THE EFFECT OF IMPORTS OF CERAMIC SEMICONDUCTOR PACKAGES ON THE NATIONAL SECURITY

AN INVESTIGATION CONDUCTED UNDER SECTION 232
OF THE TRADE EXPANSION ACT OF 1962

U.S. DEPARTMENT OF COMMERCE
BUREAU OF EXPORT ADMINISTRATION
OFFICE OF INDUSTRIAL RESOURCE ADMINISTRATION
STRATEGIC ANALYSIS DIVISION

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Where brackets appear in the text, proprietary information has been removed. For information regarding this report, please contact Brad Botwin, Director, Strategic Analysis Division, (202) 482-4060, or Karen Swasey, Section 232 Program Manager, (202) 482-3795. Copies are available for sale from the National Technical Information Service (NTIS) at (703) 487-4650 and requesting PB 93-192441.

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EXECUTIVE SUMMARY

Finding and Recommendations

- The Department of Commerce finds that ceramic semiconductor packages are not being imported into the United States in quantities and under such circumstances as to threaten to impair U.S. national security. Although current conditions in the ceramic package industry do not present an immediate threat to national security, improving the capabilities of the domestic ceramic package industry is desirable for both economic and national security reasons.

- The Department of Commerce has developed an Action Plan consisting of four elements to address the manufacturing, technology, and financial shortfalls of the domestic ceramic package industry. This plan was developed with extensive input from representatives of a number of government agencies and laboratories with expertise in ceramic package material and manufacturing issues, and is a cost-effective, broad-based industry-government effort to address the challenges facing this key sector.

- The Action Plan consists of the following four elements:

  (1) **Manufacturing Center of Excellence for Ceramic Packages** to address the production deficiencies of domestic producers, to be led by the Department of the Navy;

  (2) **Ceramic Materials Research and Development Program** to develop advanced materials to ensure the qualitative superiority of ceramic packages for defense and commercial use, to be led by the National Institute of Standards and Technology and Oak Ridge National Laboratory;

  (3) **Product and Process Qualification** will be undertaken to remove one of the most costly impediments to the growth of the domestic industry. This qualification program involving on-site company certification and laboratory support will be carried out by the National Institute of Standards and Technology and Sandia National Laboratory.

  (4) **Government-Industry Working Group on Ceramic Packages** to coordinate the above activities with each other and seek the participation of related industry end user groups to ensure continued commitment by all parties.

- In addition, the Department of Commerce will review the financial and production status of the domestic industry one year from now, and if the situation warrants will initiate another Section 232 investigation.

- The Department of Commerce/Bureau of Export Administration will also examine further the criteria for determining in future Section 232 investigations what "threaten[s] to impair the national security" in the post-Cold War environment.

Background

- On November 10, 1992, Coors Electronic Package Company (Coors) of Chattanooga, TN and Ceramic Process Systems Corporation (CPSC) of Milford, MA petitioned the Department of Commerce (DOC) to conduct an investigation under Section 232 of the Trade Expansion Act of 1962, as amended, to determine the effect of imports of ceramic semiconductor packages on the national security.

- In their petition, Coors and CPSC asserted that "(t)he most important example of the interdependence of the U.S. industrial base is the symbiotic relationship between semiconductors and the packages which house these integrated circuits." Coors/CPSC added that "a crisis exists within the ceramic package industry -- a crisis precipitated by increased imports of ceramic packages from Japan and the 'monopoly' stranglehold of one Japanese company on the ceramic packaging industry."

- The petitioners requested: 1) government support for additional research and development leading to commercialization of advanced materials; 2) qualification assistance to enable domestic suppliers to participate on existing military programs being supplied with ceramic packages from Japan; and 3) any (additional) relief the President deems appropriate to stop the further deterioration of the U.S. ceramic package industry.

- By law, the Secretary of Commerce had 270 days from the date of initiation (in this case until August 16, 1993) in which to conduct an investigation and forward his findings and recommendations to the President.

Methodology

- Section 232 (d) of the Act directs us to evaluate the "domestic production needed for projected national defense requirements, the capacity of domestic industries to meet such requirements, ... the requirements of growth of such industries ... including the investment ... and development necessary to assure such growth, the importation of goods in terms of their quantities, availabilities, character, and use, ... (and) the impact of foreign competition on the economic welfare of individual domestic industries," among other factors.

- Commerce conducted this investigation with assistance from the interagency community including the Departments of Defense (DOD), Energy, Justice, Labor, State and the Treasury; the Central Intelligence Agency; the Council of Economic Advisors; the National Aeronautics and Space Administration (NASA); the Office of

Management and Budget; and the Office of the U.S. Trade Representative. Several of the government's leading experts in this technology took part including participants from: Commerce/National Institute of Standards and Technology (NIST); Defense/Naval Command, Control, and Ocean Surveillance Center; Energy/Sandia Lab; and NASA/Jet Propulsion Lab.

- The Department gathered further information by conducting separate surveys of ceramic package producers and ceramic package importer/end users. These surveys focused on such issues as: imports, production, financial condition, supplier qualification, research and development, investment, employment, complexity of defense products, alternative technologies, capacity constraints, and foreign sourcing/dependency.

- The Department received surveys from all identified U.S. producers and all identified direct importers, and secured additional surveys from a sampling of end users in the semiconductor, computer systems and defense systems industries.

- Additional information was gathered from public comments received in response to our Federal Register notice, on-the-record meetings held with interested parties, factory visits to five leading U.S. suppliers, and supplementary independent research.

The Product

- The four major functions of the ceramic package are: 1) to distribute electric power through and outside of the device; 2) to communicate signals through and outside of the device; 3) to dissipate heat; and 4) to protect the semiconductor die from potentially harmful elements of the ambient environment such as heat, moisture, and radiation.

- The value of ceramic packages may exceed 25 percent of the value of the integrated circuit. Packages increase in cost and importance as chips contain more information, operate faster and generate more heat.

- Most packages are custom-designed in an intimate collaboration between package manufacturer and customer. Most of the process is conducted in clean room facilities to keep dust and other potential contaminants from adulterating the product.

- Both the complexity of design and difficulty of manufacturing semiconductor packages outstrip one's usual understanding of "packages" as being merely low-technology dispensable material. In their function, semiconductor packages are roughly comparable to a person's nervous system "interconnecting" the person's (or semiconductor device's) brain (or integrated circuit) with the rest of its system, as well as protecting its internal organs.

- Different package specifications are used depending upon the sophistication of the microchip housed in the package and on the device's intended use. One semiconductor producer reported to us, for example, that it employs over 100 different ceramic packages to house its various semiconductor products. Across the industry, there are many thousands of unique ceramic package products in use.

- Design and tooling costs, in particular, can be substantial. Comprehensive design capability is essential to the ultimate successful manufacture and use of the package. Green tape, the basic ceramic material, is another critical determinant of a company's capabilities and of the ultimate quality of its production. Each company's green tape formula is a closely-guarded secret consisting of a unique recipe of inputs and resulting in distinctive shrinkage during the subsequent firing process.

- In the basic production flow, after product design, green tape is produced on a tape casting machine or in rare instances, brought in from outside sources. Required holes are punched in the tape which are then filled with a conductive paste. The appropriate metallization pattern is screen-printed onto the tape, which is next laminated together with other tape if it is to be part of a multi-layer package. The single- or multi-layer tape sections are then fired at high temperature in a kiln. After firing, leads, pins and other external items are added, and gold or other protective coatings are affixed.

Importance of the Industry to National Security

- Ceramic semiconductor packages are a key component of the microelectronic element of virtually every military system. Survey respondents identified 113 distinct defense systems which require ceramic packages, and industry experts were unable to identify any system which does not include this product.

- Systems using ceramic packages include: the Patriot, Tomahawk, and Trident missiles; the Tacfire Artillery Fire Control System; the AEGIS radar; the Comanche Helicopter; the F-14 and F-18 aircraft, and the M1A1 Tank. In addition, ceramic packages are the medium of choice for latest-generation semiconductor products such as the Intel Pentium and the DEC Alpha microprocessors.

- Department of Commerce microelectronics industry experts and the Semiconductor Industry Association both estimate that direct and indirect military consumption account for approximately 20 percent of U.S. apparent consumption of ceramic packages. However, survey data show that defense users account for about 14 percent of U.S. apparent consumption of ceramic packages. This discrepancy can be accounted for by the lack of information available to package producers about the ultimate end use of some of their production.

- Virtually all producers and customers of ceramic packages state that it is extremely difficult to accurately estimate the percentage of ceramic packages they produce and/or use which ultimately go to defense end use. Reasons cited include: production of commercial and military products on the same line to identical specifications; use of commercial products for defense applications; and sale of semiconductors through distributors who do not report ultimate disposition to chip producers.

- Moreover, survey data show that imports account for 85 percent by value and 92 percent by units of all identifiable defense shipments. This finding is similar to that of a 1992 Department of Commerce study of sourcing patterns for three Naval weapon systems. That study found that ceramic packages exhibited the highest percentage foreign sourcing (in excess of 90 percent) for any of the hundreds of manufactured inputs into these systems.

Competitive Factors/Economic and Trade Data

- The 232 statute directs us to evaluate "the impact of foreign competition on the economic welfare of individual domestic industries ... in determining whether such weakening of our internal economy may impair the national security."

- Domestic customers rate Japanese suppliers as superior on a wide range of competitive factors including: breadth of product line, historical performance, quality and service.

- U.S.-owned firms' precarious competitive position is underscored by the economic and trade data. By virtually any measure, the U.S. ceramic package industry's performance has declined in recent years. Declines have occurred, for example, in profitability, production, capacity and capacity utilization, employment and other indicators.

- The eight domestic producers reporting lost $65 million in 1990 (20 percent of sales), lost an additional $96 million in 1991 (28 percent), and lost a further $90 million in 1992 (27 percent of sales). At least four of these eight firms were unprofitable for each of the three years of the survey period.

- Overall, U.S. production of ceramic packages declined 60 percent on a unit basis and 24 percent on a value basis between 1990 and 1992. The biggest declines occurred in high volume cerdip and cerpack product categories. Industry experts indicate that this trend is likely to continue.

- In 1992, the average capacity utilization rate (all firms, all types) was 52 percent on a unit basis. Capacity utilization of non-captive production was [much lower], however, and capacity utilization has sharply decreased in 1993 for the leading captive producer.

- In general, products in which U.S. production capacity had declined significantly had the highest capacity utilization rates, whereas products in which U.S. capacity had increased had low utilization rates. Capacity utilization rates in 1992 (unit basis) ranged from six percent for [product] to 85 percent for [product]). By firm, capacity utilization in 1992 ranged from 16 to 81 percent.

- U.S. producers identified labor costs/training and tooling availability as the most important bottlenecks to ramping up to maximum production capacity.

- Surveyed firms reported that employment fell 21 percent from 1991 to 1992, and is expected to decrease an additional seven percent in 1993. Nevertheless, two companies reported having difficulty in acquiring skilled labor, in particular engineers with proper education and experience in the ceramic package process.

- Import penetration has increased, and concerns are heightened by the high degree of dependence (about two-thirds of consumption) on one foreign producer with a limited number of production facilities. The danger of dependence on such a concentrated supply can be illustrated by the worldwide scramble to obtain sufficient epoxy resin for plastic semiconductor packages resulting from the recent explosion at Sumitomo's plant in Ebimo, Japan.

- Following this explosion, epoxy resin prices have sharply increased. If alternative sources of supply are not found, Japanese companies or the Japanese government may allocate the limited supplies of epoxy resin. As a result, the availability of epoxy resin -- a commodity taken for granted a few weeks ago -- could become a pacing item which will determine companies' ability to produce and supply semiconductor devices.

- Should the supply of ceramic packages from the dominant foreign producer be disrupted for whatever reason, semiconductor companies would be unable to produce semiconductor devices requiring ceramic packages for either military or advanced commercial products.

- U.S. industry investment has remained at 20 percent or above of shipments during the survey period, exceeding the level in the overall U.S. semiconductor industry. U.S. industry investment is projected to drop precipitously in 1993, however, reflecting decreased activity by two key producers.

- Based on U.S. firms' production and capacity declines and their tenuous financial condition, officials from several leading U.S. firms have told us that their continued survival in the ceramic package business is uncertain. Corroborating this, leading U.S. government industry experts including those from the Navy, Energy/Sandia and Commerce/NIST believe that survival of the U.S.-owned companies is problematic.

(Proprietary Information Withheld)

- A major captive producer of ceramic packages has just recently begun to participate in the merchant market. (Proprietary Information Withheld) However, the success of this company in commercial markets is as yet untested.

Government Policies and Trade Practices

- Most U.S. producers and importers did not report that they had experienced foreign government or company anticompetitive trade practices that had affected their companies' economic condition or hampered their ability to supply U.S. national security needs.

