 3,985 : 4,543 : 4,841 : 5,101 From additive : 0: 54 : laminates----: 0: 353 : 577 Epoxy-glass base--: 3.877 : 4,281 : 4,614 : 5,063 : 4,949 Epoxy-glass/paper : base----: 449 : 450 : 556 : 588 : 869 Other----: 552 : 830 : 1,032 : 1,021 : 835 Total production: : : and related : : : workers em-: : : ployed in : printed cir-: cuit boards---: 8,192 : 9,546 : 10,799 : 11,866 : 12,331

Average number of employees, total and productions and related workers in U.S. establishments producing printed circuit boards, by types, 1977-81

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The reported employment in the printed circuit board industry is understated since it does not include employment of small producers. However, industry sources estimated that there were a total of 30,000 production and related workers in the circuit board industry in 1981, supported by an additional 8,000 employees in the sales, distribution, and management of circuit board operations. In 1977, industry sources estimated that total employment in the industry was about 29,000 workers which were employed in the production of circuit boards. These workers are usually skilled employees engaged in shearing, drilling, printing, and etching operations. A high degree of skill is also required in producing multilayer laminations, maintaining chemical baths, testing, and plating. Base material laminates.--Employment reported by the establishments producing base material laminates increased from 4,462 workers in 1977 to 5,116 workers in 1981, as shown in the following table. Employment peaked in 1979 when the average number of all employees in these establishments reached 5,269 and employment of production and related workers engaged in the production of all products reached 3,702. Production and related workers engaged in the production of base material laminates reached 2,758 employees in 1981 compared with 2,101 employees in 1977. Production and related workers engaged in the production of laminates accounted for 68 to 80 percent of all such employees in the reporting establishments during 1977-81. High employee skill levels are also required in the laminate industry for impregnation, lamination, and bonding of copper foil.

Average number of employees, total and production and related workers in U.S. establishments producing base material laminates, as reported by domestic producers, by types, 1977-81

Item	1977	1978	1979	1980	1981
•		•	:	:	•
Average number employed in :		:	:	:	:
the reporting :		•	:	:	:
establishment(s): :		:	:	:	:
All persons:	4,462	: 4,858	: 5,269	: 5,037	: 5,116
Production and related :	-	:	:	•	:
workers engaged in :		:	•	:	:
the production of: :		•	•	:	:
All products:	3,081	: 3,423	: 3,702	: 3,442	: 3,555
Multilayer:	512	: 707	: 834	: 908	: 1.023
Additive:	9	: 21	: 20	: 23	: 27
Epoxy-glass base:	980	1.136	: 1.284	: 1.169	: 1.193
Epoxy-glass/paper :		:	:	:	:
hase	372	319	. 331	: 305	: 318
Other:	228	229	229	: 176	• 197
Total production :	220	: 225	:	:	: 177
and related :			•	:	:
workers employed:			•	:	•
in base material:		•	•	•	•
laminates	2.101	2 412	. 2 968	• 2 5 8 1	• 2758
i ami nates .	2,101	• • • • • •	. 2,900	• 2,01	. 2,750
•		•	•	•	•

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Research and development

Research and development (R. & D.) in the printed circuit board and base material laminate industries has been undertaken principally by printed circuit board producers. R. & D. expenditures incurred by laminate producers during 1977-81 were only 10 percent as large as such expenditures incurred by printed circuit board producers. Printed circuit boards.--R. & D. expenditures of circuit board producers, as reported in the Commission's questionnaire, nearly doubled during 1977-81, increasing from \$15.6 million in 1977 to \$33.8 million in 1981. R. & D. expenditures in 1981, however, were only slightly larger than in 1980, as shown in the following tabulation:

	Expenditures							
	(1,000 dollars)							
1977	15,560							
1978	17,378							
1979	18,403							
1980	31,420							
1981	32,756							

Producers of circuit boards reported that their R. & D. efforts were directed principally toward process developments, improved manufacturing techniques, and quality control measures. These process developments include increasing component density, improving thermal design, and improving "through-hole" testing of multilayer boards. Research was also directed to the increased use of computer-aided design and computer-aided manufacturing (CAD/CAM) in the production of circuit boards. These expenditures are believed to represent the bulk of funds spent in the industry since little original R. & D. is undertaken by small firms.

<u>Base material laminates</u>.--Only a limited amount of R. & D. effort was reported by laminate producers during 1977-81, with such expenditures increasing from \$1.4 million in 1977 to \$3.2 million in 1981, representing less than 1 percent of the value of U.S. shipments each year. R. & D. expenditures in the industry were directed principally to testing new materials and machines, increasing production efficiency, and increasing product quality. In response to the Commission's questionnaires, a large number of laminate producers reported that their firms did not undertake any R. & D. effort during 1977-81. The R. & D. expenditures reported by laminate producers during the period are summarized in the following tabulation:

	Expenditures							
	(1,000 dollars)							
L977	1,373							
L978	1,704							
L979	2,086							
L980	2,554							
L981	3,216							

Technology

The technology in use in the circuit board industry has been largely developed and improved by U.S. producers of process equipment and supplies. The advancement of the technology has come about through close liaison between producers of the equipment and producers of circuit boards and laminates. Equipment producers include firms producing printers, etchers, automatic drilling equipment, and other manufacturing machinery.

Printed circuit boards.--The technology and equipment in use in the United States for the production of printed circuit boards are routinely available to foreign producers and domestic producers alike. Certain circuit board fabrication processes, which have been developed in the industry, however, are proprietary. Boards produced from ceramic dielectrics, which provide better heat transfer in dense module packages, have been reportedly developed by a U.S. captive firm. This fabrication technique, although permitting size reductions in office machines and computers, has not been made available on an industry wide basis. Foreign producers have also shown technological strengths in circuit board fabrication and equipment design. Japanese circuit board firms are reportedly producing high quality multilayer boards for computer applications and have begun to supply advanced production equipment such as contact printers to the U.S. domestic market.

Base material laminates.--Domestic producers were requested to compare their firms with foreign firms in the production of laminates with respect to quality, equipment, and technology used. Of those responding, all producers except one reported that the quality of the laminates they produced was equal or superior to the laminates produced by foreign firms. They also reported that in most instances, their equipment and technology were superior to equipment and technology used by foreign firms. One firm reported that other than Japanese producers, foreign producers of laminates have no real advantage over U.S. domestic producers. This firm reported, however, that Japanese producers are able to manufacture a grade of paper-base laminates (to support their consumer electronic industry) which is superior to such laminates produced in the United States. Further, this firm reported that the copper foil bonded to Japanese-produced laminates gives a better surface appearance and that the Japanese laminators could possibly have superior technology for producing special laminates made from triazine and polyimide materials.

Capital investment

Investment, in the circuit board and laminate industries during 1977-81, was largely directed toward the acquisition of new equipment and the improvement or expansion of existing facilities. During this period, only limited investment was directed toward land acquisition and land improvement.

Printed circuit boards.--Circuit board producers, responding to the Commission's questionnaires, reported that about \$373 million was invested in the production of circuit boards during 1977-81. About 73 percent of this reported investment was used to purchase new machines and equipment, and about 26 percent was used for buildings or leasehold improvements. The remaining investment was used for land or land improvements.

On an annual basis, the largest investment in the circuit board industry was reported for 1979 when expenditures exceeded \$100 million. This large increase in investment in 1979 is explained by almost a 100-percent increase in expenditures for buildings or leasehold improvements compared with expenditures in 1978. Expenditures, for all other years during 1977-81, were well below expenditures reported for 1979 as shown in the following table.

(In thousands of dollars)										
Year :	Land or land improvements	: : :	Building or leasehold improvements	::	Machinery, equip- ment, and fixtures	Total				
:		:		;						
1977:	139	:	10,197	:	46,276 :	56,612				
1978:	761	:	17,652	:	52,971 :	71.384				
1979:	248	:	32,729	:	67.391 :	100, 368				
1980:	986	:	16,234	:	52,549 :	69,769				
1981:	378	:	22,846	:	51,962 :	75,186				
:		:		:	•	-				

Printed circuit boards: Capital investments, as reported by U.S. producers, 1977-81

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Base material laminates.--Although capital investment in the laminate industry showed a large increase during 1977-81, rising from \$1.8 million to \$37.3 million, the total investment in this industry was only 22 percent as large as that reported by the circuit board industry. Principal investments in laminate production were used for the acquisition of new equipment and machinery. Expenditures on buildings or leasehold improvements accounted for only a small share of capital investment. Little or no capital investment was made for land or land improvements as shown in the following table.

Base material laminates: Capital investment, as reported by U.S. producers, 1977-81

		(In	thousands of	do1	llars)		
:	Land or land	:	Building or		:	Machinery,	:	
Year :	improvements	:	leasehold		:	equipment,	:	Total
	1mp10vements	:	improvements		:	and fixtures	:	
:		:			:		:	
1977:		:	2	294	:	1,520	:	1.814
1978:	175	:	5	568	:	3,384	:	4,127
1979:	25	:	2,1	.91	:	12,321	:	14,537
1980:	165	:	6,8	800	:	15,829	:	22,794
1981:	162	:	5,9	955	:	31,171	:	37,288
:		:			:	,	:	, ,
Sources Co	from Jak	1						

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

International operations

Most circuit boards and base material laminates produced by U.S. and foreign firms are captively consumed rather than entered into international commerce. Circuit boards entering international commerce are usually assembled and incorporated into end products. Further, U.S. and foreign multinational firms, producing these end products abroad, tend to produce or purchase circuit boards and laminates in the countries in which their establishments are located.

<u>Printed circuit boards</u>.--As previously reported, a number of U.S. firms produce printed circuit boards in Western Europe, Canada, Japan, and the Far East. Although most circuit boards are used in the countries in which they are made, a share of these boards are exported to the United States. The high level of trade with Canada in printed circuit boards is accounted for by the proximity of Canada to the United States, the integration of the U.S. and Canadian markets, and the ***.

Base material laminates.--Although laminates are produced abroad by a number of U.S. firms, ***.

U.S. Market

The demand for printed circuit boards and laminates is derived from the demand for computers and other electronics equipment. Circuit boards provide the principal means for interconnecting components within electronic equipment; and without circuit boards, such equipment would be larger and more costly to produce. Demand for electronic equipment is expected to increase 16 percent annually, similar to the expected annual increase in demand for printed circuit boards and laminates. 1/

Printed circuit boards

The domestic market for printed circuit boards is segmented into seven basic markets, three of which account for more than 70 percent of the value of domestic shipments, according to IPC. The computer industry is the largest and fastest growing domestic market for circuit boards and accounts for approximately 50 percent of the value of multilayer board shipments and 36 percent of double-sided board shipments. The computer market includes mainframe computers, peripherals, mini-computers, terminals, printers, and add-on devices. The seven domestic markets are shown in the following tabulation:

Computers	- 40
Communications	- 20
Government/military equipment	- 13
Consumer electronics	- 10
Industrial electronics	- 9
Scientific and medical instruments	- 6
Business and educational equipment	- 2

Producers of communications and government/military equipment are the next two largest markets for circuit boards. Like the computer industry, producers of communications equipment are large users of multilayer boards and double-sided boards. Communications equipment consists of mobile radios, microwave relay transmissions, telecommunications equipment, and telephone and navigational apparatus. Government/military equipment are most often radar, sonar, electronic warfare apparatus, and guidance control systems.

The remaining domestic markets for circuit boards are those industries producing consumer electronics, industrial electronics, followed by scientific and medical instruments, and finally, equipment for business and educational purposes. Although these remaining markets together account for only 27 percent of the value of domestic circuit board shipments, a wide variety of articles are included. For example, products in the consumer electronics industry include microwave ovens, television receivers, certain automotive equipment, large home appliances, and electronic games. In the industrial electronics market, devices that control, test, and monitor manufacturing processes are included; and the remaining markets include such items as lasers, medical diagnostic equipment, copying machines, word processors, educational aids, gas pumps, and cash registers. About half of the market value of single-sided printed circuit boards is accounted for by the consumer electronic and communications equipment markets. Single-sided boards are less costly to produce, and cost is a strong consideration in these markets. 1/

Base material laminates

Circuit boards produced from glass-based laminates are principally marketed in the computer industry and in U.S. Government/military electronics. Circuit boards produced from glass/paper-based laminates are largely marketed in the consumer electronics industry and the industries producing industrial and communications equipment. Circuit boards produced from less expensive paper-based laminates are marketed almost entirely in the consumer electronics industry.

U.S. shipments

U.S. shipments of printed circuit boards are collected and reported by the U.S. Department of Commerce 2/ and estimated by the IPC and a major research organization. 3/ When data published by these sources are compared, a large difference in shipments value is apparent. The difference arises out of the problem of data collection since shipments data from small firms in the industry were neither reported by the U.S. Department of Commerce nor collected in the Commission's questionnaires. As a result, data published by Commerce, data collected in response to the Commission's questionnaires, and estimates furnished by the IPC are compared in this section. Shipments of

1/ Reported in response to questionnaires of the U.S. International Trade Commission.

2/ Circuit board shipments are reported by the U.S. Department of Commerce under the Standard Industrial Classification (SIC) No. 3679052.

3/ Gnostic Concepts, Inc.

base material laminates collected by the Commission's questionnaires and estimated by the IPC are also compared. Domestic shipments of laminates are not separately collected and reported by the U.S. Department of Commerce.

<u>Printed circuit boards.</u>—The U.S. Department of Commerce reported that domestic shipments of printed circuit boards increased from \$800 million in 1977 to \$1.4 billion in 1980, the last year for which Commerce data are available. Shipments in 1981 are estimated by the staff of the U.S. International Trade Commission to have reached \$1.5 billion. Shipments of circuit boards are not reported by Commerce by the type of dielectric materials used, such as those produced from glass- or paper-based laminates.

Shipments of printed circuit boards estimated by the IPC are substantially larger than those reported by the U.S. Department of Commerce. The IPC estimates that U.S. shipments were valued at \$1.7 billion in 1977 and \$2.9 billion in 1980. Based on IPC's estimates, the Commision's staff projected shipments at \$3.0 billion in 1981 as shown in the table on page 33. The IPC estimated that domestic shipments of printed circuit boards produced from glass-based laminates accounted for more than 80 percent of the value of total shipments during 1977-80.

Circuit board shipments reported by the IPC are estimated from its collection of data on shipments of base material laminates. Since a limited number of firms produce base material laminates, it is believed that the IPC data include virtually all U.S. laminate shipments. Using laminate shipments as a base, the association has developed a value-added formula to determine printed circuit board shipments. The reliability of the formula is consistent with estimates of the value of U.S. shipments of printed circuit boards reported by a large research firm. 1/ The formula is used by the IPC in lieu of collecting shipments data from small firms. The formula used by the IPC in 1980 divides the value of laminate shipments collected by 0.19 (or the value of laminate shipments multiplied by 5.26). 2/

In response to the Commission's questionnaires, the U.S. producers surveyed reported that circuit board shipments increased from \$433 million in 1977 to \$1.14 billion in 1981, as indicated in the following table. These producers also reported that base material laminates purchased by them for circuit board production increased from \$78.6 million in 1977 to \$176 million in 1981. Laminates purchased by these producers accounted for about 33 to 39 percent of total industry shipments reported during the period.

1/ Gnostic Concepts, Inc.

 $\overline{2}$ / The IPC developed the formula by surveying large circuit board producers to determine the average valued added to laminates in producing circuit boards.

	: Value of U.S. :	Value of laminates	: Percent of
Year	:printed circuit :	used in U.S.	: laminate
	:board shipments :	shipments	:shipments used
	: <u>1,000</u>	dollars	•
	:		•
1977	-: 432,790 :	78,562	: 34.2
1978	-: 596,966 :	111,375	: 38.9
1979	-: 822,193 :	131,902	: 32.9
	-: 972,836 :	152,536	: 35.9
1981	-: 1,135,927 :	176,201	: 38.9
	•		

Printed circuit boards and base material laminates: U.S. producers' shipments, 1977-81

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Using the ratios of laminates purchased by large circuit board producers to total laminates purchased, U.S. shipments of circuit boards are estimated to have increased from \$1.3 billion in 1977 to \$2.9 billion in 1981. Although differences in shipments still exist by using this method when compared with the IPC, in the later years, 1980 and 1981, the differences are smaller as shown in the following table.

Printed circuit boards: Comparison of U.S. producers' shipment data, 1977-81

	(11		ousanus or	<u>u</u>	ollars)		
Year	: Reported by : : U.S. Depart- : : ment of :]	Reported by the TPC 2/	::	Estimated the U.S. Inter Trade Commi	l b na .ss	y tional ion
	: Commerce <u>1</u> / :			:	From questionnaire returns 3/	:	Adjusted 4/
	:			:		:	
1977	: 799,600 :		1,650,600	:	432,790	•	1 265 468
1978	: 1,308,326 :		2,100,000	:	596,966	:	1,534,617
1979	: 1,307,327 :		2,555,000	:	822,193	•	2 499 067
1980	: 1,393,763 :		2,900,000	:	972,836	:	2,709,850
1981	: <u>4</u> / 1,463,000 :	<u>4</u> /	3,045,000	:	1,135,927	:	2,920,121
	:			:		•	

(In thousands of dollars)

1/ Data compiled from official statistics of the U.S. Department of Commerce, <u>Census of Manufactures</u> and <u>Current Industrial Reports</u>, except as noted.

 $\frac{2}{}$ Supplied by the Institute for Interconnecting and Packaging Electronic Circuits (IPC), except as noted.

3/ Data compiled from responses to questionnaires of the U.S. International Trade Commission.

4/ Estimated by the staff of the U.S. International Trade Commission.

The information presented in the prior table indicates that the value of annual U.S. shipments of printed circuit boards during 1977-81, as reported by the Department of Commerce, is likely to be understated by as much as 50 percent. The data estimated from Commission's questionnaires and the data estimated by the IPC are believed to be more representative of industry shipments. Further, in the data presented in appendix C, table 1 on U.S. shipments of printed circuit boards collected from the Commission's questionnaires, intracompany shipments (captive shipments) are shown as significantly larger than domestic merchant (or open-market) shipments and summarized in the following tabulation:

	Ratio of captive shipments
	to total shipments
	(percent)
1977	81
1978	- 75
1979	80
1980	78
1981	80

The IPC, on the other hand, estimates that the U.S. merchant market for circuit boards is slightly larger than the captive market. The level of domestic shipments accounted for by the small producers which were not surveyed in the Commission's questionnaires can be derived from the difference in these reported types of U.S. shipments.

Base material laminates.--U.S. shipments of laminates increased from \$229 million in 1977 to \$452 million in 1981, or by about 98 percent. Laminates sold in the U.S. merchant market accounted for the largest share of shipments followed by export markets and captive markets. Total U.S. laminate shipments are shown in the following table and presented by types of laminates in table 2.

Base material laminates: Comparison of U.S. shipments data, 1977-81

	Year		Report the IP	ed by C <u>1</u> /	USITC questionnaire responses
			•	:	
1977			•	266,838 :	229,398
1978			•	339,612 :	286,275
1979		الله الله،	•	413,195 :	399,903
1980			:	469,000 :	423,946
1981		الله هاه الما الله، يتاب الله، يتاب الله الما بيه بيه بيه ويه الله. وي الله الله ا	: <u>2/</u>	492,000 :	452,457

(In thousands of dollars)

1/ Supplied by The Institute for Interconnecting and Packaging Electronic Circuits.

2/ Estimated by the staff of the U.S. International Trade Commission, based on industry data.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission, except as noted.

As indicated in the previous table, annual laminate shipments reported in response to the Commission's questionnaires ranged between \$13 million and \$53 million lower than those reported by the IPC during the period. According to the IPC, U.S. laminate shipments were valued at \$267 million in 1977, rising to \$469 million in 1980. In 1981, such shipments are estimated at \$492 million.

Inventories

Printed circuit boards are not retained in inventory except during delays caused in assembly since circuit boards can only be used in equipment for which they are designed. Laminates, on the other hand, are retained in stock at producers' facilities for response to incoming orders.

U.S. producers' inventories of base material laminates increased from 11.7 million square feet in 1977 to 19.3 million square feet in 1981. Inventory data do not include laminates stocked by distributors which are located throughout the United States. Relative to production, inventories ranged between 6.8 percent and 7.9 percent of production during the period, as shown in the following tabulation:

	Quantity	Percent
	1,000 square feet	of production
1977	11,735	7.9
1978	13,318	7.1
1979	18,508	7.5
1980	17,378	6.8
1981	19,250	7.0

Imports

The importation of circuit boards and base material laminates largely represents the activity of U.S. multinational firms rather than foreign producers. Foreign competition is largely in the market for end-product equipment in which circuit boards are incorporated. A loss in the end-product market could result in a loss in the circuit board and laminate markets.

Printed circuit boards.--U.S. imports of printed circuit boards increased in value from \$25 million in 1977 to \$162 million in 1981, or by about 60 percent annually. The largest increase occurred in 1981 when imports increased by about 65 percent. Eight countries accounted for 85 to 87 percent of U.S. circuit board imports during 1977-81, with Canada being surpassed by Japan in 1981 as the largest supplier, as shown in the following table. Imports of these products from Japan reached \$46 million in 1981 and were 193 percent larger than they were in 1980. Printed circuit boards imported from Japan in 1981 accounted for 47 percent of the increase in total imports during that year.

(In thousands of dollars)												
Source	:	1977	:	1978	:	1979	:	1980	:	1981		
Japan Canada Hong Kong West Germany Taiwan Singapore	· : • : • : • :	7,035 5,207 926 2,958 2,021 1,147 1,190 770	: : : : :	13,887 9,745 2,679 3,074 4,583 1,483 2,305	:::::::::::::::::::::::::::::::::::::::	12,072 16,860 4,386 4,997 7,781 3,209 4,110	· · · ·	15,704 32,986 6,415 6,835 9,882 4,250 8,407 2,105		45,999 42,954 12,773 11,462 10,921 8,597 6,852		
All other	·:	3,860	:	5,482	:	8,114	:	11,276	:	19,683		
Total	:	25,114	:	44,903	:	63,332	: :	97,860	:	162,017		

Printed circuit boards: U.S. imports for consumption, by principal sources, 1977-81

Source: Data compiled from FT 246, "U.S. Imports For Consumption," U.S. Department of Commerce, 1977-81.

A significant share of circuit board imports is accounted for by U.S. firms which are sourcing boards from their foreign subsidiaries or from foreign facilities which have been certified to meet their production standards. Moreover, much of the trade is accounted for by ***. which are U.S. producers ***.

Other U.S. importing firms produce or source circuit boards in the Far East largely for incorporation into games, toys, and other consumer electronics.