- Allegations were made by some companies, however, that foreign suppliers provide free up-front tooling, require bundling (must buy all or nothing from one supplier), and that foreign producers will not certify the location of manufacture in order to avoid "Buy America" provisions for some weapons systems. Further, one respondent reported that it had never been able to sell ceramic packages in Japan "despite repeated efforts" even at a time when no competitive Japanese industry yet existed.

- All ceramic package producers reported having to make some type of adjustment to their business practices to meet U.S. government policies. Most complained of increased operating costs resulting from environmental and defense procurement qualifications in particular. To alleviate this perceived competitive disadvantage, most producers recommended some type of increased government assistance - such as an R&D tax credit, and increased funding of DOD's Manufacturing Technology (MANTECH) program. Importers similarly emphasized the need to adjust to environmental and defense procurement policies.

National Security Production Capacity Issues

- As a result of the rapidly changing national security challenges facing this country, the Department of Defense is currently unable to identify its exact quantitative requirements for ceramic semiconductor packages during a national security emergency.

- DOD states "that it is important to maintain a national security capability to produce semiconductor ceramic packaging, particularly custom packages and those used in space applications and in heavily corrosive environments."

- Survey respondents reported closing eight U.S. production lines since January 1991. The total annual production capacity lost due to these closings was $354 million, representing 39 percent of U.S. production capacity. In addition, several U.S. producers exited the ceramic package market altogether in recent years.

- Four firms identified six planned increases in domestic production capacity slated for 1993 through 1996; all involve expansions to current facilities, rather than greenfield construction. These expansions will represent an additional $27 million of U.S. annual production capacity (less than three percent of the 1992 total).

- The leading foreign-owned supplier of ceramic packages operates a U.S. production facility, and also serves as distributor for its company's imported packages. In 1992, [the overwhelming majority] of the units and the value of packages sold in the United States by this company were imported. In addition, for the packages built in this country, this supplier sources green tape - the critical unfired ceramic input -- and [several other very critical inputs] from its foreign parent. This company was considered a reliable and high quality supplier by both commercial and defense customers.

National Security Technology Issues

- The manufacturing of ceramic semiconductor packages is a complex multi-step practice. The basic steps of the manufacturing process are well understood by several companies, any one of whom could produce a certain package given sufficient time and money. Only very few companies, however, have mastered the art of increasing manufacturing yields, and are able to reliably produce multiple copies of a given package at competitive cost within tight delivery time.

- Most surveyed firms confirmed that they do not lack access to technologies available to their foreign competition, but noted that it was difficult to compete with Kyocera's market and financial clout.

- The DOD reported that while they are willing to use plastic semiconductor packages where feasible, a substantial number of ceramic packages will be required for DOD weapon systems for the indefinite future. DOD's continuing commitment to ceramic packages is demonstrated by the Advanced Research Projects Agency's funding of multi-chip module R&D.

- Commerce industry analysts further expect that there will continue to be demand for ceramics in high-end and next generation defense and commercial semiconductor products, and that net demand for ceramic packages will remain essentially unchanged in years to come.

- Ceramic package producers report that packages supplied for defense use are generally more complex than those supplied for commercial applications. While a minority of importer/end-users agree with this view, the majority state that defense packages are generally of equivalent complexity. Commerce industry analysts note that DOD is simultaneously a leading customer for older-generation technologies such as cerdip and a leading customer for next-generation technologies such as multi-chip modules and hybrids.

- Qualification of suppliers is generally performed by semiconductor and computer systems manufacturers, rather than by DOD. These companies reported that qualifying new suppliers did, on balance, require more time than qualifying existing suppliers for new packages. Reasons cited include: similarities between new and already qualified packages, and familiarity with the supplier's manufacturing process.

- Commercial R&D expenditures by domestic producers were fairly stable from 1990 to 1992, but are forecast to decrease precipitously in 1993, falling 80 percent from $187 million to $37 million. This decrease is primarily accounted for by expected reductions by the two firms responsible for most industry R&D.

- Defense R&D expenditures have continued to increase over the survey period, increasing from $1.5 million in 1990 to a projected $8 million in 1993. Over this period, however, defense R&D has never represented more than 17 percent of industry R&D.

- Offshore production currently accounts for over 90 percent of defense end use ceramic packages. As noted above, without remedial action, government industry experts project that all remaining U.S.-owned producers will exit the industry within three to five years.

- This dependence on foreign sources is exacerbated by the fact that [most] of the packages consumed in the United States are provided by one foreign company. If there is a disruption of shipments from this one supplier, U.S. economic and national security could be at risk.

I. INTRODUCTION

On November 10, 1992, Coors Electronic Package Company of Chattanooga, TN (Coors) and Ceramic Process Systems Corporation of Milford, MA (CPSC) petitioned the Department of Commerce (DOC) to conduct an investigation under Section 232 of the Trade Expansion Act of 1962, as amended, (the Act) to determine the effect of imports of ceramic semiconductor packages on the national security. The Act states that:

> [T]he Secretary shall submit to the President a report on the findings of [the Department's] investigation with respect to the effect of the importation of such article in such quantities or under such circumstances upon the national security and, based on such findings, the recommendation of the Secretary for action or inaction ... [I]f the President concurs [with a Commerce finding that imports threaten to impair the national security, he shall] determine the nature and duration of the action that, in the judgement of the President, must be taken to adjust the imports of the article and its derivatives so that such imports will not threaten to impair the national security.

In their petition, Coors and CPSC asserted that "[t]he most important example of the interdependence of the U.S. industrial base is the symbiotic relationship between semiconductors and the packages which house these integrated circuits." Coors/CPSC added that "a crisis exists within the ceramic package industry -- a crisis precipitated by increased imports of ceramic packages from Japan and the 'monopoly' stranglehold of one Japanese company on the ceramic packaging industry."

The petitioners requested: 1) government support for additional research and development leading to commercialization of advanced materials; 2) qualification assistance to enable domestic suppliers to participate on existing military programs being supplied with ceramic packages from Japan; and 3) any (additional) relief the President deems appropriate to stop the further deterioration of the U.S. ceramic package industry. A summary of the allegations set forth in the petition is attached at Tab A.

On November 18, 1992, the DOC determined that the Coors/CPSC petition met the pertinent regulatory criteria and formally initiated an investigation under Section 232. The DOC announced its action in the Federal Register on November 25, 1992. At the request of several interested parties, the DOC published a supplementary Federal Register notice on December 23, 1992, extending the closing date of the public comment period (copies of both notices attached at Tab B). By law, the Secretary of Commerce had 270 days from the date of initiation of this case in which to conduct an investigation and forward his findings and recommendations to the President.

The DOC conducted this investigation with assistance from the interagency community including the Departments of Defense, Energy, Justice, Labor, State and the Treasury; the Central Intelligence Agency; the National Aeronautics and Space Administration; the Office of Management and Budget; the Council of Economic Advisors; and the Office of the U.S.

Trade Representative. In order to supplement data available from earlier government studies and other published sources, the Department conducted separate surveys of ceramic package producers and ceramic package importer/end users (copies of surveys attached at Tab C).

These surveys focused on such issues as: imports, production, financial condition, supplier qualification, research and development (R & D), investment, employment, complexity of defense products, alternative technologies, capacity constraints, and foreign sourcing/dependency. Additional information was gathered from public comments received in response to our Federal Register notices (summary of comments attached at Tab D), on-the-record meetings held with interested parties, factory visits, and supplementary independent research.

Regarding methodology, Section 232 (d) of the Act directs DOC to evaluate the "domestic production needed for projected national defense requirements, the capacity of domestic industries to meet such requirements, ... the requirements of growth of such industries ... including the investment ... and development necessary to assure such growth, the importation of goods in terms of their quantities, availabilities, character, and use, ... [and] the impact of foreign competition on the economic welfare of individual domestic industries," among other factors.

In most past Section 232 investigations, the focus of the Department's national security analysis has been on a two-step determination of whether maximum available supplies of the product(s) in question would be sufficient to meet anticipated national security demand in a conventional war or other national emergency. As a result of the rapidly changing national security challenges facing this country, the Department of Defense has been unable to identify its exact quantitative requirements for ceramic packages in a national emergency. Similarly, in the 1992 Section 232 investigation of gear and gearing product imports, DOD was unable to provide such requirements.

Therefore, without the demand side of the equation, the Department's analysis has focused on the growth and development requirements and economic welfare of subject industries, and on their role as "technology driver" to strengthen and maintain U.S. deterrent capabilities.

Importance of the Industry to National Security

As Under Secretary of Defense for Acquisition and Technology John M. Deutch stated May 18, 1993, before the Senate Armed Services Subcommittee on Defense Technology, Acquisition and the Industrial Base:

> I do not want this country ... to be dependent on foreign technology which is critical for defense. ... We are continually concerned about areas where we are becoming dependent either on technology or on products or on processes from foreign sources. And of course, the area which is of greatest concern in this area is in microelectronics, and we try and watch that very carefully, and take whatever mitigating actions we can take, including strengthening our own industry.

Ceramic semiconductor packages are a key component of the microelectronic element of virtually every military system. Ceramic packages protect a semiconductor's electronic circuitry and enable the chip to communicate with other parts of the electronic system. Ceramic packages provide heat dissipation and moisture protection for integrated circuits (ICs) that are superior to that of plastic packages, and remain the package medium of choice for ICs operating under the most severe operating conditions. In addition, ceramic packages are also being utilized for latest-generation semiconductor products such as the Intel Pentium and the DEC Alpha microprocessors. The value of ceramic packages may exceed 25 percent of the value of the integrated circuit, and increases in cost and importance as chips contain more information, operate faster and generate more heat.

Department of Commerce microelectronics industry experts estimate that direct and indirect military consumption account for approximately 20 percent of U.S. apparent consumption of ceramic packages. Moreover, for this ubiquitous critical component, a 1992 Department of Commerce study of sourcing patterns for three Naval weapon systems[1] found that ceramic packages exhibited the highest percentage of foreign sourcing (in excess of 90 percent) for any of the hundreds of manufactured inputs into these systems.

Report Outline

This report begins with a description of the ceramic package products under review, the manufacturing process by which these products are built, and a description of the package industry. This is followed by an assessment of the industry's international competitiveness. We next present an analysis of industry economic and trade data. A national security assessment follows, focusing on both capacity and technology issues. The investigation concludes with our findings and recommendations.

[1] U.S. Department of Commerce/Bureau of Export Administration, National Security Assessment of the Domestic and Foreign Subcontractor Base: A Study of Three U.S. Navy Weapon Systems, March 1992.

II. INDUSTRY AND PRODUCT DESCRIPTION

Ceramic semiconductor packages protect a semiconductor's electronic circuitry and allow it to communicate ("interconnect") with other parts of the electronic system. While most often made of plastic, semiconductor packages are also made of ceramic for use in the most demanding operating conditions and/or for latest-generation semiconductor products. A ceramic package consists of one or more layers of ceramic material onto which metal circuitry has been printed. The four major functions of the ceramic package are: 1) to distribute electric power through and outside of the device; 2) to communicate signals through and outside of the device; 3) to dissipate heat; and 4) to protect the semiconductor die from potentially harmful elements of the ambient environment such as heat, moisture, and radiation. While the package varies with the sophistication of the microchip it houses, the generic qualities of the package remain consistent.

Both the complexity of design and difficulty of manufacturing semiconductor packages outstrip one's usual understanding of "packages" as being merely low-technology dispensable material. In their function, semiconductor packages are roughly comparable to a person's nervous system, "interconnecting" the person's (or semiconductor device's) brain (or integrated circuit) as well as protecting its internal organs. The value of semiconductor packages may exceed 25 percent of the value of the semiconductor, and increases in cost and importance as chips contain more information, operate faster and generate more heat. Semiconductor packages have become increasingly critical as chips have been called upon to operate in denser configurations and perform more operations at a faster speed to meet the needs of increasingly complex computing systems.

Design and tooling costs, in particular, can be substantial and rise significantly with increases in the sophistication of the package application. These costs may be offset, however, if a package can be designed to be substantially similar to one previously designed and stored in a package supplier's "tool library."

Product Descriptions

Different package specifications are used depending upon the sophistication of the microchip housed in the package and on the device's intended use. One semiconductor producer reported to us, for example, that it employs over 100 different ceramic packages to house its various semiconductor products. Across the industry, there are many thousands of unique ceramic package products currently in use.

For this investigation DOC worked with government and industry experts, the petitioners and other interested parties to develop a consensus list of ceramic package product categories which reflects industry practice and disaggregates the industry into categories among which there is substantial intra-category production fungibility.