A relatively small share of circuit board imports is represented by foreign producers, most of which have established end-product production in the United States or have an equity interest in U.S. end-product firms. A Canadian firm producing telephone apparatus in the United States is a large importer from Canada and a Japanese computer firm tied with a U.S. computer firm is the largest importer from Japan. Certain European end-product firms operating in the United States are importing from Western Europe.

Base material laminates.--U.S. imports of base material laminates increased from *** square feet in 1977 to *** square feet in 1980, and then decreased to *** square feet in 1981. Imports of laminates were valued at *** in 1977 and at *** in 1980; and in 1981, laminate imports were valued at *** as presented in table 3.

Data received in response to the Commission's questionnaires show that a substantial share of U.S. laminate imports is accounted for by ***.

percent in 1981 compared with 1980, *** continued to account for a large share of imports. In 1980, *** in the United States began importation of laminates followed by a *** in 1981. Combined, these *** accounted for about *** of the value of U.S. laminate imports in 1981 compared with *** which accounted for ***.

Exports

During 1977-81, over 90 percent of (unassembled) printed circuit boards and base material laminates produced worldwide never entered into international commerce. Printed circuit boards are usually produced and assembled within the same firm or produced by firms in the area (or region) where end-product producers are located. Close liaison is often required between the designer and producer of printed circuit boards and the producer of end products for which the boards are dedicated.

Printed circuit boards.--U.S. exports of circuit boards increased in value from \$40 million in 1978 to \$125 million in 1981. The largest increase occurred in 1980 when such exports rose by 58 percent compared with those in 1979. Official statistics on exports of printed circuit boards are not available for 1977.

Eight countries accounted for 60 to 75 percent of the value of U.S. circuit board exports during 1978-81. Mexico accounted for the largest share, followed by Canada, the United Kingdom, and Sweden. Circuit boards are exported from the United States primarily to the border area in Mexico where U.S. assembly plants are located. After assembly, these boards are imported as parts of television receivers or parts of other electronic equipment, and not as printed circuit boards. U.S. exports of printed circuit boards by principal markets are shown in the following table. Exports of these products reported by the U.S. producers covered in the Commission's survey are shown in detail in table 4.

Printed circuit boards: U.S. exports of domestic merchandise, by principal markets, 1978-81

(III CHOUSA	nus	UI UUIIA	113					
Market	:	1978	•	1979	:	1980	:	1981
	:		:		4		;	
Mexico	-:	10,382	:	14,935	:	28,511	:	34,716
Canada	-:	4,740	:	8,368	:	8,219	:	13,543
Sweden	:	842	:	2,547	:	10,057	:	12,215
United Kingdom	:	3,760	:	7,886	:	9,972	:	9,411
West Germany	-:	1,822	:	2,701	:	4,515	:	6,329
Japan	-:	1,755	:	2,008	:	4,795	:	5,616
Australia		329	:	610	:	1,247	:	4,805
Singapore	-:	668	:	7 38	:	2,702	:	3,910
All other	-:	15,395	:	19,717	:	23,910		34,139
Total	-:	39,693	:	59,510	:	93,928	:	124,684
	:		:		:		:	-
Source: Data compiled from FT 446	"11	S Evnor	+ 0	Sahada	10	P Com		d ton loss

(In thousands of dollars)

Source: Data compiled from FT 446, "U.S. Exports, Schedule B, Commodity by Country," U.S. Department of Commerce, 1977-81.

Base material laminates.--U.S. exports of base material laminates, as reported by U.S. producers, increased from 13.2 million square feet, valued at \$22.8 million, in 1977 to 34.1 million square feet, valued at \$67.2 million, in 1981. During this period, laminates produced from epoxy-glass materials accounted for 64 to 73 percent of the value of all exported laminate types as shown in table 5. Major export markets for base material laminates were Canada, the Far East, and Western Europe. U.S. exports of base material laminates were significantly larger than such U.S. imports during 1977-81, thus resulting in a favorable balance of trade each year during the period.

Apparent U.S. consumption

U.S. shipments of printed circuit boards and laminates represent a good approximation of apparent U.S. consumption. As previously noted, a large share of these articles are not imported or exported from the United States.

Printed circuit boards.--Based on shipments data published by the U.S. Department of Commerce, apparent U.S. consumption of printed circuit boards increased in value from an estimated \$800 million in 1977 to \$1.5 billion in 1981. As a share of apparent U.S. consumption, imports rose each year, increasing from 3.4 percent in 1978 to an estimated 10.8 percent in 1981. Printed circuit boards: U.S. shipments, exports of domestic merchandise, imports for consumption, and apparent consumption, 1977-81

Year :	Shipments	: : Exports :	: : Imports :	Apparent consumption	: Ratio of : imports to :consumption
•	والما وحال المال	<u>1,000</u>	dollars	الحدر الحي المعر بلين بلين المدر كمر كمر ومع ومع المع المدر المر	: Percent
:		:	:		:
1977:	799,600	: 1/	: 25,114 :	2/ 800,000	: 3.1
1978:	1,308,326	: 39,693	: 44,903 :	1,313,536	: 3.4
1979:	1,307,327	: 59,519	: 63,332 :	1,311,140	: 4.8
1980:	1,393,763	: 93,928	: 97,860 :	1,397,695	: 7.0
1981:	<u>2</u> / 1,463,000	: 124,684	: 162,017 :	: 2/ 1,500,933	: 2/ 10.8
:		:	: :	-	: _

1/ Not available.

2/ Estimated by the staff of the U.S. International Trade Commission, based on industry data.

Source: Data compiled from <u>Census of Manufactures</u>, <u>Current Industrial</u> <u>Reports</u>, FT 410, "U.S. Exports", and FT 246, "U.S. Imports for <u>Consumption</u>," U.S. Department of Commerce, 1977-81, except as noted.

When apparent U.S. consumption of circuit boards is based on industry shipments estimated from data collected in response to the Commission's questionnaires, apparent consumption during the period was significantly higher and the share accounted for by imports was significantly lower. For example, based on the Commission's estimates, the value of apparent U.S. consumption of these products in 1981 was \$3.0 billion, and imports accounted for about 5.4 percent of consumption, as shown in the following table. It is believed that the apparent consumption estimated from Commission data for the circuit board industry more accurately represents U.S. apparent consumption during 1977-81.

Printed circuit boards: U.S. shipments, exports of domestic merchandise, imports for consumption, and apparent consumption, 1977-81

						_			
Year : :	Shipments	::	Exports	:	Imports	:	Apparent consumption	: : :c	Ratio of imports to consumption
:	ويبه ويبه ويبه ويبه ويبه ويبه ويبر ويبر ويبر فيبر فيبر ويبر ويبر		<u>1,000</u>	d	ollars			:	Percent
:		:		:		:		:	
1977:	1,265,468	:	1/	:	25,114	:	2/ 1,265,100	:	2/ 1.3
1978:	1,534,617	:	39,693	:	44,903	:	1,539,827	:	- 2.9
1979:	2,499,067	:	59,519	:	63,332	:	2,502,880	:	2.5
1980:	2,709,850	:	93,928	:	97,860	:	2,713,782	:	3.6
1981:	2,920,121	:	124,684	:	162,017	:	2,957,454	:	5.4
•		:		:		:		:	

1/ Not available.

 $\overline{2}$ / Estimated by the staff of the U.S. International Trade Commission, based on industry data.

Source: Data compiled from the FT 410, "U.S. Exports", and FT 246, "U.S. Imports for Consumption," U.S. Department of Commerce, 1977-81, and responses to questionnaires of the U.S. International Trade Commission, except as noted. Base material laminates.--Apparent U.S. consumption of base material laminates rose by *** percent during 1977-81, increasing from *** square feet to *** square feet. During this period, the value of apparent consumption increased from *** or by percent. The value of imports accounted for only a small share of apparent U.S. consumption during 1977-81, increasing from *** of such consumption in 1977 to 2.9 percent in 1980, and then decreasing to 0.7 percent in 1981. Imported laminates as a share of the quantity of apparent U.S. consumption followed the same trend, as shown in the following table.

						_			
	:	:		:		:		:	Ratio
T7	Domestic	:	_	:		:	Apparent	:	(percent)
rear	shipments 1/	:	Exports	:	Imports	:	consump-	:	of imports
	:	:		:		:	tion	:	to con-
	:	:		:		:		:	sumption
	:	Qı	uantity (1,	,000 squa	ar	e feet)		
	:	:		:		:		:	
1977	: 131,935	:	13,239	:	***	:	***	:	***
1978	: 166,112	:	18,229	:	***	:	***	:	***
1979	: 212,179	:	28,773	:	***	:	***	•	***
1980	: 210,903	:	31.889	:	***	:	***	:	***
1981	: 228,321	:	34,083	:	***	•	***	:	***
	:		Value (1	L,	000 dol1	a	rs)		
	:	:				:		:	
1977	: 206,635	:	22,763 :		***	:	***	:	***
1978	: 253,435	:	32,840 :		***	:	***	:	***
1979	: 349,821	:	50,082 :		***	:	***	:	***
1980	: 360,957	:	62,989 :		***	:	***	:	***
1981	: 385,263	:	67,194 :		***	:	***	:	***
	•	:	:			:		:	

Base material laminates: U.S. domestic shipments, exports of domestic merchandise, imports for consumption, 1977-81

1/ Exports are not included in U.S. domestic shipments.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Prices

Due to the great variety of products and large price differences among the products of the printed circuit board and laminate industries, prices are difficult to measure. To deal with the difficulty in price measurement, products of the printed circuit board and the laminate industries are classified into seven and eight groups, respectively, as shown in the tables on pages 32 and 34. The average value of domestic shipments is used as an approximation of the average price of each of the commodity groups. 1/ An

1/ The average price is in dollars per board for printed circuit boards, and is in dollars per square foot for laminates. Domestic shipments do not include intracompany and export shipments. This section examines only prices of products sold in the open market. examination of the price changes during 1977-81 suggests that the prices of the printed circuit boards trended downward and prices of base material laminates trended upward.

<u>Printed circuit boards</u>.--To satisfy different users' needs, firms in the printed circuit board industry produce a number of differentiated products. Product differentiation in the market can be described by types of base material laminates, specifications of the circuits, and types of bonded copper foil. <u>1</u>/ The price and costs of printed circuit boards vary with different specifications.

Production of circuit boards can use presetting or programing machines. The programing cost does not vary with the level of output. Tooling costs are also a one-time fixed charge. Due to high fixed cost, the average cost declines in a wide range of output levels. Under these conditions, the price can vary substantially with the quantity shipped. 2/ It is common practice for U.S. producers to sell printed circuit boards at negotiated prices. 3/ Usually, firms quote prices f.o.b. shipping point. In addition to price, delivery is also a main determinant of the sale of circuit boards. Domestic shipments of printed circuit boards are classified into seven groups in accordance with the types of base material laminates from which the boards were made. The average prices of these groups differ greatly from one to another, as shown in the following table.

1/ Specifications of wire systems include the number of circuit sides (one or two), the number and sizes of holes, and conductor spaces and widths. The hole size and cost are inversely proportional if the diameter of holes is below a certain size. The specifications of metallic sheet overlays refer to types, sizes, and the thicknesses of metals to be used. Customers often write these specifications.

2/ One firm indicated that the unit prices of the same printed circuit board they listed were \$51.46 for a shipment of 10 units and \$14.61 for a shipment of 1,000 units. Usually, their material cost varied from 28 to 35 percent of their total production cost.