Ultimately, it was decided to collect information regarding the ceramic package industry using the following 17 product categories. These categories emphasize generic distinctions rather than end-use application, focusing on such factors as single layer or multiple layer,

terminal/lead count (i.e. number of connections), and number of chips mounted in the package. The product category list includes an "other" basket category to capture unique packages not readily classifiable elsewhere.

Ceramic Package Product Categories

A. Crystal oscillator carriers - multi-layer, surface mounted products used to package oscillating crystals in products such as timing devices, computer applications, and fuses for munitions

B. Ceramic packages incorporating ceramic components joined with glass (frit) or epoxy seals

i. **Cerdip** - (ceramic dual inline packages) - each package includes both a top and bottom member

ii. **Cerquad** - like cerdip, but with flat leads on all four sides

iii. **Cerpack** - single layer surface mount flat package including both a top and bottom member with flat leads exiting parallel to the seating plane from the frit glass on two opposite sides

iv. **SLAM** - single layer metallization chip carriers
   a. less than 50 terminal count
   b. 50 or more terminal count

C. Multi-layer cofired single chip ceramic packages - includes both low and high temperature cofired variations where metallization and ceramic (or glass/ceramic) is simultaneously sintered (cofired)

i. **Sidebraze** - any multi-layer package with coaxial leads of dual inline (DIP) and single inline (SIP) configuration designed for lead insertion through holes in printed circuit boards

ii. **Multi-layer Chip Carriers** - all single-chip cofired packages designed for surface mount assembly on circuit boards; includes LCC (leadless chip carriers), and LDCC (conventional and fine pitch leaded chip carriers)
   a. chip carriers with less than 50 terminal count
   b. chip carriers with 50 or more terminal count

iii. **Multi-layer Flat Packs** - a low-profile package whose leads project parallel to, and are designed primarily to be attached parallel to, the seating plane. Leads may be formed generally away from the package body. If the leads are formed back toward the package body, the packages should be reported as chip carriers

a. flat packs with less than 100 lead count
b. flat packs with 100 or more lead count

iv. **Pin Grid Arrays** (PGAs) - single-chip, cofired packages with electrical input/output handled by a two-dimensional array of pins

a. pin grid arrays with less than 144 lead count
b. pin grid arrays with 144 or more lead count

v. **Other Area Array Packages** - all other single chip, cofired packages with electrical input/output handled by a two-dimensional array including land grid arrays, pad array carriers, ball grid array and similar devices

D. Multi-chip Packages - Any ceramic package which includes more than one integrated circuit

i. **MCM-C** - any multi-chip package which incorporates interconnecting circuitry into the multi-layer cofired ceramic structure

ii. **Hybrid packages** - any ceramic package designed to enclose a pre-assembled hybrid circuit interconnect or an MCM-D (deposited) interconnect

E. Other

Manufacturing Process

The manufacturing of ceramic semiconductor packages is a complex multi-step practice. The basic steps of the manufacturing process are well understood by several companies, any one of whom could produce a certain package given sufficient time and money. Only very few companies, however, have mastered the art of increasing manufacturing yields and are able to reliably produce multiple copies of a given package at competitive cost within tight delivery time. Most packages are custom-designed in an intimate collaboration between package manufacturer and customer. Most of the process is conducted in clean room facilities to keep dust and other potential contaminants from adulterating the product. Employees also wear special clothing to prevent transfer of contaminants during the manufacturing process. In addition, disposal of toxic wastes is a problem for package producers, as cyanide and other poisonous materials are used during the manufacturing process.

The manufacturing process begins by combining a powder (most often aluminum oxide) with a binder, a plasticizer and solvents in a ball mill, which combines the ingredients by rolling action for as long as 24 hours. Exact milling time is determined by the specific particle size distribution required for the particular application. Air is removed from the resulting slurry, which is poured into a tape caster machine that will produce long strips of "green tape." Tape thickness (most often measured in mills, i.e., thousandths of an inch) can vary due to machine capabilities and intended product application. This product is called "green" not because of its pigment, but rather because it has not yet been fired in a kiln into a ceramic product. Each company's green tape formula is a closely-guarded secret consisting of a unique recipe of inputs and resulting in distinctive shrinkage during the subsequent firing process.

The flexible tape is fed onto a spool, after which it is transferred to either a manual or computerized punching machine which punches vias (electrical paths), tooling holes, cavities (for placement of the integrated circuit) and registration (i.e., reference) holes. The tape is also cut to appropriate lengths at this time. Holes in the tape are either bore-coated or via-filled so that they can be filled with a conductive paste to facilitate electrical connections. This paste most often is a tungsten- or molybdenum-based compound.

Following this, a screen with the required metallization pattern is placed on the tape in a process similar to silk-screening using a standard thick film screen printer. For multi-layer cofired ceramic packages, constituent tape layers will then be laminated together by pressing between heated platens. Registration holes on the tape placed over matching pins on the tooling are used to ensure that tape layers are assembled in the proper order and with the proper orientation. The part's final shape may be cut after lamination. Cut reference points may be printed on the top layer of the package for detection by a sensor.

The laminated layers are next fired ("sintered") at elevated temperature for several hours in a kiln. Speed, temperature, ambient atmosphere and other elements must be carefully controlled during firing to ensure high-yield manufacturing. Following the firing, nickel plating is applied to create a wet surface to facilitate adhesion of items which will subsequently be brazed to the fired surface. External conductors, resistors and capacitors may be applied in a post-firing printing operation.

Leads, input/output pins, and/or seal rings are next brazed onto the fired parts by passing through a second furnace which operates at significantly lower temperatures than the first firing operation. After brazing, a protective nickel layer and a final corrosion-resistant conductive gold layer are applied to the product surface. Finally, packages are inspected visually and through use of coordinate measuring machinery to ensure satisfaction of customer specifications. Further testing for compliance with electrical and mechanical requirements can also be done.

Industry Overview

Both producers and importer/end users of ceramic packages were asked to describe their manufacturing and importing establishments. Producers were asked to identify their U.S. and foreign manufacturing facilities and importers were asked to provide the U.S. locations of their assembly/manufacturing or warehouse/storage facilities. Producers were also asked to report the locations of their distributorships, sales offices, and customer support centers, and the number of employees responsible for their ceramic packaging products. Importers were also asked the extent of their foreign ownership and the primary and secondary focus of their import/end-user businesses.

Producer Establishments

There are 11 identified U.S. producers of ceramic packages, operating 15 U.S. and foreign ceramic semiconductor package manufacturing facilities.[1] Twelve of these were in the U.S., including six in California, two in New York, and one each in Arizona, Maryland, Massachusetts, and Tennessee. Three manufacturing facilities were located abroad in Singapore, Germany, and Canada. It should be noted, however, that not all firms reported their offshore facilities.

Producers also reported the locations for their domestic and foreign semiconductor package distributorships, sales offices, and customer support centers, and the number of employees responsible for their products. Eight companies identified 24 U.S. sales offices, including 16 customer support centers and three distributorships. The majority of these facilities (11) were in California; in addition, three were in Massachusetts, two were in Arizona, two were in Texas, and one each was in New York, New Jersey, Tennessee, Florida, Colorado, and Washington. Additionally, companies reported four foreign sales offices in France, Belgium, Germany, and Singapore.

Eighty-three percent, or 568, of the total employees of these U.S. distributorships, sales offices, and customer support centers were employed in California and Tennessee with 368 employed in California alone. The remaining 17 percent were employed in Florida, Colorado, Texas, Arizona, Washington, Massachusetts, New York, and New Jersey. Only two percent of the 697 total reported domestic and foreign employees were in foreign locations.

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[1] The largest domestic producer is IBM, although its production was entirely captive until very recently. Alcoa and Coors are other significant U.S. producers. Kyocera America operates another U.S. facility, although this facility lacks green tape and [several other very critical inputs] found at other U.S. producers.

Importer/End Users

In addition to U.S. producers, ceramic packages are supplied through a variety of importer and end users.[2] Ceramic package importer/end users were also asked to describe the extent of ownership by another firm, if any; their primary and secondary type of business; and the U.S. locations of their warehouse/storage or manufacturing/assembly facilities. Twenty-three establishments responded; of these, 14 reported that they were foreign-owned, including nine Japanese, four European and one Filipino. Forty-five establishments indicated their primary type of business, including 18 importers of semiconductors packaged in ceramic packages, 12 end user/importers, eight end users only (not importers), five agents/importers, one distributor/importer, and one producer/importer. Ten companies also reported their secondary type of business, including five importers of semiconductors packaged in ceramic packages, four end user/importers and one end user only. The table below presents the survey results.

Table II-1
Importer/End Users
Primary and Secondary Lines of Business

Type of Importer/End User	Primary	Secondary
Agent/ Importer	5	
Distributor/ Importer	1	
End User/ Importer	12	4
Producer/ Importer	1	
Importer of Semiconductors Packaged in Ceramic Packages	18	5
End User ONLY (not importer)	8	1
TOTAL	**45**	**10**

SOURCE: OIRA Importer/End User Survey

Thirty-eight companies reported locations for 50 U.S. warehouse/storage areas and manufacturing/assembly facilities; of these, 30 were for the assembly/manufacture of semiconductor products containing ceramic packages, nine were for the warehousing/storage of imported ceramic packages, and ten were for both the warehousing/storage and assembly/manufacture of ceramic packages and related products. Thirty-eight percent (19) of facilities reported were located in California, 18 percent (seven) were in Massachusetts, and

[2] Japanese producers supplied all identified ceramic package imports. The largest of these companies - Kyocera - supplied more than half of the packages consumed in the United States. Other significant Japanese suppliers include: NTK (a subsidiary of NGK Spark Plug), Sumitomo Metal Industries (formerly Narumi Ceramics) and Shinko.

eight percent (four) were in Arizona. The remaining 36 percent of the facilities were scattered across Texas, New York, Minnesota, Pennsylvania, Maryland, New Jersey, Wisconsin, Florida, Idaho, Colorado, North Carolina, Maine, and Oregon. The number and percentage of facilities by state are presented in the table below.

Not surprisingly, the majority of importers and producers located their manufacturing, sales, and assembly type operations in California, the home of Silicon Valley. Sixty percent of those importer/end users that reported ownership were foreign-owned; of these 64 percent were Japanese and 28 percent were European. The majority of importers described themselves as, primarily, importers of semiconductors packaged in ceramic packages.

Table II-2
Number of Facilities by State

California	19 (38%)
Massachusetts	7 (18%)
Arizona	4 (8%)
Texas	2 (6%)
New York	2 (6%)
NJ, WI, FL, ID, CO, NC, ME, OR	8 (4%)
Total:	50 (100%)

SOURCE: OIRA Survey

III. COMPETITIVE FACTORS

The following section analyzes the competitive factors, both internal and external to the companies, which lead to success in the ceramic semiconductor package business. This analysis is undertaken to fulfill the statutory requirement to "take into consideration the impact of foreign competition on the economic welfare of individual domestic industries ... in determining whether such weakening of our internal economy may impair the national security."

Competitive Assessment

Companies responding to the producer and importer/end user surveys were asked to rate the importance of 14 competitive factors. In order to quantify the importance given to each of the competitive factors, points were assigned to each of the ratings:

Extremely important:	3 points	Very important:	2 points
Not very important:	1 point	Not at all important:	0 points

An average score for each factor was developed by summing scores and dividing the total by the number of respondents. The results for producers are shown below.

Table III-1
Producers' Ranking of Competitive Factors

Factor	Score	# Responding
Other: "Quality"	3.00	5
Supply Reliability	2.71	14
Price	2.64	14
Vendor Technical Support	2.43	14
Product Delivery Time	2.36	14
Availability of Product	2.36	14
Engineering/Design	2.36	14
Prototype Delivery Time	2.29	14
Ability to Deliver High Volume	2.14	14
Service	2.14	14
Historical Performance	2.07	14
Breadth of Product Line	1.93	14
Training	1.53	14
Warranties	1.42	12
Country of Origin	0.77	13

SOURCE: OIRA Survey

The same process was used to develop scores for the competitive factors from the ratings given by end users. The results are shown in Table III-2 below.

Table III-2
End Users' Ranking of Competitive Factors

Factor	Score	# Responding
Supply Reliability	2.75	32
Product Delivery Time	2.53	32
Other: "Quality"	2.50	2
Price	2.47	32
Prototype Delivery Time	2.44	32
Vendor Technical Support	2.28	32
Service	2.13	32
Historical Performance	2.06	32
Ability to Deliver High Volume	1.84	32
Breadth of Product Line	1.81	32
Warranties	1.48	29
Training	1.25	28
Country of Origin	0.78	32

SOURCE: OIRA Importer/End User Survey

Both producers and importer/end users rated **supply reliability**, **price**, **quality** and **product delivery times** among their top five most important factors, although the rankings varied within the range. The two groups also agreed that **warranties**, **training** and **country of origin** are the least important competitive factors. It is more interesting to note the differences in the ratings than to discuss similarities; that they differ in many ways indicates that both groups have a lot to learn from and communicate to each other.