3/ All cost factors are used in determining the price of a printed circuit board. Each of the factors is assigned a weight. These weights are regularly reviewed and adjusted.

Printed circuit boards: Average prices of printed circuit boards constructed from the average value of U.S. domestic shipments, 1977-81

	(Per boar	d)			
Туре	1977	1978	1979	1980	1981
Multilayer (3 layers or more) Additive Epoxy-glass base: (average) 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper Double-sided copper Epoxy-glass/paper base Other		: ; ; ; ; ; ; ; ; ; ; ; ; ;	$ \begin{array}{c} : \\ : \\ : \\ : \\ : \\ 10.41 \\ : \\ 1/ \\ : \\ 15.41 \\ : \\ 10.38 \\ : \\ 1.54 \\ : \\ 1.54 \\ : \\ 12.26 \\ \end{array} $	$\begin{array}{c} \$62.44\\ \underline{1}'\\ 1\overline{1.04}\\ \underline{1}'\\ 20.27\\ 10.98\\ 1.65\\ 48.00\\ 12.81\end{array}$	\$56.36 1/ 10.35 1/ 15.95 10.44 1.80 64.71 12.03
	•	•			

1/ Not available.

 $\overline{2}$ / Fixed weights are proportional to the average domestic shipment quantities during 1977-81.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The weighted-average values indicate that the prices of printed circuit boards declined by 14 percent in the 5-year period, from \$13.92 in 1977 to \$12.03 in 1981. The prices of the two most common groups--multilayer (3 layers and more) and the epoxy-glass base with double-sided copper--changed differently. Prices of multilayer boards, which accounted for more than 33 percent of domestic shipments, had a downward trend during 1977-81, gradually declined by 31 percent, from \$82.20 in 1977 to \$56.36 in 1981. Epoxy-glass boards with double-sided copper accounted for 63 percent of domestic shipments. Their prices ranged from \$10.38 in 1979 to \$10.98 in 1980, and fluctuated within 5.5 percent in other years. Because the changes in sales and/or product mix of the residual group "other" were larger than those of the specified groups, the large fluctuations in average prices of this group were not surprising.

Since official statistics on imported printed circuit boards by major product groups were unavailable until January 1982, it was not possible to make price comparisons between domestically produced and imported printed circuit boards.

Base material laminates.--Prices and production costs of base material laminates are determined mainly by types and quantities of materials that were used for production. In order to satisfy different users' needs, firms may produce a number of differentiated products. The product differentiation can be shown by the base material, resin, and physical volume. Base materials vary from paper to glass mat; resin materials include a number of chemicals; physical volume differentials are affected by differences in thickness. It is common practice for domestic producers to sell base material laminates at published prices. 1/ Generally, producers quote prices f.o.b. shipping point. A minimum quantity is required to be purchased. Any customer buying less than the minimum quantity pays an additional charge, which is normally a certain percentage of list price. Unlike price quotas on printed circuit boards, prices of base material laminates are not discounted once the purchase exceeds the minimum amount.

The weighted-average values indicate that the prices of U.S.-produced base material laminates rose modestly and exhibited small fluctuations during 1977-81. According to questionnaire information, the two most common groups were the thin multilayer laminates and the epoxy-glass base laminates with double-sided copper. Prices of the thin laminates (0.031 inch thick and less), which accounted for 14 percent of the value of total domestic shipments during 1977-81, increased by 17 percent, from \$1.92 in 1977 to \$2.24 in 1981, as shown in the following table. Prices of epoxy-glass base laminates with double-sided copper rose by 22 percent, from \$2.05 in 1977 to \$2.51 in 1981. This group accounted for about 48 percent of the value of total domestic shipments during 1977-81. The price of epoxy-glass base laminates experienced the smallest increase, 8 percent over the 5-year period. Pushed by increasing demand, the price of epoxy-glass/paper base laminates increased rapidly from \$1.33 in 1978 to \$1.69 in 1981; annual sales of this product increased by 92 percent during the period.

1/ In 1981, there were 19 firms in the industry, producing hundreds of different types of laminates. If a customer needed a unique laminate the producer and customer would negotiate the price.

(Per square foot) : 1977 1978 1979 Type 1980 1981 : : : : : Multilayer: : Thin laminates of 0.030 inch : thick or less-----: \$1.92 : \$2.04 : \$1.96 : \$2.16 : \$2.24 Prepreg, single-ply uncured : : • : epoxy-----: .46 : .44 : •45 **:** •44 : .48 Additive----------1.91 : 1.84 : 1.91 : 2.16 : 2.11 Epoxy-glass base: : 0.031 inch thick and less-----: 1.98 : 2.00 : 1.83 : 2.20 : 2.18 More than 0.031 inch thick: : : : : : 1.99 : Single-sided copper-----: 1.94 : 1.97 : 2.10 : 2.10 Double-sided copper-----: 2.05 : 2.08 : 2.22 : 2.46 : 2.51 Epoxy-glass/paper base-----: 1.47 : 1.33 : 1.53 : 1.66 : 1.69 Other-----1.44 : 1.54 : 1.67 : 1.70 : 2.03 Weighted average 1/-----1.50 : 1.51 : 1.60 : 1.71 : 1.78 --:

Base material laminates: Average prices of base material laminates constructed from the average value of U.S. domestic shipments, 1977-81

1/ Fixed weights are proportional to the average domestic shipment quantities during 1977-81.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Japanese Industry

The Japanese printed circuit board industry is characterized by a higher degree of vertical integration (captive production) than is the U.S. industry. Large Japanese electrical and electronics firms produce both printed circuit boards and base material laminates to support the production of their end products. The markets, i.e., the product mix, for printed circuit boards produced in Japan are also different than those in the United States. The demand for printed circuit boards (those produced from paper- or glass/paper-based laminates) dedicated for consumer products is proportionately larger than the demand for such articles in the United States. The industrial market in the United States, on the other hand, is proportionately larger than the industrial market in Japan.

The level of direct Japanese competition in the production of printed circuit boards in the United States (other than through U.S. imports) has been rather limited. The only Japanese producer of printed circuit boards in the United States was recently purchased by a large U.S. printed circuit board producer. This Japanese producer was reportedly unable to compete directly with other producers in the U.S. market because of its product mix.

Printed circuit boards

Shipments of printed circuit boards in Japan grew at an average annual rate of 25 percent during 1977-81. According to the 1981 edition of the Japan Electronics Almanac, producers' shipments were valued at \$1.1 billion in 1981 compared with \$425 million in 1977 as shown in the following table. Printed circuit boards produced for consumer products accounted for 43 to 48 percent of shipments during the period followed by industrial products with 40 to 46 percent; single-sided boards accounted for about 90 to 92 percent of boards incorporated in consumer products.

Туре	1977	:	1978	:	1979	:	1980	:	1981 <u>1</u> /
:				-1	,000 doll	la	rs		
:		:		:		:		:	
Industrial: :		:		:		:		:	
Single-sided:	25,672	:	41,010	:	44,450	:	48,053	:	52,754
Double-sided:	148,321	:	282,115	:	338,073	:	396,726	:	435, 539
Total:	173,993	:	323,125	:	382,523	.:	444,779	:	488 293
Consumer: :		:		:	,,		· · · , · · · ·	•	100,200
Single-sided:	188,955	:	272,452	:	335.872	:	376.549	:	413, 388
Double-sided:	16,269	:	22,260	:	31,835	:	42,699	:	46,876
Tota1:	205,224	:	294,712	:	367,707	:	419,248	•	460 264
Multilayer: :		:	,	:	,	:	123,210	•	400,204
Industrial:	10,374	:	19.279	:	15.734	•	14.956	•	16 419
Other:	34,925	:	66.731	:	69,771	:	79, 381	•	87 147
Total:	45,299	:	86,010	:	85,505	:	94,337	<u>.</u>	103,566
Grand total:	424,516	:	703,847	:	835,735	:	958,364	:	1,052,123
:		:		:		:		•	, _,

Printed circuit boards: Japanese producers' shipments, by markets, and by types, 1977-81

1/ Estimated by the staff of the U.S. International Trade Commission, based on industry data.

Source: Japan Electronics Almanac, 1981, except as noted.

Note.--Yen exchange rates in yen per dollar: 1977=268, 1978=208, 1979=218, 1980=226, and 1981=231.

Although printed circuit boards with components attached are outside the scope of this report, about 43 percent of the value of printed circuit boards produced in Japan in 1979 for industrial products and about 23 percent produced for consumer products were exported to the United States with components attached. Countries in Asia were the next largest market, accounting for 43 percent of exports of printed circuit boards found in consumer products in 1979.

Base material laminates

Data on shipments of base material laminates in Japan are not available. However, based on the estimation formula used by the IPC and the different product mix in Japan, the Commission staff estimated that the value of laminate shipments increased from \$64 million in 1977 to \$158 million in 1981. ***.

West European Industry

The West European industry, 1/ like the Japanese industry, is believed to be more vertically integrated than the U.S. industry. The large electrical equipment firms in Western Europe are the largest producers of circuit boards, which are manufactured for internal demand.

Printed circuit boards

Shipments of printed circuit boards in Western Europe according to the <u>MacKintosh Yearbook of West European Electronics Data</u>, increased in value from an estimated \$419 million in 1977 to about \$936 million in 1981, as seen in following the tabulation:

Shipment	1977	1978	1979	1980	1981
			Million doll	lars	
Printed circuit boards	<u>1</u> / 419	609	815	990	936

1/ Estimated by the staff of the U.S. International Trade Commission, based on industry data.

The average annual growth in such shipments was about 20 percent during the period.

The industry concentration in Western Europe is fragmented with the United Kingdom and West Germany each accounting for about 25 percent of shipments in 1981, France and Italy were the next largest suppliers in 1981, accounting for 16 percent and 14 percent, respectively. The market for printed circuit boards in Western Europe is similar to that in the United States; office machines and telecommunications equipment account for about 36 percent of the market, followed by instrumentation and commercial/military

1/ Includes the following 15 countries in Western Europe: Austria, Belgium, Denmark, Finland, France, Irish Republic, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and West Germany. equipment, each accounting for about 13 percent. Consumer products in Western Europe account for about 12 percent of the printed circuit board market.

Base material laminates

Data on shipments of base material laminates are not available on the West European industry. Using the data published on the U.S. laminate industry as a base, it is estimated that West European shipments increased in value from about \$67 million in 1977 to about \$150 million in 1981. Data are also not available on the amount of intercountry shipments of laminates produced in Western Europe.

Canadian Industry

The printed circuit board industry in Canada is relatively small and is integrated with the U.S. industry. There are no base material laminators in Canada; and therefore, the Canadian industry is dependent on outside sources for the laminates used in the production of printed circuit boards. The high level of U.S.-Canadian imports and exports of printed circuit boards is the result of ***.

Current Status of Major World Producers

The world market growth rate for circuit boards and laminates depends on the growth rate for electronic products. Countries showing high growth rates in the production of electronic products will show high growth rates in the production of circuit boards and the laminates from which they are made. The circuit board and laminate industries in the United States are integrated with the industries in Canada, and are larger than the combined industries in Western Europe and Japan. During 1977-81, the U.S. industries showed a lower growth rate than the Japanese industries, but a higher growth rate than the European industries. Although producers in Western Europe and Japan are more vertically integrated than those in the United States, the markets in Western Europe and the United States are more similar. The relatively large consumer electronics market in Japan makes that market different.

The technology and equipment for producing circuit boards and laminates are available to foreign and domestic producers alike. As a result, no real competitive advantage is held by foreign and domestic producers over each other except in cases of certain special dielectrics or processes. A large U.S. laminator reported that Japanese circuit board producers may have an advantage over U.S. producers in the production of superior, paper-based laminates. Paper-based laminates are used by Japanese producers in the production of consumer electronic products. A large U.S. producer of office machines and computers reportedly has developed a proprietary process for the production of ceramic-based boards which are efficient thermal conductors. Other than special cases such as these, the technology needed for circuit board production is available usually through producers of equipment and chemicals. Circuit boards and laminates imported into the United States are related to the activities of *** and to a lesser degree to foreign firms producing end products in the United States. During 1977-81, ***.

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During

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1977-81, the United States realized a strong, positive balance of trade in base material laminates and a moderate, negative balance of trade in printed circuit boards.

Circuit boards and laminates are produced and consumed in the same firm (or region) in which the end product is produced, and are not usually entered into international commerce. Circuit boards are most often imported and exported after incorporation into the end product. Therefore, a loss in the end-product market can result in a decline in the U.S. market for circuit boards.

Appendix A

Letter to the Commission From the Subcommittee on Trade, Committee on Ways and Means, U.S. House of Representatives, and a Copy of the Commission's Notice of Investigation as It Appears in the <u>Federal Register</u> AND COMMENTER ON TRADE

DAM REGISTEREDWERL, D.L. JAMES R. JONES, OKLA. CD JERNER, GA. THOMAS J. DOWNEY, M.Y. DON J. PEASE, ONIO KENT HANGE, TEX, WILLIAM M. SMODNEAD, MISH DON BALLEY, PA.

CLY VANDER JAST, MICH, BLL ARCHER, TEL, BLL, FRENER, MARN, L. A. (SEOP) BAFALIS, FLA, RIGHARD T. SCHREIE, PA,

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COMMITTEE ON WAYS AND MEANS RECEIVED ON WAYS AND MEANS STON, M RETY GALEF OF STAFF U.S. HOUSE OF REPRESENTATIVES 10 S. ABHR, STAFF DIR WASHINGTON, D.C. 20515 81 NOV 23 SUBCOMMITTEE ON TRADE OFFICE OF THE SECRETARY ODCKET/USHIC November 16, 1981 **PERCIN** VEK DE CUTTI. 51.2 RE CEIVED The Honorable William Alberger Chairman International Trade Commission 701 E Street, N. W. Washington, D. C. 20436 c n 5

Dear Mr. Chairman:

My colleague Congressman Richard T. Schulze of the Subcommittee has informed me of his interest in obtaining information about the trends in international trade in printed circuit boards and in the basic material from which such boards are produced, i.e., copper-clad laminates. I understand that demand for these products is expected to increase significantly. However, there appears to be little readily available import and foreign production data for these items.

Therefore, I request that the ITC conduct the appropriate study pursuant to section 332 of the Tariff Act of 1930 to determine relevant international trade data.

Thank you for your consideration.

Sincerel Gibbons Sam M. U.S. I. I.C. Chairman

SMG/DBRm

cc: The Honorable Richard T. Schulze

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Any business information which a submitter desires the Commission to treat as confidential shall be submitted separately and each sheet must be clearly marked at the top "Confidential business data." Confidential submissions must conform with the requirements of § 201.5 of the Rules of Practice and Procedure (19 CFR 201.6). All written submissions, except confidential business data, will be available for public inspection. A staff report containing preliminary findings of fact will be available to all interested parties on January 25, 1982.

Public hearing.-The Commission will hold a public hearing in connection with this investigation on February 16, 1982, beginning at 10:00 a.m., p.s.t., in room 223 of the New Federal Building, 1220 South West 3rd Street, Portland, Oregon. Requests to appear at the hearing should be filed in writing with the Secretary to the Commission not later than the close of business (5:15 p.m., e.s.t.) on January 29, 1982. All persons desiring to appear at the hearing and make oral presentations should attend a prehearing conference to be held at 2:00 p.m., e.s.t. on February 2, 1982, in Room 117 of the U.S. International Trade Commission Building and must file prehearing statements on or before February 10, 1982. For further information concerning the conduct of the investigation, hearing procedures. and rules of general application, consult the Commission's Rules of Practice and Procedure, Part 207, Subpart C (19 CFR Part 207), and Part 201, Subparts A through E (19 CFR Part 201).

The Commission has waived Commission rule § 201.12(d). "Submission of prepared statements," in connection with this investigation. This rule states that "Copies of witnesses prepared statements should be filed with the Office of the Secretary of the Commission not later than 3 business days prior to the hearing and submission of such statements shall comply with §§ 201.6 and 201.8 of this subpart". It is nevertheless the Commission's request that parties submit copies of witnesses prepared testimony as early as practicable before the hearing in order to permit Commission review.

FOR FURTMER INFORMATION CONTACT: Daniel Leahy, investigator, Office of Investigations, U.S. International Trade Commission, (202) 523-1369 or Jane Albrecht, attorney, Office of the General Counsel, U.S. International Trade Commission, (202) 523-1827.

By Order of the Commission,

Issued: December 14, 1981. Kenneth R. Mason, Secretary. (PR Dec. Statute Flori 12-22-51: Les anj BRLING CODE 7828-51-51

[332-133]

Trends in International Trade in Printed Circuit Boards and Base Material Laminates

AGENCY: United States International Trade Commission.

ACTION Following receipt on November 18, 1981, of a request from the Chairman of the Subcommittee on Trade of the Committee on Ways and Means of the U.S. House of Representatives, the Commission, on its own motion, instituted investigation No. 332-133 under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)), for the purpose of gathering and presenting information on trends in international trade in printed circuit boards and base material laminates and the factors affecting the competitiveness of U.S. producers of such products. This study will present a profile of the United States market and industry, and to the extent possible, the Canadian, European, and Japanese markets and industries and their comparative technical and economic strengths.

EFFECTIVE DATE December 10, 1981. FOR FURTHER INFORMATION CONTACT: Mr. Nelson Hoggé or Mr. Harold Graves, Machinery and Equipment Division, U.S. International Trade Commission. Washington, D.C. 20436, telephone 202-523-0377 or 202-523-0360, respectively. PUBLIC HEARING: A public hearing in connection with the investigation will be held in the Commission Hearing Room, 701 E Street NW., Washington, D.C. 20436, beginning at 10:00 a.m., e.d.t., on May 12, 1982, to be continued on May 13, 1982, if required. All persons shall have the right to appear by counsel or in person, to present information, and to be heard. Requests to appear at the public hearing should be filed with the Secretary, United States International Trade Commission, 701 E Street NW., Washington, D.C. 20438, not later than noon, May 5, 1982.

WRITTEN SUBMISSION In lieu of or in addition to appearance at the public bearing, interested persons are invited to submit written statements concerning the investigation. Communcial or financial information which a submitter desired the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's Rules of Practice and Procedure (19 CFR 201.6). All written submissions. except for confidential business information, will be made available for inspection by interested persons. To be ensured of consideration by the Commission.

written statement should be submitted at the earliest practicable date, but no later than May 20, 1982. All submissions should be addressed to the Secretary at the Commission's office in Washington, D.C.

By order of the Commission. Issued: December 14, 1981. Kenneth R. Mason, Secretary. [FR Dec. 81-3823 Flict 13-23-51: 545 and

(FR Dec. 61-39625 Files 13-23-61; 845 am) Billing Coofe 7028-43-41

DEPARTMENT OF JUSTICE

Drug Enforcement Administration

[Docket Nos. 81-7, 8, 9, 10; and 13]

Loyd B. Rapp, et al.; Approval of Limited Registrations

On March 11, 1981, the Administrator of the Drug Enforcement Administration issued Orders to Show Cause proposing to deny the application for registration submitted by Loyd B. Rapp. N.D., Ralph R. Weiss, N.D., Donald C. Walker, N.D., Edmonde G. Samuel, N.D., and Joseph A. Rombough, N.D. (Respondents). The Orders to Show Cause were issued because the Drug Enforcement Administration (DEA) was unable to determine whether the Respondents. Naturopathic Physicians licensed to practice naturopathic medicine by the Naturopathic Board of Examiners of the State of Oregon, were authorized to utilize controlled substances under the laws of the State of Oregon regulating the practice of naturopathic medicine and the use of controlled substances.

The Respondents, through counsel, requested hearings on the issues raised by the Orders to Show Cause and these matters were placed on the docket of Administrative Law Judge Francis L Young. Since the issues involved in all five cases were identical. Judge Young consolidated them for hearing and other proceedings.

Prior to the scheduled hearing in these matters, counsel for the Government and counsel for the Respondents filed a Stipulation of Settlement which resulted in the termination of the proceedings pending before the Administrative Law

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158. Washington, D.C. 20438, telephone 202-523-0471.

FOR FURTHER INFORMATION CONTACT: Robert S. Budoff, Esq., Unfair import Investigations Division, U.S. International Trade Commission, telephone 202-523-0113.

By order of the Commission. Issued: January 25, 1982. Kenneth R. Mason, Secretary: (FR Doc.45-238 Flict 3-57-52, 5et5 on) SLLDIG COOL 7000-0-01

[Investigation No. 332-133]

Trends in International Trade in Printed Circuit Boards and Base Material Laminates; Change of Date of Public Hearing

Notice is hereby given that the time and date for the public hearing to be held in connection with United States International Trade Commission investigation No. 332-133. Trends in International Trade in Printed Circuit Boards and Base Material Laminates. has been changed to 10 a.m., a.d.t., Wednesday, May 5, 1982, in the Commission's Hearing Room, U.S. International Trade Commission Building, 701 E Street, NW., Washington, D.C. A hearing date of May 12, 1982, had previously been announced in the Commission's notice of institution of the investigation as published in the Federal Register of December 23, 1981 (46 FR 62348). Requests to appear at the hearing should be filed in writing with the Secretary to the Commission not later than the close of business (5:15 p.m., e.d.t.) April 28, 1982.

By order of the Commission. Issued: January 25, 1982. Kenneth R. Mason, Secretary. (FR Dec. 52-525) Filed 1-57-52 545 enj pt.Ling. CODE 7020-03-45

DEPARTMENT OF JUSTICE

Antitrust Division

United States v. Western Electric Company, et al.; Proposed Modification of Final Judgment; United States v. American Telephone and Telegraph Co., et al.; Stipulation for Voluntary Dismissal

Notice is hereby given pursuant to an order of the United states District Court of the District of Columbia. dated January 21, 1982, in Civil Action Nos. 74– 1698 and 82–0192 that a proposed Modification of Final Judgment and

Stipulation. as set forth below, have been filed, originally with the United States District Court for the District of New Jersey in United States v. Western Electric Company, et al., Civil Action No. 17-49. By order of the District Court in New Jersey dated January 14, 1982. No. 17-49 has been transferred to the United States District Court for the District of Columbia where it has been docksted under Civil Action No. 82-0192. A Stipulation for Voluntary Dismissal, as set forth below, has been lodged with the District Court for the District of Columbia in United States v. American Telephone and Telegraph Company, et al., Civil Action No. 74-1698.

The Complaint in the case now docksted as Civil Action NO. 82-0192 was filed in 1949 and charged the defendants with monopolizing the manufacture and distribution of telephone equipment in violation of the Sherman Act. A consent decree was entered in 1956 in settlement of that case in the District Court in New Jersey. The 1956 Decree contained various restrictions on AT&T's activities.