Next, producers were asked to assess their own company's performance relative to these standards. Again, the ratings were quantified:

Excellent = 3 points Good = 2 points Fair = 1 point Poor = 0 points

The results of the ratings are shown in table III-3 below.

Table III-3
Producers' Self Assessment on Competitive Factors

Factor	Score	# Responding
Country of Origin	2.56	9
Service	2.50	10
Vendor Technical Support	2.40	10
Engineering/Design	2.30	10
Supply Reliability	2.22	9
Warranties	2.13	8
Price	2.00	9
Prototype Delivery Times	2.00	9
Product Delivery Times	2.00	9
Training	2.00	8
Other: "Quality"	2.00	2
Availability of Product	1.89	9
Historical Performance	1.67	9
Breadth of Product Line	1.44	9
Ability to Deliver High Volumes	1.44	9

SOURCE: OIRA Survey

Producers believe that their greatest strengths are in country of origin, service, vendor technical support and engineering/design, with supply reliability coming in a close fifth. The three lowest ratings were for historical performance, breadth of product line and ability to deliver high volume. One way to view the results of the producers' self assessment is in relation to the data shown in table III-2 regarding what their customers, the end users, consider to be important competitive factors. Producers and end users concurred that country of origin was the least important competitive factor. When asked to assess their individual company performance, however, this rating factor received high marks for something that the firms were excellent in providing.[1] Similarly, producers gave themselves

[1]High country of origin ratings for the Japanese companies can be attributed to their strategic location in Japan, near the East and Southeast Asian semiconductor assembly plants. High ratings for U.S. country of origin were probably due to their location near U.S. semiconductor

quite favorable marks for service and vendor technical support, but end users rated these factors seventh and eighth in importance. For those competitive factors considered most important, such as quality and delivery time, U.S. firms gave themselves only a good rating.

Finally, both producers and end users were asked to evaluate the top two foreign companies and the top two domestic companies by these 14 factors. Once again, the ratings were excellent, good, fair, and poor. The tables below present the results for the companies identified.

Judging from the end users' responses, it is clear that they do not rely on U.S. manufacturers of ceramic packages. Twenty-five of 32 end users responding named Kyocera as their number one or number two foreign supplier; 17 mentioned NTK, most often as their number two supplier. Other foreign suppliers mentioned included Sumitomo, named four times, and Shinko, mentioned twice. Among domestic suppliers the most frequently mentioned was Kyocera America with five mentions, followed by Coors with four, and Diacon, with two. The remaining U.S. firms listed in the tables received just one mention each. Some U.S producers, such as Ceramic Process Systems and Pantronix, were not mentioned at all.

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plants and for defense contract purposes.

Table III-4
Producers/Competitors Ratings of U.S. and Foreign Manufacturers

Factor	Kyocera Japan	NTK	Shinko	SMI	OSE, Taiwan	Alcoa	Coors	Diacon	IBM	MPA	Genl. Ceram.	Kyocera America
Number Responding	9	9	1	3	1	2	5	1	1	2	1	1
Breadth of Product Line	3.00	2.44	1.00	2.00	2.00	0.00	1.40	2.00	2.00	0.00	1.00	2.00
Ability to Deliver High Volume	3.00	2.44	2.00	2.00	2.00	1.00	1.20	2.00	1.00	0.00	2.00	3.00
Historical Performance	2.80	2.56	2.00	1.67	2.00	0.50	0.60	3.00	0.00	0.00	1.00	2.00
Price	2.56	2.33	2.00	2.67	3.00	1.00	1.60	1.00	0.00	1.00	2.00	3.00
Supply Reliability	2.56	2.33	2.00	2.00	2.00	1.00	1.20	2.00	0.00	1.50	2.00	2.00
Availability of Product	2.56	2.22	2.00	2.33	3.00	1.00	1.20	2.00	1.00	0.50	1.00	3.00
Other: "Quality"	2.50	2.50	3.00	2.00	NA	1.00	1.00	NA	3.00	NA	NA	NA
Vendor Technical Support	2.11	2.13	2.00	2.00	2.00	1.50	1.20	2.00	2.00	0.50	2.00	3.00
Service	2.11	2.13	2.00	2.00	2.00	1.00	1.20	2.00	1.00	1.50	2.00	2.00
Product Delivery Times	2.11	2.11	1.00	2.00	3.00	1.50	1.00	2.00	1.00	1.00	2.00	2.00
Engineering/Design	2.00	2.00	2.00	1.67	2.00	1.00	1.20	2.00	3.00	0.50	2.00	2.00
Training	1.83	1.60	2.00	1.67	2.00	1.00	1.50	1.00	2.00	NA	2.00	2.00
Country of Origin	1.75	1.63	3.00	2.00	2.00	2.50	2.75	2.00	3.00	2.00	1.00	3.00
Prototype Delivery Time	1.67	1.67	1.00	1.67	2.00	0.50	0.80	2.00	1.00	1.50	1.00	2.00
Warranties	1.63	1.75	2.00	2.00	2.00	1.50	1.75	2.00	1.00	2.00	2.00	2.00

SCALE: 0 = Poor 1 = Fair 2 = Good 3 = Excellent

SOURCE: OIRA Producer Survey

Table III-5
End User Ratings of U.S. and Foreign Manufacturers

Factor*	Kyo. Japan	NTK	Shinko	SMI	Coors	Diacon	Kyo. Amer.	IBM	MPA
Number Responding	25	17	2	4	4	2	5	1	2
Breadth of Product Line	2.64	2.06	1.50	2.00	0.50	0.00	2.40	3.00	0.50
Ability to Deliver High Volume	2.60	2.24	2.00	2.25	1.50	1.00	2.00	3.00	0.50
Historical Performance	2.36	2.18	2.00	2.25	1.00	0.50	2.20	NA	0.50
Price	2.00	1.94	1.50	2.25	1.00	0.50	1.80	NA	1.00
Supply Reliability	2.40	2.35	2.00	2.25	1.50	1.00	2.20	NA	0.50
Availability of Product	2.38	2.19	1.50	2.50	0.75	0.50	1.60	NA	0.00
Other: "Quality"	2.67	3.00	NA	3.00	NA	2.00	NA	NA	NA
Vendor Technical Support	2.12	2.29	1.50	2.50	1.50	1.00	2.20	NA	1.00
Service	2.25	2.35	1.50	2.75	1.50	1.00	2.20	NA	1.00
Product Delivery Times	1.96	1.82	1.50	2.25	1.25	1.00	1.80	NA	1.00
Engineering/Design	2.44	2.35	2.00	2.25	1.25	1.00	2.00	NA	1.00
Training	1.67	1.75	1.50	2.00	1.00	1.00	1.75	NA	1.00
Country of Origin	1.56	1.55	2.00	NA	2.00	1.00	2.33	NA	NA
Prototype Delivery Time	1.76	1.71	1.50	2.25	1.00	1.00	1.60	3.00	1.00
Warranties	1.96	2.13	1.50	2.00	1.50	1.50	1.50	NA	1.00

* Proprietary Information Withheld
SCALE: 0 = Poor 1 = Fair 2 = Good 3 = Excellent

SOURCE: OIRA Importer/End User Survey

Additionally, some companies were rated on other factors written in by their competitors or end users. Since these were firm-specific, they do not appear in tables III-4 and III-5 but are outlined in table III-6 below. In each case, only one respondent wrote in the factor listed.

Table III-6
Additional Factors Mentioned

By Producers/Competitors:

Company	Factor	Score
Kyocera Japan	Performance on Government Contracts	0.00
Kyocera Japan	Past Reputation	3.00
NTK	Performance on Government Contracts	0.00

By Importers/End Users:

Company	Factor	Score
Kyocera Japan	Advanced Technology	3.00
Kyocera Japan	Line Yield	3.00
NTK	Advanced Technology	2.00
NTK	Stability	3.00
SMI	Line Yield	3.00
IBM	Stability	3.00

SOURCE: OIRA Survey

Japanese Companies

Both producers and importer/end users gave Japanese companies higher overall scores than U.S. companies. The only poor ratings given to Japanese companies were for Kyocera and NTK from a competitor, in the write-in category, for performance on government contracts. Both Kyocera Japan and NTK received excellent ratings in the three competitive factors which both producers and end users agree are "extremely important" (supply reliability, price and quality), and had excellent scores in other categories as well. Sumitomo (SMI) also received some excellent ratings for quality and line yield.

No companies received an excellent rating from end users for price, although some companies received such ratings from competitors. Since ceramic packages are more expensive than plastic, end users are probably comparing ceramic with plastic pricing, while ceramic package companies are looking only at the ceramic package market.

The exception to the high ratings of Japanese companies was for Shinko, which received fair and fair/good ratings in some categories. Two of the competitive factors for which Shinko received only fair ratings were prototype delivery time and product delivery time, which are cited by producers and end users as very or extremely important.

- Kyocera

Kyocera is one of the few companies which received similar ratings from both end users and competitors. As mentioned above, Kyocera received excellent ratings in the three factors which both users and producers consider extremely important (price, quality, supply reliability). They also received excellent ratings in engineering/design and line yield, two factors cited as very important.

Considering Kyocera's dominance in the market, it is not surprising that they received high ratings in breadth of line and ability to deliver high volume. Kyocera also is able to invest in engineering/design, advanced packaging technology and an efficient production line. Further, economies of scale probably allow Kyocera to set lower prices than its competitors. As the largest supplier of ceramic packages, Kyocera was also cited for its supply reliability and historical performance.

- NTK

Seventeen end users assessed NTK's performance. NTK was given high ratings in service, supply reliability, engineering/design and in the write-in categories of quality and stability. NTK received good ratings in all other categories.

NTK's competitors gave them excellent ratings in price, breadth of product line, ability to deliver high volume and historical performance. NTK received good ratings in all other categories, except for the write-in comment regarding performance on government contracts.

Similar to Kyocera, NTK received excellent ratings in the three factors end users and producers feel are extremely important. Unlike Kyocera, however, NTK's competitors did not rate NTK as excellent in supply reliability and quality. End users also gave NTK an excellent rating in engineering/design, a very important factor.

NTK's competitors felt that NTK's strength was in its breadth of product line, ability to deliver high volume, historical performance and price. These strengths indicate that NTK has large-scale production capacity.

- Sumitomo (SMI)

While only four companies rated SMI packages, all appear to be pleased with SMI's products. Users of SMI's packages gave them excellent ratings in availability of product, vendor technical support and service, and in the write-in categories of quality and line yield.

SMI also received a good-excellent rating for all other categories except training and warranties, where they received good ratings. SMI's competitors gave the company an excellent rating in price and availability of product, and good ratings in all other categories, including the write-in factor quality.

SMI received excellent or good ratings in two of the three factors that both producers and end users feel are extremely important: price and quality. In addition, all of the other factors for which SMI received excellent ratings are either "extremely important" or "very important". SMI's strengths appear to be in quality, technical support and service.

- Shinko

While only two end users rated Shinko, it is the only Japanese company to receive fair or fair to good ratings in any category. Further, Shinko did not receive a single excellent rating. Shinko received good ratings in ability to deliver high volume, historical performance, country of origin, engineering/design, and supply reliability, and fair-good rankings in all other categories.

The one competitor ranking Shinko gave them an excellent rating for quality and country of origin. This competitor gave Shinko a good rating in all other categories except breadth of product line, and prototype and product delivery times, for which they received a fair rating.

Although Shinko received only good ratings in supply reliability, and engineering/design and quality -- three of the very or extremely important competitive factors -- the other Japanese companies received an equal or better rating in these categories. Shinko's fair ratings from its competitors in prototype and product delivery times may indicate a weakness, as both these factors are cited as being very important.

U.S. Companies

- Kyocera America

Kyocera America is a U.S. subsidiary of Kyocera Corporation of Japan. It was rated as at least good in all categories, except in warranties, where it received a fair-good rating. Still, its ratings on the whole are higher than those of other U.S. companies, and similar to those of Japanese companies (except Shinko).

Five end users ranked Kyocera America's products. Kyocera America received excellent ratings in breadth of product line and country of origin, and a fair-good rating in warranties. All other ratings were good. The one competitor ranking Kyocera America gave them an excellent rating in price, availability of product, ability to deliver high volume, vendor technical support and country of origin, and a good rating in all other categories.

Both users and competitors agree that one of Kyocera America's strengths is its U.S. location. Kyocera America also received an excellent rating in price, one of the "extremely important" competitive factors. Similar to its parent company, it received excellent ratings in breadth of product line and ability to deliver high volume. Kyocera America's ability to rely on Kyocera Japan for needed product line and volume could account for the high ratings given.

The remaining U.S. companies did not fare as well in the assessments. The two strong points for U.S. companies were country of origin and warranties. Most U.S. companies had at least one poor rating, and average scores were fair rather than good. A rating of other than poor in price, breadth of product line and historical performance highlights the strengths of certain U.S. companies compared with the others.

IBM received the most excellent ratings, including one in quality, one of the extremely important competitive factors, and was the only company recognized for its production capacity and breadth of line. (Proprietary Information Withheld) Coors received above fair ratings in all three of the factors which are considered extremely important by both users and producers of ceramic packages. Diacon received a good rating in quality (from its end users). MPA had the worst scores overall, with only two good ratings: warranty and country of origin, and poor ratings in a number of very or extremely important competitive factors.

- Alcoa

(Proprietary Information Withheld)

- Coors

Coors' end users gave the company a good rating in country of origin and fair-good ratings in ability to deliver high volume, vendor technical support, supply reliability and warranties. All other ratings were fair, except a poor-fair rating in availability of product, and poor in breadth of product line.

Coors' competitors gave them an excellent score in country of origin, good scores in price and warranties, and a fair-good rating in training. Coors was rated fair in all other categories except historical performance, for which they received a poor rating.

Coors received ratings above fair in three of the factors which are considered extremely important by both users and producers of ceramic packages: supply reliability, quality and price. Coors was the only U.S. company to receive a good rating for price. Coors received a low rating from end users in availability of product, which is an extremely important competitive factor for end users, and a poor rating for breadth of product line. As stated before, these are two areas in which U.S. companies are not very strong.

- Diacon

Diacon received a good rating from end users in quality and a fair-good rating in warranties. For all others, Diacon was rated as fair, except for poor ratings in breadth of product line, price, and availability of product.

One Diacon competitor gave them an excellent score in historical performance, a fair score in price and training and a good rating in all other categories. Overall, Diacon's competitor gave them higher scores than did the end users. This assessment may be a comparison, rather than an assessment of Diacon's actual position. U.S. companies are, for example, weak in historical performance, and are not typically as competitive in pricing as their Japanese competitors.

- IBM

One end user gave IBM scores of excellent for breadth of line, prototype delivery, ability to deliver high volume and stability, but did not give IBM scores in any of the other categories. One IBM competitor gave IBM excellent ratings for country of origin, engineering/design, training and quality, and a good rating for breadth of product line, and vendor technical support. All other scores were fair, except price, historical performance and supply reliability.

IBM shares two strengths with large Japanese producers: excellent breadth of line and ability to deliver high volume. However, recent layoffs at IBM and its lack of experience in the merchant market are apparent in its poor ratings for historical performance and supply reliability. Further, even with its large capacity, IBM's prices are viewed as poor (i.e. higher than its competitors). These poor ratings show a possible weakness, as IBM has poor ratings in two of the three extremely important competitive factors (price and supply reliability). However, some industry experts believe that IBM could even challenge Kyocera if IBM can overcome these weaknesses with its broad base of products and capacity.

- MPA

End users gave MPA poor ratings for price, availability of product, ability to deliver high volume, historical performance and supply reliability. MPA was given a fair score in all other categories.

MPA's competitors gave them good ratings in warranties and country of origin, a fair-good rating in service and prototype delivery time, and fair in all other categories except availability of product, ability to deliver high volume, historical performance, vendor technical support and breadth of product line, for which they received a poor rating.

MPA was the lowest rated company. They have good or fair-good ratings in warranty, country of origin, service and prototype delivery. Only one of these three factors was considered to be important to competitiveness (prototype delivery). MPA received poor ratings in two out of the three extremely important categories (and did not receive a rating

for quality), and poor ratings in the very important competitive factor of vendor technical support. Both users and competitors gave MPA poor ratings in ability to deliver high volume and historical performance.

Competitiveness Forecast

Producer survey recipients were asked to forecast the competitiveness of their U.S. production operations over the next five years. Respondents were asked whether their competitive prospects would: improve greatly, improve somewhat, stay the same, decline somewhat, or decline greatly. Of the ten companies responding, six expect their competitiveness to improve greatly, and four anticipate that their competitiveness will improve somewhat.

Companies who expect that their competitiveness will improve greatly cited reasons such as improved manufacturing technology, new product lines, developments in materials, and faster response times. At least two companies reported improvements as a result of continuing to "move down the manufacturing learning curve." One company mentioned forming "key alliances" with U.S. and international industry leaders. Another company expressed concern over future labor costs.

Companies that anticipated their competitiveness would improve somewhat cited niche markets, faster response times, better products and customer service. One company remarked that it would be entering the "merchant marketplace" for the first time. Two other companies reported that their small size would enable them to focus more on conventional designs, niche markets, and faster response times. According to one company, "We have targeted growth opportunities ... [in] niches [which are] not of primary interest to Kyocera. We do not believe we will be competitive with Kyocera in their primary market segments." One foreign-owned producer commented that plastic packages would be increasingly used for standardized products, while ceramic packages would continue to be used in advanced applications. According to this company: "[Although] the market dollar value will rise slightly each year, the quantity of packages will decline. As new circuits and systems are designed into ceramic, others will convert to plastic."

Overall, companies were optimistic about their U.S. manufacturing capabilities over the next five years because of improved manufacturing processes and products in particular. Small companies were content to focus on niche market applications and to produce more conventional products.

Trade Practices

Producers were asked if they had experienced any foreign government or foreign company trade practices that may have affected their economic welfare or limited their ability to supply U.S. national security needs. Importers were asked if they had experienced any anticompetitive practices, such as suppliers withholding technology or tying their willingness

to supply ceramic packages to agreements to purchase additional products. Ten producers and 44 importer/end users responded to these questions.

Producers

Eight producers reported that they had not or were unaware of having experienced the effect of any foreign trade practices on their operations. Two establishments, however, reported that foreign trade practices had impacted their businesses. One company related the responses it had received from potential Japanese customers regarding why their bids had lost, as follows:

> The most common reason we are given is that our competitors, primarily the Japanese, have lower unit prices. However, other answers we are given by customers include...[free of charge] 'up-front tooling' and 'bundling' -- [a requirement] by our current supplier that we must buy all or nothing from him and we can't risk elimination of the one known stable source of supply.

Additionally, this company reported that its customers had told them that "Kyocera in particular" will not certify the location of manufacture for certain ceramic packages in order to avoid "Buy America" provisions for some weapons systems.

Another survey respondent described, at length, alleged anticompetitive practices by Japanese competitors:

> Since the invention of ceramic packages in the U.S. in the late 1960s, Japanese firms have never purchased packages from the U.S., even though in the early years they had no package industry. This has occurred despite repeated efforts on our part to sell into this market. Japanese also frequently engage in a practice of 'buying' future market share by submitting overly low price quotes on current bid requests in exchange for priority consideration on future bids, tantamount to a right of first refusal. Such tactics cause the Japanese producers to lose money on current sales, but locks competitors out of future business. There is also a consistent and severe pattern of Japanese companies simply absorbing tooling costs, thus capturing business without covering the full costs of production and sale.

Importer/End Users

While most importer/end users did not report any anticompetitive behavior by their suppliers, one company reported resistance by "several Japanese sources (Proprietary Information Withheld)" to a purchasing clause referring to weapons end-use and sales restraints. One other company reported that a supplier failed to provide requested drawings for multi-layer packages.

In summary, U.S. producers and importers reported that they had not experienced any

foreign government or company anticompetitive trade practices that had affected their companies' economic condition or hampered their ability to supply U.S. national security needs.

Government Policies

Producers and importers were also asked whether U.S. government policies, laws, and regulations had affected their firms' business practices and to recommend adjustments to alleviate any resulting competitive disadvantages. Importers were asked in particular if military specification requirements or defense cuts had affected their shipments or purchasing decisions of ceramic packages and related products. Additionally, importers were asked if they would change their sourcing pattern for defense-use ceramic packages should the Department of Defense allow (as it subsequently did) the offshore assembly of JAN (Joint Army-Navy) program semiconductors. Fifty-six companies responded, including ten producers and 46 importer/end users.

Producers

All ten producers of ceramic packages reported having to make some type of adjustment to their business practices to meet U.S. government policies, laws, and regulations. Eight companies complained of increased operating costs resulting from environmental and defense procurement qualifications in particular. Companies reported having to improve manufacturing processes, record-keeping, and cost-accounting procedures. One firm reported time spent "to show that granted [issued] patents are...invalid." According to another firm, however:

> [R]egulations are [not] the source of any competitive disadvantage. In our opinion, the source of the competitive disadvantage of U.S. ceramic packaging industry is a unique combination of events which have occurred over the last 30 years which have resulted in Kyocera obtaining ... an 'economic monopoly' ... that allows Kyocera to dictate the terms of any engagement in the marketplace."

Nine of ten producers provided recommendations for alleviating perceived competitive disadvantages. Five companies recommended some type of increased government assistance, including a research and development tax credit "by line of business versus taxpayer in total," more funding of the DOD's Manufacturing Technology Program (MANTECH), and government procurement of products containing ceramic packages to encourage use of manufacturing technology. One company proposed limiting defense purchases of ceramic packages to U.S.-owned suppliers only. In contrast, two companies advised abandoning "Buy America" type programs. A third company urged removing restrictions on international trade such as import quotas and increased tariffs. Other suggestions were for policies to increase trade with Japan and to revise the U.S. patent law system "to allow for more open examination of patent applications."

Importers

Twenty-four of the 46 importers responding reported that they had made adjustments in their business practices to comply with U.S. government policies, laws and regulations. These included revising manufacturing processes to meet environmental regulations, increasing overhead and operating costs to comply with alleged on-shore assembly requirements, meeting rigid military specifications, and complying with burdensome reporting and accounting defense procurement requirements. One foreign-owned company complained of being locked out of the defense market due to defense procurement regulations, and another mentioned having to implement international monitoring procedures to comply with a U.S. anti-dumping ruling.

- Military Specifications

Twenty-two importer/end users reported that military specifications had affected their ceramic package purchasing decisions. In most cases, these companies indicated that they had to qualify their suppliers of ceramic packages. Three companies reported also that military hermetic requirements encouraged their decision to use ceramic packages. According to one, "The 'hermeticity' issue has convinced us that wherever we can, we should use ceramic packages. With ceramic there is no question of cracked glass or other 'hermeticity' problems." A couple of importers reported using MIL specifications as a "de facto" commercial standard.

- Impact of JAN Program

In 1969, Defense issued a new specification for microcircuits to require that all microcircuits meet standardized electrical performance and reliability requirements. The specification, MIL-M-38510, became known as the JAN specification, for Joint Army Navy specification. Prime contractors and the government could procure these items and be certain that they were approved for use in all services.

Until March 1993, the specification also required that all wafer fabrication, assembly, test and screening of ICs must be done in the United States or its territories. In order to qualify for JAN procurement, suppliers had to locate their manufacturing facilities in the United States which made it possible for Defense to inspect the facilities used for these operations.

With the decline in JAN procurement, however, producers are less willing to maintain the U.S. manufacturing operations necessary to fulfill JAN requirements, as economic trends make offshore production more and more attractive. In March 1993, Defense decided to make it possible for JAN-compliant products to be produced in offshore facilities. Only those destined for space and other particularly critical end uses must still be manufactured on shore.

Respondents were asked if they would change their sourcing pattern for defense-use semiconductor packages should DOD allow the offshore assembly of JAN program semiconductors. Only seven establishments reported that this would affect their sourcing pattern; four indicated that they would move their ceramic assembly operations off-shore; another two preferred to weigh additional volume, price, delivery and quality considerations. Twenty-five companies reported that they would not change their sourcing pattern.

IV. ECONOMIC AND TRADE DATA ANALYSIS

The following section provides information on the economic performance of U.S. ceramic package manufacturers, the role foreign producers play in the U.S. market, and the size and characteristics of the defense market for ceramic packages. This analysis is based on statistical information that was collected for 17 categories of ceramic packages from 11 U.S. producers and 42 importers. While all known U.S. producers and all known direct importers are included in the database, some end users and firms that import semiconductors that contain packages - including many key defense contractors - did not complete surveys.

Summary

In 1992, the U.S. market for ceramic packages (including those assembled with semiconductors) was slightly over $1.2 billion. This included shipments by U.S. producers of $498 million, and imports of $728 million. Reported exports came to only $14.2 million. Import penetration was 60 percent, up from 49 percent in 1990. Unit totals were much more lopsided because of near total foreign dominance of the higher volume package business. In 1992, overall unit import penetration exceeded 95 percent. Unit consumption totaled 643 million, while imports were 612 million, and exports 30 million, less than five percent of consumption.