Under the modified Decree, all of the provisions of the 1958 Decree would be eliminated and replaced by provisions requiring AT&T to undertake an 18month regressization, after which local Bell operating companies providing local exchange telephone services would be divested by AT&T. AT&T would continue to own a nationwide intercity network composed of its Long Lines Department and the intercity facilities of the Bell operating companies, and would ratain ownership of Bell Telephone Laboratories and Western Electric. AT&T wold also provide customer premises equipment. AT&T's plan for the required reorganization is to be submitted to the Department of Justice for its approval within six months of the effective date of the modified Decree.

The modified Decree would also require the to-be-divested operating companies to provide, on a phased-in basis, exchange access to all intercity carriers equal to that provided to AT&T. and forbid the operating companies from discriminating against AT&T's competitors with respect to procurement, interconnection of equipment or services, the establishment and disclosure of technical specifications, and the planning of new facilities and services. In addition, the modification would require the operating companies, after divestiture. to provide through a centralized organization a single point of contact for coordination of those companies to meet the requirements of national security and emergency prepareciness.

Simultaneously with the filing of the modification on January 8, 1982, the Government and AT&T stipulated to dismissel without prejudice of the Government's more recent monopolization case against AT&T [No. 74-1698), which was filed in 1974 in the District of Columbia. In that case, the Government alleged that AT&T had monopolized certain telecommunications services and equipment markets. The reorganization achieved by the modification of the 1958 Decree is similar to the relief that had been sought by the Department of justice in the 1974 litigation.

Under the terms of the January 21, 1982 court order, the United States, on or before February 5, will file with the District Court in the District of Columbia and publish in the Federal Register a competitive impact statement reciting:

"(1) the nature and purpose of the proceeding:

(2) a description of the practices or events giving rise to the alleged violation of the antitrust laws:

(3) an explanation of the proposal, including an explanation of any unusual circumstances giving rise to the proposal or any provisions contained therein, relief to be obtained thereby, and the anticipated effects on competition of such relief;

(4) the remedies available to potential private plaintiffs damaged by the alleged violation in the event that the Modification of Final Judgment and the Dismissal are entered in these proceedings;

(5) a description of the procedures available for modification of the proposal; and

(6) a description and evaluation of alternatives to the proposal actually considered by the United States."

At the time the competitive impact statement is published in the Federal Register, the United States will invite public comment on the proposed modification.

Joseph H. Widmar,

Director of Operations Antitrust Division.

Stipulation

In the matter of United States of America, Plaintiff v. Western Electric Company, Incorporated, and American Telephone and Telegraph Company, Defendants, Civil Action No. 17-49.

It is stipulated by and between the undersigned parties. Plaintiff. United States of America, and Defendants. American Telphone & Telegraph Company and Western Electric Company. Incorporated, by their respective attorneys, that: Appendix B

Scheduled Staged Rates of Duty for Printed Circuit Boards and Base Material Laminates Printed circuit boards and base material laminates: U.S. rates of duty, by TSUS items

	(1 or obite a	a varorem/			
TSUS item No. <u>1</u> /	Description	Pre-MTN col. 1 rate of duty <u>2</u> /	: Sta : du : re : en :; 1980 :	aged col. ty effect spect to tered on Jan. 1981	l rate of tive with articles or after 1 1982 : 1983
685.90A	Articles for making, breaking, protecting, and	8.5%	: 8.1% :	7.7% :	7.3% : 6.9%
774.55A :	connecting electrical circuits. Articles not specially provided for of rubber or plastics. <u>3</u> /	8.5%	8.1%	: 7.7% : :	: : 7.3% : 6.9% :
• : : :		Staged duty respe enter	: : i col. l effectiv ect to ar ced on or	: rate of e with ticles after	: : : Col. 2 : rate of
:		1984 19	Jan. 1 985 19	86 198	: duty 37
685.90A :	Articles for making, breaking, protecting, and :	: 6.5% : 6. :	: .1% : 5. :	: 7% : 5.3 :	: 3% : 35%. :
774.55A : :	circuits. Articles not specially provided for of rubber or plastics. <u>3</u> /	6.5% : 6. : :	: 1% : 5. : :	: : 7% : 5.3 : :	: : 8% : 80%. : :

(Percent ad valorem)

1/ The designation "A" indicates that the item is currently designated as an eligible article for duty-free treatment under the U.S. Generalized System of Preferences (GSP) and that all beneficiary developing countries are eligible for the GSP.

 $\frac{2}{3}$ Rate effective prior to Jan. 1, 1980. $\frac{3}{7}$ Formerly part of TSUS item 774.60 which was discontinued Jan. 1, 1980.

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Appendix C Statistical Tables Table 1.---Printed circuit boards: U.S. domestic and intracompany shipments, by types, 1977-81

Quantity (1,000 boards) Domestic shipments: 1/ Multilayer (3 layers or more) **** **	ltem	1977	1978	1979	1980	1981
Domestic shipments: 1/ Multilayer (3 layers or more) ***		:	Quanti	.ty (1,000) boards)	
Domestic Shipments: 1/ ***	Democratic chieveness 1/	:	:	:	:	:
Allillayei (J layers of more) ***	Domestic snipments: 1/	:	:	: alta da alta	:	•
1: Contact in thick in thi	Multilayer (5 layers or more)	· · · · · · · · ·	: ***	: ***	: ***	: ***
Untri: Epoxy-glass base: ****	from additive laminates	•: ***	: ***	: ***	: ***	· ***
Dody-glass Dase: *** <td>Energy base bases</td> <td>•</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td>	Energy base bases	•	:	:	:	:
0.001 inch thick and less *** <t< td=""><td>0 021 doch thick and line</td><td>:</td><td>: </td><td>:</td><td>:</td><td>:</td></t<>	0 021 doch thick and line	:	: 	:	:	:
Note that 0.031 inch thick: ***	More then 0 021 dash shield		: ^^~	: ***	: ***	: ***
Single-side Copper	More than 0.031 inch thick:	:	:	: 	:	:
Double-side Double-side X+X X+X<	Single-Sided copper	***	: ^^^	***	· ***	: ***
Doty-glass/paper Dase **** *** *** *	Double-sided copper	***	: ***	***	****	·
Sightotal	Cpoxy-glass/paper base	***	:		:	: ***
3,641 7,055 9,260 10,581 11,151 Multilayer (3 layers or more) **** *** ***	Subtatal		<u> </u>	<u>: ***</u>	***	***
Intracompany shipments: **** *** *** <td< td=""><td></td><td>•: 5,641</td><td>: 7,055.</td><td>: 9,260</td><td>: 10,581</td><td>: 11,158</td></td<>		•: 5,641	: 7,055.	: 9,260	: 10,581	: 11,158
Multilayer (3 layers or more) ***** **** ****	intracompany shipments:	:	:	:	:	:
Prom additive laminates ****	Multilayer (3 layers or more)		: ***	: ***	***	: ***
outer: : <td:< td=""> : <td:< td=""> <td:< td=""></td:<></td:<></td:<>	From additive laminates	.: ***	: ***	: ***	: ***	: ***
Epoxy-glass base: *** <td>Other:</td> <td>:</td> <td>•</td> <td>:</td> <td>:</td> <td>:</td>	Other:	:	•	:	:	:
0.031 inch thick and less ****	Epoxy-glass base:	:	:	:	:	:
More than 0.031 inch thick: : <td:< td=""><td>0.031 inch thick and less</td><td>·: ***</td><td>: ***</td><td>: ***</td><td>: ***</td><td>: ***</td></td:<>	0.031 inch thick and less	·: ***	: ***	: ***	: ***	: ***
Single-sided copper	More than 0.031 inch thick:	• • • • • •	:	:	:	:
Double-sided copper	Single-sided copper	: ***	: ***	: ***	: ***	: ***
Epoxy-glass/paper base **** *** ***	Double-sided copper	: ***	: ***	: ***	: ***	: ***
Other x** : *** : *** : *** : *** : *** Subtotal 91,194 :112,635 :118,449 :118,069 : 115,927 Total 96,835 :119,690 :127,709 :128,650 : 127,08 Walue (1,000 dollars) *** : *** : *** : *** : *** *** : *** : *** : *** : *** : *** : *** Multilayer (3 layers or more) *** : *** : *** : *** : *** : *** *** : *** : *** : *** : *** : *** : *** : *** Prom additive laminates *** : *** : *** : *** : *** : *** : *** Other: : : : : : : : : : : : : : : : : : : :	Epoxy-glass/paper base	***	: ***	: ***	: ***	: ***
Subtotal 91,194 :112,635 :118,449 :118,069 : 115,925 Total 96,835 :119,690 :127,709 :128,650 : 127,087 Walue (1,000 dollars)	Other	***	: ***	: ***	: ***	***
Total	Subtotal	: 91,194	:112,635	:118,449	:118,069	: 115,929
Domestic shipments: 1/ Image: Shipments: 1/ Multilayer (3 layers or more)	Total	: 96,835	:119,690	:127,709	:128,650	: 127.087
Domestic shipments: 1/ Multilayer (3 layers or more)		:	Value	(1,000 do	llars)	
Domestic shipments: 1/ Multilayer (3 layers or more)			•	•	•	
Multilayer (3 layers or more) **** **** *** ***	Domestic shipments: 1/		•	•	•	•
From additive laminates ***	Multilayer (3 layers or more)	: ***	* ***	• ***	• ***	
Other:	From additive laminates		• • • •	• • • • •		
Epoxy-glass base:	Other:	• ***	* ***	· ***	***	***
0.031 inch thick and less	Epoxy-glass base:		•	•		
More than 0.031 inch thick: : <td:< td=""><td>0.031 inch thick and less</td><td>• ***</td><td></td><td>•</td><td>; </td><td></td></td:<>	0.031 inch thick and less	• ***		•	; 	
Single-sided copper	More than 0.031 inch thick:	•			: ^^^	****
Double-sided copper ***<	Single-sided copper-	· · ***	• ***	• ***	: 	
Epoxy-glass/paper base	Double-sided conner-		م ماد ماد ماد ماد ماد ماد		; ^\XX 1	***
Other *** <td< td=""><td>Epoxy-glass/paper base</td><td>• ***</td><td>· · · · · · · · · · · · · · · · · · ·</td><td>· · · · · · ·</td><td>· ***</td><td>***</td></td<>	Epoxy-glass/paper base	• ***	· · · · · · · · · · · · · · · · · · ·	· · · · · · ·	· ***	***
Subtotal	Other	. ***	***	***	: XXX ;	. <u>7777</u>
District and pany shipments: : <td< td=""><td>Subtotal</td><td><u></u></td><td></td><td>100 000</td><td>****</td><td>***</td></td<>	Subtotal	<u></u>		100 000	****	***
Multilayer (3 layers or more) ***		: 02,210	: 02,402	:108,280	:139,253	: 155,438
Mattilizet (3) layers of more) ****	Multilever (3 levers on some)	***	بالد مايد مايد	د. ماد ماد ماد	:	
Other: : ***	Free addition landatte		· · · · ·		: * **	***
Conter: : </td <td>fibe additive laminates</td> <td>: ***</td> <td>: ***</td> <td>: ***</td> <td>: *** ;</td> <td>***</td>	fibe additive laminates	: ***	: ***	: ***	: *** ;	***
Lpoxy-glass Dase: :	FROMW-Gloop been	:	:	:	:	1
0.031 inch thick: : *** :	DO21 dest black	:	: :	:	: ; ;	:
Note than 0.031 inch thick: : *** <t< td=""><td>None that 0 021 is a list</td><td>: ***</td><td>: ***</td><td>: ***</td><td>: *** ;</td><td>***</td></t<>	None that 0 021 is a list	: ***	: ***	: ***	: *** ;	***
Single-sided copper	more than 0.031 inch thick:	: ***	: ***	ماد ماد ماد	:	J 1 1.
Double-sided copper	Single-sided copper	:	: ^**		· ***	***
Epoxy-glass/paper base: *** : *** : *** : *** : *** Other:: *** : *** : *** : *** : *** : *** Subtotal::: 349,659 :477,416 :657,302 :758,482 : 913,332 Total:: 411,875 :559,818 :765,582 :897.735 :1.068.820	Double-sided copper	: ***	: ***	***	***	***
Other	Epoxy-glass/paper base		ماہ ماہ ماہ	***		***
Subtotal:: <u>349,659</u> :477,416:657,302:758,482:913,332 Total::414,875:559,818:765,582:897.735:1.068.820		****	: *** :	;	1 000 H	
Total		: <u>***</u>	***	***	***	***
	Subtotal	*** *** : <u>349,659</u>	*** :477,416	*** 657,302	*** 758,482	***

1/ Domestic shipments excluded intracompany and export shipments.