A truer picture of the role of imports in the U.S. market is obtained by concentrating on the merchant market. [A substantial majority] of U.S. production in 1992 was captive, primarily under the control of a single large firm (Proprietary Information Withheld). This firm's production and capacity substantially declined in 1993. Non-captive, or merchant, production in the United States was comparatively small, comprised of U.S. firms competing both among themselves and directly with major foreign producers. In 1992, the overall U.S. merchant market for ceramic packages totaled $794 million. However, U.S. firms supplied only $67 million, while imports supplied $728 million, more than 93 percent of the total.

Table IV-1
U.S. Ceramic Package Market - 1992

Market	U.S. Production	(+) Imports	(-) Exports	(=) Consumption	% Imports to Consump.
in millions of **dollars**					
Overall	$497.8	$727.7	$14.2	$1,211.3	60.1%
Merchant	$66.6	$727.7	$14.2	$780.1	93.3%
Defense Share	$16.5	$91.0	n/a	$107.5	84.7%
in millions of **units**					
Overall	62.5	611.6	30.9	643.2	95.1%
Merchant	53.5	611.6	30.9	634.2	96.4%
Defense Share	3.0	34.1	n/a	37.1	92.0%

Note: Totals may not add because of rounding
Source: OIRA Producer Survey

Domestic Production Statistics

Table IV-2 below shows unit and value production of ceramic packages by product group for domestic firms participating in the survey. By volume, cerdip and SLAMs account for the bulk of production. In contrast, by value, MCM-C and hybrid packages account for the majority of the total. The number of establishments participating in each product category is also presented on the table. Hybrid packages, MCM-C, and pin grid arrays have the most firms involved, while crystal oscillators, cerdip, and SLAMs have relatively few.

Obviously, ceramic package demand and production is heavily dependent on the semiconductor industry. Unit production of integrated circuits showed zero growth in 1992 over 1991 levels, and experts predict lower than normal growth in the next few years. Changes in system architecture from large pieces of hardware to networked smaller systems and placement of greater number of connections on one chip have affected the growth of all package material suppliers, including those of ceramic packages.

U.S. production of ceramic packages was $498 million in 1992, down from $654 million in 1990. Unit production of ceramic packages by domestic establishments fell between 1990 and 1992 in 13 out of 17 package categories (nine out of 17 in value terms). Overall, production fell by nearly 60 percent between 1990 and 1992 on a unit basis and 24 percent on a value basis. The value-based production figures generally show less extreme percentage changes than do the unit-based figures. This could be explained by production economies of scale -- the per unit cost increases as the volume of production declines.

Table IV-2 Production - Units and Dollars*

PRODUCT CATEGORY	# of Est.	PRODUCTION - THOUSANDS OF UNITS				PRODUCTION - MILLIONS OF DOLLARS			
		1990	1991	1992	% CHANGE 90-92	1990	1991	1992	% CHANGE 90-92
Crystal Oscillator	1								
Cerdip	2								
Cerquad	4				+8.1%				-25.6%
Cerpack	4				-65.7%				-16.1%
SLAM < 50 Terminals	3				-38.8%				-63.1%
SLAM > 50 Terminals	2								
Side Braze	2								
Chip Carriers, < 50 Terminals	5				-24.4%				+0.0%
Chip Carriers, > 50 Terminals	4				0.0%				-41.8%
Flat Packs, < 100 Leads	4				+24.6%				+106.8%
Flat Packs, > 100 Leads	2								
PGAs, <144 Leads	6				-1.0%				5.4%
PGAs, >144 Leads	5				+10.7%				+49.7%
Other Area Arrays	4				+114.3%				+271.7%
MCM-C	8				-33.6%				-59.3%
Hybrid Packages	7				-12.7%				-3.8%
Other	6				-43.3%				+33.0%
TOTAL, ALL TYPES, INCLUDING CAPTIVE	**12**	**156041**	**91632**	**62472**	**-60.0%**	**$654.22**	**$701.28**	**$497.76**	**-23.9%**

* Proprietary Information Withheld

SOURCE: OIRA Producer Survey

Those categories experiencing the greatest decline in units produced include cerdip (down 96 percent), cerpack (down 66 percent), and SLAM < 50 terminals (down 39 percent). These categories all show significant declines in dollar-based production as well, although the dollar-based production declines again were relatively more moderate. Only two establishments participate in cerdip production domestically, and one of these (Kyocera America) ended its operations in 1992, explaining the steep decrease.

The decline in cerdip production, which began prior to 1990, is associated with the replacement of conventional EPROMS with flash memory. While conventional EPROMs require a special cerdip package, flash EPROM memory does not. Decline in military sales also affected producers of cerdip.

Those categories experiencing production growth over the period tend to be in low volume products, including flat packs with less than 100 leads (up 25 percent), pin grid arrays with more than 144 leads (up 11 percent), and other area arrays (up 214 percent from an extremely low base). Production of pin grid array packages increased strongly prior to 1990. This increase was curtailed with the availability of plastic quad flatpacks with lead counts up to 208. Plastic quad replaced ceramic PGA in the commercial market for packages with 84 to 105 pins, as is evidenced by the slight decline in unit production of PGAs with less than 144 leads. Hybrid package demand has been adversely affected by the downturn in military budgets, although a slight improvement is expected for 1992.

Table IV-2 also shows domestic production of ceramic packages, excluding those produced for internal consumption (i.e., those made by IBM). The effect of excluding captive manufacturing on total production is significant, especially in value terms since IBM does not make lower value, high volume cerdip packages. (Proprietary Information Withheld) Excluding captive manufacturing, U.S. production dropped 56 percent between 1990 and 1992 in terms of units. In terms of value, the decline was less steep, at 11.2 percent from its 1990 level.

- Disposition of Production

Domestic ceramic package production is consumed in any of three basic ways: internally by the company making the packages (captive production), sold to a domestic end user or exported to an end user overseas. Table IV-3 below displays the disposition of U.S. package production in 1992, in units and in value.

Table IV-3
Disposition of Domestic Production of Ceramic Packages: 1992*

	UNITS		VALUE	
	Number (000's)	Percent	Dollars (Millions)	Percent
Sold Domestically or In-House Consumption	31,600	50.6%	$482.91	97.1%
Exports	30873	49.4%	$14.23	2.9%
TOTAL	**62,473**	**100%**	**$497.13**	**100%**

* Proprietary Information Withheld
SOURCE: OIRA Producer Survey

Almost half of U.S. ceramic package production was exported, on a unit basis. Almost all of these exports are accounted for by two types. (Proprietary Information Withheld) The packages which were sold to domestic end users represent all product categories.

By value, the disposition of U.S. package production is quite different. Exports account for a minuscule proportion, whereas in-house consumption accounts for [the majority] of the value. The remaining [amount] is sold domestically. (Proprietary Information Withheld) When captive production is excluded, U.S. package producers sell approximately 80 percent of their products domestically (Proprietary Information Withheld) and export about 20 percent (Proprietary Information Withheld).

Import Statistics

Importers were grouped into three types: 1) **Resellers** (eight firms) that included primarily the agents or U.S. divisions of the major foreign package producers, but also included three U.S. producer firms (Kyocera America, MPA, and Pantronix); 2) **End Users** (15 firms) that imported packages for internal consumption; and, 3) **Importers of Semiconductors** already assembled in ceramic packages (19 firms). Resellers and end users are generally the importers of record of packages that enter U.S. customs territory. However, some end users also reported indirect purchases of imported packages through resellers. Also, some end users purchased additional quantities of domestic origin from U.S. producers. Importers of pre-packaged semiconductors were asked to estimate the package value contained in the imported package assemblies. The weighted average value of the package for all firms was calculated to be 24 percent, although the reported average value varied widely from firm to firm.

[Data for imports by type of importer are shown in table IV-4 below.] Importers of assembled semiconductors reported a decline in cerdips and increases in the more expensive varieties.

Table IV-4
Imports By Type of Importer, 1990-1992

Importer Type	(millions of units)			% of Total	(millions of dollars)			% of Total
	1990	1991	1992		1990	1991	1992	
Resellers	302.7	322.4	313.8	51.3%	196.8	197.6	207.8	28.6%
End Users	87.6	126.0	158.3	25.9%	194.1	199.0	241.8	33.2%
Importers, Semiconductors w/packages	176.4	163.7	139.4	22.8%	243.3	263.8	278.1	38.2%
Total	566.7	612.1	611.6	100%	634.2	660.4	727.7	100%

Note: Totals may not add because of rounding
Source: OIRA Importer/End User Survey

Total imports from 1990-1992 by product category in unit and dollar values are shown on Table IV-5 for unembedded ceramic packages only. Note that cerdip alone represented [the majority] of the total units imported in 1992, but [much less] of the dollar total. Further, while imported cerdip units rose (Proprietary Information Withheld) from 1990 levels, the value of imports fell (Proprietary Information Withheld). The value decline is related to an ongoing shift toward cheaper plastic-based packages in many applications, and increases in cheaper unit imports, (Proprietary Information Withheld). These developments coincided with slight decreases in cerdip imports from Japan.

Table IV-5
Imports: Units and Dollars*

Product Category	Millions of Units				Millions of Dollars			
	1990	1991	1992	% Change 90-92	1990	1991	1992	% Change 90-92
Crystal Oscillator								
Cerdip				24.8%				-40.4%
Cerquad				21.4%				57.3%
Cerpack				-25.4%				-20.4%
SLAM, < 50 Terminals								-
SLAM, > 50 Terminals				-				-
Side Braze				36.8%				-1.6%
Chip Carriers, < 50 Terminals				-57.8%				-40.7%
Chip Carriers, > 50 Terminals				-27.2%				-51.3%
Flat Packs, < 100 Leads								
Flat Packs, > 100 Leads				13.5%				1.2%
PGAs, < 144 Leads				0.2%				13.1%
PGAs, > 144 Leads				502.9%				257.7%
Other Area Arrays								
MCM-C				773.9%				66.0%
Hybrid Packages				443.9%				78.6%
TOTAL, ALL TYPES	**388.9**	**441.4**	**469.1**	**20.6%**	**384.1**	**362.5**	**393.6**	**2.5%**

*Proprietary Information Withheld
SOURCE: OIRA Producer Survey

Substantial increases in both dollar and unit terms were recorded in six categories: 1) Crystal Oscillators, 2) SLAM < 50 terminals, 3) PGAs >144 leads, 4) Other Area Arrays, 5) MCM-Cs, and 6) Hybrid Packages. A single firm in Japan supplied 100 percent of three of the categories (Proprietary Information Withheld), and is also the largest factor in the unit increase of lower value MCM-C packages. (Proprietary Information Withheld)

Table IV-6
Import Penetration Levels, 1990-1992
As Percent of New Supply*

Product Category	% of units			% of dollars		
	1990	1991	1992	1990	1991	1992
Crystal Oscillator						
Cerdip	82.6	91.0	99.3	90.8	91.5	95.1
Cerquad	67.0	67.7	69.5	32.7	31.4	50.7
Cerpack	40.1	56.0	59.3	46.4	45.9	45.1
SLAM, < 50 Terminals						
SLAM, > 50 Terminals						
Sidebraze	56.0	70.6	69.9	64.5	74.2	72.3
Chip Carriers, < 50 Terminals	96.6	96.6	94.0	81.5	79.9	72.3
Chip Carriers, < 50 Terminals	48.9	35.5	41.2	70.7	55.2	66.9
Flat Packs, < 100 Leads						
Flat Packs, > 100 Leads	45.3	43.7	58.8	86.2	82.9	85.8
Pin Grid Arrays, < 144 Leads	93.0	90.3	93.1	95.9	95.5	96.2
Pin Grid Arrays, > 144 Leads	79.5	85.8	95.5	90.1	94.2	95.6
Other Area Arrays						
MCM-C	4.5	7.0	38.1	.7	3.0	2.7
Hybrid Packages	67.0	49.8	92.7	.1	.1	.2
Other	90.3	96.0	92.7	78.0	75.9	70.0
TOTAL, ALL TYPES	**71.4%**	**82.8%**	**88.3%**	**37.0%**	**34.1%**	**44.2%**
TOTAL, INCL. SEMI W/PACKAGES	**78.4%**	**87.0%**	**90.7%**	**49.2%**	**48.5%**	**59.4%**

* Proprietary Information Withheld

SOURCE: OIRA Importer/End User Survey

Major declines in imports occurred in the two chip carrier categories, and in flat packs with fewer than 100 leads. These items, which are single layer packages, are subject to substitution by plastic based packages. In addition, the latest generation of more powerful semiconductor chips are shifting to multi-layered packages.

Import penetration levels were calculated based on new supply (i.e., production plus imports) because package export data was only available for 1992. As a result, 1992 import penetration levels shown here are lower than those shown in Table IV-1. However, overall import penetration increased from 1990 to 1992 in both units and dollars as imports increased and domestic production fell. Measured in units, import penetration rose from 78 to 91 percent largely due to increases in cerdip. Of 18 package categories, only three saw unit import penetration levels decrease (both types of chip carriers and flat packs < 100 leads). Imports of chip carriers with fewer than 50 terminals fell only slightly from 97 percent in 1990 to 94 percent in 1992, as U.S. production of the item declined almost apace with imports. Cerdip import levels reached nearly 100 percent of the U.S. market, mainly because U.S. production dropped sharply after 1990. Import penetration for PGAs > 144 rose steadily from almost 80 percent in 1990 to over 95 percent in 1992.

Dollar valued import penetration was up moderately in 11 of 18 categories. Additional upward movements would have been registered had prices and (presumably) package sophistication remained unchanged from 1990 levels. Also, in several categories, such as flat packs > 100 leads, more expensive U.S. produced product increased its share of the dollar market while losing share on the unit side. If captive production is removed, sharp increases in dollar valued import penetration levels occur in multi-layered MCM-C and hybrid packages. (Proprietary Information Withheld)

Three foreign suppliers; Kyocera, NTK, and SMI; accounted for over 88 percent of package imports in 1992. (Proprietary Information Withheld) In only two categories (Proprietary Information Withheld) did the three firms provide less than 70 percent of total imports, and for 11 categories, they supplied over 90 percent of imports. (Proprietary Information Withheld)

Table IV-7
1992 Import Shares - Top Three Sources
(based on dollar value)*

Product Category	3 Firm Total
Crystal Oscillator	100%
Cerdip	52.4%
Cerquad	79.8%
Cerpack	72.5%
SLAM, < 50 Terminals	100%
SLAM, > 50 Terminals	-
Sidebraze	92.3%
Chip Carriers, < 50 Terminals	94.5%
Chip Carriers, < 50 Terminals	98.0%
Flat Packs, < 100 Leads	95.9%
Flat Packs, > 100 Leads	98.0%
Pin Grid Arrays, < 144 Leads	98.4%
Pin Grid Arrays, > 144 Leads	98.8%
Other Area Arrays	100%
MCM-C	98.3%
Hybrid Packages	27.5%
Other	100%
TOTAL, ALL TYPES	**88.2%**

* Proprietary Information Withheld
SOURCE: OIRA Producer Survey

New Supply

New supply is defined as domestic production plus imports. The overall market for ceramic packages rose from $1.29 billion in 1990 to $1.36 billion in 1991, before falling ten percent to $1.23 billion in 1992. The drop in U.S. production more than offset an overall increase in imports. Unit totals were also down, dropping from 722.8 million units in 1990 to 674.0 million in 1992, off almost seven percent. In dollar terms, 11 of 18 categories showed declines, in five instances of more than 30 percent. The most dramatic drops occurred in (Proprietary Information Withheld) and MCM-C (58 percent), (Proprietary Information Withheld). PGAs >144 leads and (Proprietary Information Withheld) more than doubled in value and units.

Table IV-8
New Supply, Units and Dollars*

Product Category	Millions of Units				Millions of Dollars			
	1990	1991	1992	% Change 90-92	1990	1991	1992	% Change 90-92
Crystal Oscillator								
Cerdip				3.8%				-43.1%
Cerquad				17.0%				1.5%
Cerpack				-49.6%				-18.1%
SLAM, < 50 Terminals								
SLAM, > 50 Terminals								
Side Braze								
Chip Carriers, < 50 Terminals				-56.7%				-33.2%
Chip Carriers, < 50 Terminals				-13.5%				-48.5%
Flat Packs, < 100 Leads								
Flat Packs, > 100 Leads								
Pin Grid Arrays, < 144 Leads				.1%				12.8%
Pin Grid Arrays, > 144 Leads				401.9%				237.2%
Other Area Arrays								
MCM-C				2.1%				-58.5%
Hybrid Packages				293.0%				-3.7%
Other				-24.7%				-2.4%
TOTAL, ALL TYPES	**544.9**	**533.0**	**531.6**	**-2.4%**	**1038.3**	**1063.8**	**891.4**	**-14.2%**
TOTAL,INCL. SEMI'S W/PACKS	**722.8**	**703.7**	**674.0**	**-6.8%**	**1288.4**	**1361.7**	**1225.5**	**-4.9%**

* Proprietary Information Withheld
Source: OIRA Producer Survey

Units exhibited declines in nine of 18 categories. MCM-C units were up slightly (two percent) in contrast to the large decline in dollar terms. Also, several others such as cerdip, sidebraze, and hybrids all showed increases over 1990 levels in contrast to value drops.

New [merchant] supply increased from $709.2 to $794.3 million from 1990-1992, up 12 percent. U.S. production, representing just over eight percent of the total, fell more than 11 percent, while imported packages grew nearly 15 percent. Unit totals were generally the same, declining over three percent from 688 to 665 million during the period.

The Defense Market for Ceramic Packages

The producer and importer/end user surveys show that the defense market for ceramic packages totalled about $107.5 million in 1992. This figure includes domestically produced ceramic packages and imports, including the package value of semiconductors assembled in ceramic packages. Accordingly, the defense market accounted for about eight percent of the total U.S. consumption of ceramic packages in 1992 ($1.2 billion). When captive U.S. production is excluded from consumption figures, defense use accounts for about 14 percent of total consumption ($780.1 million).

As discussed elsewhere, defense use of ceramic packages is most likely understated due to the fact that the end-user survey did not capture all potential defense-destined ceramic packages. Moreover, since ceramic packages are several tiers away from defense finished products, in many cases their ultimate defense use was not known by producers, importers, and users. Department of Commerce microelectronics industry experts and the Semiconductor Industry Association both estimate that direct and indirect military consumption accounts for 20 percent of U.S. apparent consumption of ceramic packages. Some product ceramic package product categories are particularly dependent on the defense market. For example, defense accounts for over 85 percent of the value of cerpack consumption (51 percent of units). Defense also accounts for a large portion of total consumption of chip carriers (one third). The following sections provide further details about what is known about defense production and use of ceramic packages.

Domestic Production for Defense Use

U.S. producers of ceramic packages were asked to indicate their shipments of various types of packages for defense application. Since almost no ceramic packages are purchased directly by the Department of Defense, these figures are estimates provided by the domestic producers. They are most likely understated, since U.S. producers of ceramic packages often do not know that their customers are selling finished products for defense application. (Proprietary Information Withheld) Table IV-9 shows defense shipments as reported by the 11 surveyed ceramic package producers.

As can be seen from the table, defense applications reportedly account for about 20 percent of total domestic production on a value basis, excluding captive production. When captive production is included, (Proprietary Information Withheld) this percentage drops to three percent. On a unit basis, this percentage is much smaller, around four percent, with or without the captive production.

Shipments of [one package category] for defense applications rose sharply between 1991 and 1992, (Proprietary Information Withheld). Most other package categories show declining defense production during the period. Overall, production of ceramic packages for defense use was down by about five percent in units and 27 percent by value between 1991 and 1992.

The percentage of domestic shipments going to defense use varies significantly by individual product category. In unit terms, defense applications account for about half of all domestic cerpack production, about one quarter of all flat packs with less than 100 leads, and the vast majority of packages in the "other area array" and "other ceramic packages" categories. Cerpack accounts for about a third, and crystal oscillators and other ceramic packages (not categorized) about one quarter each, of the total volume of defense production.

In value terms, defense represents an even higher percentage of total cerpack production, about 80 percent. Cerpack alone accounts for nearly 40 percent of the value of total defense production. Defense also accounts for significant percentages of total production for cerquad (24 percent), chip carriers with less than 50 terminals (45 percent), flat packs with less than 100 leads (31 percent), other area arrays (96 percent), and other ceramic packages (24 percent). These same product categories account for the majority of the remaining 60 percent of the value of defense production.

Purchases of Ceramic Packages by Defense End Users

In addition to the data from U.S. ceramic package producers presented above, information on the quantity of ceramic packages used in defense applications was also obtained through the survey of package importers, resellers, and end users (42 surveys). As with domestic production for defense use, this information is also likely underestimated. Although the survey captured virtually all direct importers and resellers of ceramic packages, it did not capture all end users. A number of prominent defense prime and sub-contractors did not participate in the survey; and their purchases of embedded ceramic packages are most likely not fully captured. Thus, the actual total defense use of ceramic packages is probably somewhat higher than that reported in this section.

Table IV-9
Domestic Production of Ceramic Packages for Defense Use*

PRODUCT CATEGORY	1991		1992	
	Units (000s)	Dollars ($000s)	Units (000s)	Dollars ($000s)
Crystal Oscillators				
Cerdip				
Cerpack				
Cerquad				
Side Braze				
Chip Carriers < 50 terminals				
Chip Carriers > 50 terminals				
SLAMs < 50 terminals				
SLAMs > 50 terminals				
Flat Packs < 100 leads				
Flat Packs > 100 leads				
PGAs < 144 leads				
PGAs > 144 leads				
Other Area Arrays				
MCM-C				
Hybrid Packages				
Other Ceramic Packages				
TOTAL	**2236**	**$16363.4**	**2131**	**$13017.5**
PERCENT OF TOTAL MERCHANT DOMESTIC PRODUCTION				

* Proprietary Information Withheld

SOURCE: OIRA Producer Survey

End users and importers purchase ceramic packages in one of two basic ways: directly or embedded in finished semiconductors, circuit boards, and similar items. These purchases can be made from domestic sources, or imported from abroad. The following summary table shows defense purchases of ceramic packages by end users and importers, broken down by these categories:

Table IV-10
Defense Purchases of Ceramic Packages
By End Users and Importers

Type of Purchase	1991		1992	
	Units (000s)	Dollars ($000s)	Units (000s)	Dollars ($000s)
Domestic Production for Defense	2236	$16363	2131	$13018
Domestic Purchase of Semiconductors	862	$891	800	$1579
Domestic Purchase of Package Only	29	$1932	41	$1871
Foreign Purchase of Semiconductors	29385	$48522	25341	$47670
Foreign Purchase of Package Only	11553	$46390	8793	$43337
TOTAL REPORTED DEFENSE PURCHASES	44,065	$114,098	37,107	$107,475

SOURCE: OIRA Importer/End User Survey

From this table, a picture of the defense market for ceramic packages emerges. The most obvious point is that a very high percentage of total defense ceramic package purchases are made from foreign sources, both in semiconductors and packages alone. In 1992, imports accounted for 85 percent of the value and 92 percent of the volume of defense purchases, higher levels than import penetration in the overall market. Foreign purchases were made in approximately equal proportions in the form of finished semiconductors and packages alone, on a dollar basis. Total defense purchases fell by about six percent between 1991 and 1992, likely as a result of the declining defense budget.

Again, by examining these data by ceramic package product categories, a more complete picture of the defense market emerges. This information is presented in Table IV-11 below. From this table, it can be seen that nearly half of all defense purchases (value basis) are in the form of finished semiconductors assembled in ceramic packages. On a unit basis, finished semiconductors account for an even larger percentage of the total (70 percent). The vast majority (97 percent) of defense-use semiconductors contained imported ceramic packages, according to the surveyed firms.

With regard to ceramic packages themselves, cerdip accounts for the largest amount of defense use in both unit and value terms. Virtually all of these packages are imported. Other types of package representing significant defense usage include cerpack, PGAs with more than 144 leads, and chip carriers with less than 50 terminals.

U.S. ceramic package producers have the majority of the defense market for cerquad, cerpack, flat packs, SLAMs, other area arrays, hybrid packages, and other. However, with the exception of cerpack, none of these product types is heavily used in defense applications, and these types account for only a small percentage of total defense purchases. On the other hand, foreign suppliers account for the majority of defense supplies of sidebraze packages, chip carriers, PGAs, and MCM-C. Many of these categories are used extensively in defense applications.

Tracking Defense Shipments

We asked producers and importer/end users whether they produced a separate product line for defense applications or if they believed that their packages destined for defense use were essentially similar to their commercial products. We also asked both groups if they were always, sometimes or never aware that a ceramic semiconductor package they produced was eventually used for defense applications.

- Producers

Five of the eight producers responding stated that they did not produce a separate product line for defense. For these respondents, the packages produced are "essentially equivalent" and are "produced using the same processes and production equipment."

When asked if they were aware of the eventual end use of the package, five of the seven firms responding indicated that they were "sometimes" aware if the package produced would be used for defense, and the remaining two were "always" aware when the package was destined for defense use. One of the firms that reported it was always aware of the eventual end use indicated that their products are "100 percent custom." The other firm produces only for R&D and prototype testing, and reports that the purchaser always tells them if the test program is for defense.