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Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

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Туре	1977	1978	1979	1980	1981	
	: Quantity (1,000 square feet)					
		:		:	handi yang kang di sang sa	
Domestic shipments: 1/			71 992 .	81 / 7/ .	9/ 511	
Multilayer:	: 38,470 :		/1,005 :	01,4/4 ;	74,241	
or less-	. 12.578	17.792	21.896	24,552 :	25,643	
Prepreg. single-ply uncured epoxy	: 25,892	37,927 :	49,987	: 56,722 :	68,868	
Additive	: 710 :	: 1,459 :	1,418	: 1,195 :	1,801	
Epoxy-glass base:	: 58,531	: 68,859 :	97,312	: 89,084 :	84,809	
0.031 inch thick and less	: 677	: 750	1,175	1,068 :	1,136	
More than 0.031 inch thick:	. 10 0/3	12 308	10 677	15 909 -	15 384	
Single-sided copper	46 91.1	54.711	76.460	72.107	68,289	
FDOTY-glass/base-	: 18.287	: 23,116	23,627	: 23.872 :	30,579	
Other	: 12,949	: 13,291	13,701	: 10,689 :	11,870	
Subtotal	:128,947	:162,444	207,941	:206,314 :	223,570	
Intracompany shipments:	:	:	;	: :		
Multilayer:	: 576	: 598	683	: 800 :	1,330	
Thin laminates of 0.030 inch thick	:				£1/	
or less	: 336	: 320 . 373	: 3// . 306	: 40∠: . २२ २ -	. 014 - 716	
Additive	: 240	. 412		: 0.0	, 10 , 10	
Additive	. 742	: 1.029	: 1,157	: 1,077	1,004	
0.031 inch thick and less	: 5	: 8	: 4	: 8:	: 1	
More than 0.031 inch thick:	:	:	:	:		
Single-sided copper	: 50	: 80	: 105	: 63`:	: 54	
Double-sided copper	: 687	: 941	: 1,048	: 1,006	: 949	
Epoxy-glass/paper base	: 1,466	: 1,900	: 2,220	: 2,537	: 2,332	
Other	: 139	: 141	: 1/8	: 1/5		
Subtotal	: 2,988	: 3,000	: 4,230	: 4,209	: 4, 751	
		177 113				
Total	: <u>131,935</u>	:166,112	:212,179	:210,903	: 228,321	
Total	: <u>131,935</u> : :	:166,112 Value	:212,179 (1,000 do	:210,903 11ars)	: 228,321	
Total	: <u>131,935</u> : :	:166,112 Value :	:212,179 (1,000 do : :	:210,903 11ars) : :	: 228,321	
Total Domestic shipments: <u>1</u> / Multilayer:	: <u>131,935</u> : : : :	:166,112 Value : :	:212,179 (1,000 do : :	:210,903 llars) : :	: 228,321 : : :	
Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick	: <u>131,935</u> : : : :	:166,112 Value : : :	:212,179 (1,000 do : : :	:210,903 11ars) : : : :	: 228,321 : : :	
Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less	: <u>131,935</u> : : : : : : : : : : : : : : : : : : :	:166,112 Value : : : : : 34,862	:212,179 (1,000 do : : : : : : 44,756	:210,903 11ars) : : : : : : 53,025	: 228,321 : : : : 57,54	
Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy	: <u>131,935</u> : : : : : : : : : : : : : : : : : : :	<pre>:166,112 Value : : : : : : : : : : : : : : : : : : :</pre>	:212,179 (1,000 do : : : : : 44,756 : 22,229	:210,903 11ars) : : : : 53,025 : 25,237	: 228,321 : : : : 57,54 : 32,96	
Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive	: <u>131,935</u> : : : : : 24,098 : 11,776 : 1,357	:166,112 Value : : : : 34,862 : 16,818 : 2,684	:212,179 (1,000 do : : : : : : : : : : : : : : : : : : :	:210,903 11ars) : : : : 53,025 : 25,237 : 2,578	: 228,321 : : : : 57,54 : 32,96 : 3,794	
Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base:	: <u>131,935</u> : : : : : 24,098 : 11,776 : 1,357 :	<pre>:166,112 Value : : : : : : : : : : : : : : : : : : :</pre>	:212,179 (1,000 do : : : : : 44,756 : 22,229 : 2,713 : : . 2,150	:210,903 11ars) : : : : 53,025 : 25,237 : 2,578 : : : : : : : : : : : : :	: 228,321 : : : 57,54 : 32,96 : 3,794 : : 2,47	
Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less	: <u>131,935</u> : : : : : 24,098 : 11,776 : 1,357 : : 1,338	<pre>:166,112 Value : : : 34,862 : 16,818 : 2,684 : : 1,501 ;</pre>	:212,179 (1,000 do : : : : : 44,756 : 22,229 : 2,713 : : 2,150	:210,903 11ars) : : : 53,025 : 25,237 : 2,578 : : 2,349 :	: 228,321 : : : 57,54 : 32,96 : : 3,79 : : 2,47	
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Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper	: <u>131,935</u> : : : : : : : : : : : : : : : : : : :	:166,112 Value : : : 34,862 : 16,818 : 2,684 : : 1,501 : : 26,715 :113,047	:212,179 (1,000 do : : : : 44,756 : 22,229 : 2,713 : : 2,150 : : 38,792 :172,031	:210,903 11ars) : : : : 53,025 : 25,237 : 2,578 : : 2,349 : : : 33,433 :177,062	: 228,321 : : : 57,54! : 32,96 : : 3,794 : : 3,794 : : 3,794 : : 3,794 : : 3,794 : : 3,794 : : 3,794 : : 1,71,210	
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Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper	: <u>131,935</u> : : : : : : 24,098 : 11,776 : : 1,338 : : : 1,338 : : : 21,237 : : 96,159 : : 26,807 : : 18,638	:166,112 Value : : : 34,862 : 16,818 : 2,684 : : 1,501 : : 26,715 :113,047 : 30,776 : 20,429	:212,179 (1,000 do : : : : 44,756 : 22,229 : 2,713 : : 2,150 : : 38,792 :172,031 : 36,052 : 22,863	:210,903 11ars) : : : : 53,025 : 25,237 : 2,578 : : 2,349 : : 33,433 :177,062 : 29,555 : 18,162	: 228,321 : : : 57,54 : : 32,96 : : 32,96 : : 3,794 : : 2,477 : : 2,477 : : 32,915 : : 32,915 : : 32,95 : : 3,794 : : 2,477 : : 32,915 : : 32,915 : : 2,477 : : 32,915 : : 32,9	
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Total Total Domestic shipments: <u>1</u> / Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper	: <u>131,935</u> : : : : : : : : : : : : : : : : : : :	:166,112 Value : : : 34,862 : 16,818 : 2,684 : : 26,715 :113,047 : 30,776 : 20,429 :246,832 : : 1,045 : : 946 : 99 : -	:212,179 (1,000 do : : : 22,229 : 2,713 : : 22,150 : : 38,792 :172,031 : 36,052 : 22,863 : 341,586 : : 1,405 : : 1,282 : 123 : -	:210,903 11ars) : : : : : : : : : : : : :	: 228,321 : 228,321 : 32,967 : 32,967 : 32,967 : 3,794 : 2,477 : 2,475 : 2,475 : 2,475 : 2,475 : 2,475 : 2,475 : 2,475 : 2,234 : 2,247 : 2,2	
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Total Domestic shipments: 1/ Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper Double-sided copper	: <u>131,935</u> : : : : : : : : : : : : : : : : : : :	:166,112 Value : : : : : : : : : : : : :	:212,179 (1,000 do : : : : 44,756 : 22,229 : 2,713 : : 22,150 : : 38,792 : 172,031 : 36,052 : 22,863 : 341,586 : : 1,282 : 1,282 : 1,282 : 2,637 : 2,637 : 8 : 240	:210,903 11ars) : : : : : : : : : : : : :	: 228,321 : 228,321 : 32,967 : 32,967 : 32,967 : 32,967 : 32,947 : 2,477 : 2,475 : 2,475 : 2,234 : 1,888 : 2,697 : 2	
Total Domestic shipments: 1/ Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper	: <u>131,935</u> : : : : : : : : : : : : :	:166,112 Value : : : : : : : : : : : : :	:212,179 (1,000 do : : : : 22,229 : 2,713 : : 22,229 : 2,713 : : 2,150 : : 38,792 : 172,031 : 36,052 : 22,863 : 341,586 : : 1,282 : 1,282 : 1,282 : 1,282 : 2,637 : 2,389 : 2,389	:210,903 11ars) : : : : : : : : : : : : :	: 228,321 : 228,321 : 32,967 : 32,967 : 32,967 : 3,794 : 2,477 : 2,234 : 1,888 : 2,697 : 2,697 : 2,547 : 2,547 : 2,697 : 2,547 : 2,5	
Total Domestic shipments: 1/ Multilayer: Thin laminates of 0.030 inch thick or less Prepreg, single-ply uncured epoxy Additive Epoxy-glass base: 0.031 inch thick and less More than 0.031 inch thick: Single-sided copper	: <u>131,935</u> : <u>131,935</u> : <u>24,098</u> : <u>11,776</u> : <u>1,357</u> : <u>1,338</u> : <u>21,237</u> : <u>96,159</u> : <u>26,807</u> : <u>18,638</u> : <u>201,410</u> : <u>864</u> : <u>788</u> : <u>788</u> : <u>788</u> : <u>788</u> : <u>129</u> : <u>1,601</u> : <u>1,482</u> : <u>1,482</u> : <u>2,003</u>	:166,112 Value : : : : : : : : : : : : :	:212,179 (1,000 do : : : : 22,229 : 2,713 : : 22,150 : : 38,792 :172,031 : 36,052 : 22,863 :341,586 : : 1,282 : 1,282 : 1,282 : 2,637 : 8 : 2,400 : 2,389 : 3,099 : 3,099	:210,903 11ars) : : : : : : : : : : : : :	: 228,321 : 228,321 : 32,967 : 32,967 : 32,967 : 32,967 : 32,967 : 32,967 : 32,967 : 2,477 : 2,234 : 1,888 : 2,697 : 2,697 : 144 : 2,544 : 3,677 : 7,774	
Total Total	: <u>131,935</u> : <u>131,935</u> : <u>24,098</u> : <u>11,776</u> : <u>1,357</u> : <u>1,338</u> : <u>21,237</u> : <u>96,159</u> : <u>26,807</u> : <u>18,638</u> : <u>201,410</u> : <u>864</u> : <u>788</u> : <u>788</u> : <u>788</u> : <u>788</u> : <u>129</u> : <u>1,601</u> : <u>1,482</u> : <u>1,482</u> : <u>2,003</u> : <u>628</u> : <u>5,225</u>	:166,112 Value : : : : : : : : : : : : :	:212,179 (1,000 do : : : : 22,229 : 2,713 : : 2,150 : : 38,792 : 172,031 : 36,052 : 22,863 : 341,586 : : 1,282 : 1,282 : 1,282 : 1,282 : 2,637 : 2,150 : : 2,637 : 2,389 : 1,094 : 2,389 : 1,094 : 8,735	:210,903 11ars) : : : : : : : : : : : : :	: 228,321 : 228,321 : 32,967 : 32,967 : 32,967 : 32,967 : 32,967 : 2,477 : 2,234 : 1,888 : 2,544 : 2,544 : 3,677 : 7,224 : 2,244 : 3,677 : 7,244 : 3,677 : 7,244 : 3,677 : 7,244 : 3,677 : 7,247 : 7,447 : 7	
Total Total	: <u>131,935</u> : <u>131,935</u> : <u>24,098</u> : <u>11,776</u> : <u>1,357</u> : <u>1,338</u> : <u>21,237</u> : <u>96,159</u> : <u>26,807</u> : <u>18,638</u> : <u>201,410</u> : <u>864</u> : <u>788</u> : <u>788</u> : <u>76</u> : <u>129</u> : <u>1601</u> : <u>1,482</u> : <u>99</u> : <u>110</u> : <u>1,482</u> : <u>2,003</u> : <u>628</u> : <u>5225</u> : <u>206,235</u>	:166,112 Value : : : : : : : : : : : : :	:212,179 (1,000 do : : : : : 22,229 : 2,713 : : 2,150 : : 38,792 : 172,031 : 36,052 : 22,863 : 341,586 : : 1,282 : 1,282 : 1,282 : 1,282 : 2,637 : 2,637 : 2,637 : 2,389 : 1,094 : 3,099 : 1,094 : 36,052 : 2,389 : 1,094 : 36,052 : 2,389 : 1,094 : 36,052 : 2,150 : 1,094 : 36,052 : 2,150 : 1,282 : 2,150 : 1,282 : 1,282 : 1,282 : 2,389 : 1,094 : 3,099 : 1,094 : 36,052 : 2,389 : 1,094 : 36,052 : 2,150 : 1,282 : 1,282 : 1,282 : 2,150 : 1,282 : 2,150 : 1,282 : 1,282 : 2,150 : 1,282 : 2,389 : 1,094 : 1,094 : 3,099 : 1,094 : 3,095 : 1,094 : 3,095 : 1,094 : 3,095 : 1,282 : 2,385 : 3,095 : 3,055 : 3,0555 : 3,0555 : 3,0555 : 3,0555 : 3,0555 :	:210,903 11ars) : : : : : : : : : : : : :	: 228, 321 : 228, 321 : 32, 967 : 375, 937 : 2, 24, 105 : 375, 937 : 2, 234 : 1,882 : 375 : 2, 693 : 2, 693 : 2, 693 : 146 : 2, 544 : 3, 679 : 2, 544 : 3, 679 : 2, 544 : 3, 679 : 2, 544 : 3, 724 : 3,	

1/ Domestic shipments exclude intracompany and export shipments.

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Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

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Туре	1977	1978	1979	1980	1981
		Quantity	(1,000 squ	are feet)	······································
		:		:	:
	:	•	:	:	:
Multilayer:		: :	:	:	:
Thin laminates of 0.030 :		:	:	•	:
inch thick or less:	***	: ***	***	: ***	: ***
Prepreg, single-ply,		:		:	:
uncured epoxy:	***	: ***	***	: ***	: ***
Additive:	***	: *** :	***	: ***	: ***
Epoxy-glass base: :		: :		: 1	:
0.031 inch thick and :		: :		•	:
less:	***	: *** :	***	: ***	: ***
More than 0.031 inch :		:		•	:
thick: :		: :		•	:
Single-sided copper:	***	***	***	: ***	: ***
Double-sided copper:	***	***	***	: ***	: ***
Epoxy-glass/paper base:	***	***	***	: ***	: ***
Other:	***	***	***	: ***	: ***
lotal:	***	***	***	: ***	: ***
:		Value	(1,000 do	llars)	
				:	•
				:	•
Multilayer: :				:	•
Thin laminates of 0.030 :				:	• • • • • • • • • • • • • • • • • • •
inch thick or less:	***	***	***	***	
Prepreg, single-ply, :				:	:
uncured epoxy:	***	***	***	***	
Additive:	***	***	***	***	· · · · · · · · · · · · · · · · · · ·
Epoxy-glass base: :		:		:	:
0.031 inch thick and :		:		:	:
less:	***	*** :	***	***	ماد ماد باد
More than 0.031 inch :				:	
thick: :					•
Single-sided copper:	***	*** :	***	***	***
Double-sided copper:	***	*** :	***	***	
Epoxy-glass/paper base:	***	***	***	***	- ^^X
Other:	***	***	***	***	
Total:	***	***	***	***	***
• • • • • • • • • • • • • • • • • • •	-	•			
0				· · · · · · · · · · · · · · · · · · ·	

Table 3.--Base material laminates: U.S. imports, by types, 1977-81

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

1 1 0

	Туре	1977	1978	:	1979	:	1980	:	1981
		· •	Quantity	(1,00	0 squar	:e	feet)		
			:	:		:		:	
	•		:	:		:		:	
	Multilayer (3 layers :		:	:		:		:	
	or more) :	***	***	:	***	:	***	:	***
	From additive laminates :	***	: ***	:	***	:	***	:	***
	Other: :		•	:		:		:	
	Epoxy-glass base: :		•	:		:		:	
	0.031 inch thick		:	:		:		:	
	and less :	***	: ***	:	***	:	***	:	***
	More than 0.031 inch :		:	:		:		:	
	thick: :		•	:		:		:	
	Single-sided copper:	***	: ***	:	***	:	***	÷	***
	Double-sided copper:	***	: ***	:	***	:	***	:	***
	Epoxy-glass/paper base:	***	: ***	•••••••••••••••••••••••••••••••••••••••	***	:	***	:	***
	Other:	***	***	:	***		***	:	***
	Total:	12,242	: 11,101		10,708	:	15,025	:	17,500
. 1	•		Value	(1,00	0 do11a	ırs	;)		
			:	:		:		:	
				:		:		:	
	Multilaver (3 lavers :			:		:		:	
	or more:	***	***	:	***	:	***	:	***
	From additive laminates:	***	***		***	:	***	:	***
	Other: :			:		:		:	
	Epoxy-glass base: :		•	:		:		:	
	0.031 inch thick :		i in an an an an a	:		:		:	
	and less:	***	***	:	***	:	***	:	***
	More than 0.031 inch :		•	[°] :		:		:	
	thick: :			• : • •		•		:	
	Single-sided copper:	***	***	:	***	;	***	:	***
	Double-sided copper:	***	***	:	***	•	***	:	***
	Epoxy-glass/paper base:	***	***	:	***	:	***	÷	***
	Other:	***	***	:	***	:	***	:	***
	Total:	20,916	: 37,148	:	56,611	:	75,101	:	67,107
			•	:		:		:	

Table 4.--Printed circuit boards: U.S. exports, by types, 1977-81

1/ Less than 500 square feet.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Туре	1977	1978	1979	1980	1981
	; q	uantity	(1,000	square f	eet)
	:	•	:	:	
Multilayer:	•	•	•	•	
Thin laminates of 0.030 inch	•	•	•	•	• • • • • • • • • • •
Prepreg, single-ply,	• ****		: ***	: ***	: ***
uncured epoxy	***	: ***	: ***	: ***	: ***
Additive	: ***	: ***	: ***	: ***	***
Epoxy-glass base:	:	.	:	:	•
0.031 inch thick and less	***	***	***	. ***	***
More than 0.031 inch thick:			•	•	•
Single-sided copper	• ***	• ***	· ***	•	• ***
Double-sided conner	• ***	***	• ***	• ***	• • ***
Epoxy-glass/paper base	· ***	***	· · ***	. ***	· · ***
Other	•	• ***	• ***	• ***	• ***
"otal	•	• 10 220	• • • • • • • • • • • • • • • • • • • •	•	. 2/ 002
1000	.13,239	.10,229	•20,115	• 51,009	34,003
	•	Value	(1,000	dollars)
	:	:	:	:	:
	•	•	:	•	:
Multilayer:		•	:	•	•
Thin laminates of 0.030 inch	:	•	:	•	•
thick or less	***	: ***	: ***	: ***	: ***
Prepreg, single-ply,	:	•	:	•	•
uncured epoxy:	***	: ***	: ***	: ***	: ***
Additive	***	: ***	: ***	: ***	: ***
Epoxy-glass base:		•		•	:
0.031 inch thick and less	***	***	: ***	* ***	* ***
More than 0.031 inch thick:		:	•	•	:
Single-sided copper	***	: ***	: ***	* ***	: ***
Double-sided copper	***	: ***	: ***	***	: ***
Epoxy-glass/paper base	***	: ***	: ***	: ***	: ***
Other	***	***	***	***	***
Tota1	22 763	• 32 840	• 50 .082	.62 989	. 67 194
	,, / UJ				• · · · · • • • • • • • • • • • • • • •
	•	•	<u> </u>	•	0

Table 5.--Base material laminates: U.S. exports, by types, 1977-81

1/ Less than 500 square feet.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Appendix D

Witnesses Appearing at the Public Hearing

TENTATIVE CALENDAR OF PUBLIC HEARING

Those listed below appeared as witnesses at the United States International Trade Commission's public hearing on trends in international trade in printed circuit boards and base material laminates, Investigation No. 332-133. Sessions were held in connection with the investigation in the Hearing Room of the United States International Trade Commission, 701 E Street, N.W., in Washington, beginning at 10:00 a.m., e.d.t., on May 5, 1982.

Witness and organization:

Subject:

e.S.

The Institute for interconnecting and Packaging Electronic Circuits, Evanston, Illinois

R. E. Pritchard, Executive Director

Norplex Division, UOP, Inc., La Crosse, Wisconsin

David Verbeten, Divisional Planning Manager

Burlington Glass Fabrics Company, a division of Burlington Industries, Inc., Link Drive, Rockleigh, New Jersey

William Bennison, President

Owens/Corning Fiberglas, Textile Operating Division, Toledo, Ohio

Stephen R. Hudson, Manager, Marketing Research

Synthane-Taylor, an Alco Standard Company, Valley Forge, Pennsylvania

Joseph J. McLoughlin, Manager, Market Development

The Mica Corporation, Pinehurst, Mass.

William O. Walichiewicz, Regional Manager

NVF Company, Technical Products Division, Kennett Square, Pennsylvania

Morris Phinney, Manager, Circuitry Product Sales

Printed circuit boards and base material laminates

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