Those who indicated that they were sometimes aware that a package they produced was going to a defense end use reported that the packages usually differ in complexity, and many are unique to the military. Other clues, such as government contract numbers and flowdown clauses, make the ultimate destination more identifiable.

Table IV-11
Total 1992 Defense Purchases and Percent from Foreign Sources*

Product Category	Defense Purchases, 1992		Percent from Foreign Sources	
	Units (000s)	Dollars ($000s)	Unit Basis (%)	Dollar Basis (%)
Semiconductors in Ceramic Packages	26142	$49249	96.9%	96.8%
Crystal Oscillators				
Cerdip				
Cerquad	100	$891	0.2	4.7
Cerpack	1715	$8810	63.2	47.1
SLAM < 50 Terminals	57	$24	0.0	0.0
SLAM > 50 Terminals	0	$0	0.0	0.0
Side Braze				
Chip Carriers, < 50 Terminals	484	$5933	92.7	62.5
Chip Carriers, > 50 Terminals	111	$3329	89.8	80.6
Flat Packs, <100 Leads	135	$1698	15.2	48.2
Flat Packs, > 100 Leads				
PGAs < 144 Leads	143	$1299	91.5	79.0
PGAs > 144 Leads	479	$7720	99.4	98.7
Other Area Arrays	3	$276	0.0	0.0
MCM-C	31	$2418	88.8	77.5
Hybrid Packages	20	$762	30.1	1.6
Other Ceramic Packages	540	$3678	0.4	9.6
TOTAL	**37107**	**$107475**	**92.0**	**84.7**

* Proprietary Information Withheld

SOURCE: OIRA Importer/End Users Survey

- Importer/End Users

Nineteen of the 30 importer/end users firms responding indicated that they do not produce a separate defense product line. The remaining 11 importer/end users described how their defense items significantly differ from their commercial products. Two mentioned different manufacturing processes or "flow" of products through the line, although often the same facilities are used. One respondent stated the difference this way: "Our wafer fabs (where ICs are produced) are producing ceramics chips (dice) on a single line -- no separate line for military. At the Assembly and Test operations, separate lines are utilized since Mil-Spec parts require different processing...i.e., must be hermetic...from commercial."

Importer/end users were also asked whether they were always, sometimes or never aware that a ceramic package they produce will eventually be used in a defense setting. One respondent helped define awareness, saying that "it is a function of how the Military Contractor purchases - direct or through one of our franchised distributors...how much program info the contractor will [provide] when procuring...and to what specification and class level they are specifying."

Twelve of the thirty-eight firms responding to the next question stated that they always know when a product is going to a defense use: most of their customers cite standard military specifications, such as MIL-M38510, MIL-STD 883C or MIL-STD 965. Eighteen indicated that they sometimes know when a product is destined for a defense application. Again, the presence of military contract numbers or the use of military specifications are clues, and occasionally customers disclose the end use. Several of these firms mentioned that distributors do not report back to them regarding the end use of their products. Finally, eight importer/end users stated that they never know the ultimate destination of their products. Most of these respondents implied that customers did not share the information; one firm stated that "company policy prohibits knowingly selling into defense applications."

Financial Performance

Firms responding to the producer survey were asked to provide basic balance sheet and income statement data for their ceramic package production operations. In some cases, the operations constitute only a small part of a large corporation; in other instances, the firm produces only ceramic packages. Eight firms reported this information (Proprietary Information Withheld). Aggregate financial data are shown in the table below.

Table IV-12
Ceramic Package Operations: Profitability Measures
($000s)

	1990	1991	1992
Net Sales	$325,811	$346,182	$338,624
Operating Income	-65,467	-95,929	-89,988
Before Tax Profit Margin	-20%	-28%	-27%
Losses Reported	4 of 8	4 of 8	5 of 8

SOURCE: OIRA Producer Survey

Operating income is reported instead of net income because those operations which are divisions of larger corporations often did not report income tax. As can be seen from the table, five out of eight surveyed package companies lost money in 1992, and their average loss was 27 percent of sales. (Proprietary Information Withheld) [T]his is weak, especially compared to the before tax profit margin for the electrical and electronic equipment sector as a whole, which was 5.1 percent in 1990, 3.7 percent in 1991, and 6.8 percent in the third quarter of 1992.[1]

Table IV-13 below provides information on the operations' financial balances for 1990 through 1992. Using data from the two tables, a number of performance ratios can be calculated. The *current ratio* measures a company's ability to quickly pay its debts, and is derived by dividing current assets by current liabilities. For these package operations, the current ratio was 1.6:1. Here, a ratio of 2:1 is generally considered ideal; however, the current ratio for the entire electrical and electronic equipment sector was only 1.45 for the third quarter of 1992. A variant of the current ratio is the *quick ratio*, which subtracts inventories from current assets (therefore including only the most liquid assets), then divides by current liabilities. The quick ratio for these operations was 1.3. This again compared favorably with the quick ratio for the electrical and electronic equipment sector, which reached .91 in the third quarter of 1992.

[1]Data for the Electrical and Electronic Equipment sector was taken from "Financial Ratios for Manufacturing Corporations Third Quarter 1992," U.S. Department of Commerce, Washington, DC.

Table IV-13
Ceramic Package Operations: Financial Balances ($000s)

	Most Recent Accounting Period
Current Assets	$110,895
Current Liabilities	69,937
Inventories	22,379
Total Assets	222,788
Equity	124,782
Short Term Debt and Current Long Term Debt	4,557
Long Term Debt	4,571

SOURCE: OIRA Producer Survey

Another useful performance measure is *inventory turnover*, which shows how efficiently firms use inventory purchases. It is derived by dividing net sales by inventory. Using the 1992 sales figure, inventory turned over 15 times. This is significantly higher than the average of 6.2 times recorded by the electrical and electronic equipment sector for the third quarter of 1992.

By calculating the *long-term debt to equity* ratio, it is possible to tell how much an industry or firm relies on long term debt vs. equity for financing. It is calculated simply by dividing long-term debt by equity. For our firms, the result was 3.7 percent; this was much lower than other firms in the sector, which reported a result of 37.5 percent in the third quarter of 1992.

Investment

Ten producers furnished both the physical plant and the machinery and equipment expenditures for their U.S. ceramic package manufacturing operations from 1990 to 1992, with an estimate of their 1993 spending. As is shown by Table IV-14 below, total capital investment rose and peaked in 1991, dropping back below the 1990 level in 1992. Expenditures for 1993 are expected to decline sharply to less than half those of 1992.

Table IV-14
Investment In Operations
(in thousands)

Year	Plant	Machinery and Equipment	Total
1990	$ 12,634	$ 116,960	$ 129,594
1991	33,942	157,011	190,953
1992	12,683	91,659	104,252
1993 (estimate)	2,916	37,149	40,065

SOURCE: OIRA Producer Survey

Total investment as a percentage of the value of package shipments was 19.2 percent in 1990, increased to 26.4 percent in 1991, then fell to 19.9 percent in 1992. Although 1993 shipments are not yet known, the significant decrease in estimated 1993 investment will likely represent a marked decrease in total investment as a percentage of package industry shipments.

The level of ceramic package industry investment exceeded that of new capital expenditures for semiconductors and related devices -- the larger industry of which ceramic packages are a part. According to the Census Bureau, semiconductor industry investment was 13 percent of total shipment value in 1990, and decreased to ten percent in 1991 -- less than half the 1991 percentage reported by package producers.

Investment per employee shows a similar picture. Package producers reported investing an average of $27,061 per employee in 1990 and an average of $39,823 in 1991. This compares to $18,918 in 1990 and $16,829 in 1991 per employee for the semiconductor industry as a whole. Broken down even further, package industry investment per production worker was $47,838 and $69,793 in 1990 and 1991, respectively, compared to the overall semiconductor industry's investment of $39,217 and $34,165.[2]

It should be noted that [one firm] consistently accounted for [a majority] of total reported industry investment for any given year. Even with [this firm's] figures excluded, however, investment as a percentage of total shipments still exceeds the overall industry averages for 1990 and 1991: With [this company] omitted, investment as a percentage of package shipments for the nine remaining producers was 16.2 percent in 1990, vaulted to 74.6 percent in 1991 (Proprietary Information Withheld), then settled back to a still healthy 20.1 percent in 1992.

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[2] Overall industry data for SIC code 3674, semiconductors and related devices. U.S. Bureau of the Census, 1991 Annual Survey of Manufactures. Washington: U.S. Government Printing Office, December 1992.

[Again, excluding one firm accounting for the majority], investment per employee and investment per production worker dipped below overall semiconductor industry levels in 1990 -- at $7,961 per employee and $14,675 per production worker -- but rose to more than double the industry averages in 1991, at $36,199 per employee and $68,460 per production worker (Proprietary Information Withheld). Given survey respondents' pessimistic projections for 1993, it is doubtful that ceramic package producers will maintain a high level of investment in their manufacturing operations.

Investment Decisions

On what basis did companies determine the amount of money to invest in the physical plant, machinery and equipment of their ceramic semiconductor package manufacturing operations? Ten producers outlined the factors most important in influencing their companies' investment decisions, each usually listing more than one factor.

The state of the market for ceramic packages figured most prominently; nine out of ten companies' investments were attributed to market concerns of one type or another. Six responses called market potential or opportunities a primary influence on investment, while two more cited customers' requirements as a deciding factor.

Availability of capital and expected return on investment, mentioned four times each, were also key influences. Three firms were prompted by technical concerns: the necessity of meeting the "needs of specific production requirements;" the progress made in "achieving technical milestones;" and the need "to maintain our technical state of the art service for the semiconductor industry." A single firm cited investing to deal with "environmental issues where return would not be a determining factor."

Three firms commented specifically on the relationship of foreign competition to their investment decisions. One company took into account its "competitive position -- usually relative to foreign companies" when investing. Another noted, "Our investment decisions to date have been driven primarily by the size of our product backlog, which in turn is driven primarily by the market position of foreign suppliers." The third company stated the link most explicitly. "Equipment purchased for specific applications to a particular product would be influenced by the estimated market for that product. We are driven by the market and how stable our customer business levels are. Intensive Japanese competition for specific orders and important customers is definitely a negative factor in our current investment decisions and may be for future decisions."

Effect of Ceramic Package Imports

Both importers and producers were asked to assess the positive and negative effects that imports of ceramic semiconductor packages and of "embedded imports" (i.e. imports of foreign-assembled semiconductors which included ceramic semiconductor packages) have had on U.S. manufacturing, as well as the effects imports have had on the ability of the responding firm and the ceramic packaging industry as a whole to meet U.S. national security needs.

Importer/End Users

Twelve companies either had no comment on this issue or said that it was not applicable. Thirty-three companies responded, often at some length and usually listing more than one effect. Under Positive Effects, one company wrote, "No positive effect of total dependence on foreign suppliers to support national security needs." Other respondents, however, responded that there have been positive effects including the reported high quality of imported packages which was praised by two-thirds of the respondents. One firm further asserted that competition from imports "forced U.S. manufacturers to improve quality levels to that of import products." Another company disagreed, stating, "domestic sources have been unable to [sufficiently] improve their quality and costs in light of the competition from the large foreign sources even though improvement is evident."

Lower costs were another effect of imports cited in two-thirds of the responses. High quality and low cost were often mentioned together. In one such response the positive effect was qualified: "Lower prices when U.S. competitor exists, but higher prices when [there are] no U.S. competitors." Foreign producers also received kudos for their for their service, reliable delivery, ability to meet customer specifications and the variety of their product mix. Seven importers cited imported packages as expanding the U.S. market for packages or products incorporating packages. Only one company mentioned that defense companies, who buy in smaller volume, benefit from imports' larger commercial volume, but this theme recurs more often with regard to embedded imports.

A final positive effect of imports was to provide access to products not manufactured in this country. Five companies could not get the products they needed without importing them; at least the packages were, as on company put it, "available from someone." The flip side of this positive effect, however, was the most-mentioned negative effect of ceramic package imports: foreign dependency.

While 47 percent of respondents listed foreign dependency as a negative effect of ceramic package imports, the degree of concern about this dependency varied. One foreign-owned company listed it as a negative effect only to dismiss it: "Foreign dependency -- but this is a result of lack of competitiveness of U.S. suppliers." Others, while acknowledging dependency, had not experienced negative effects. "Foreign dependency could have been an issue/concern. Fortunately there has been a good supply of packages available," responded one firm. "We recognize some vulnerability," wrote another. Two companies deemed foreign dependency "undesirable," and another worried that "availability could be jeopardized should the product be required."

Other pitfalls encountered stemmed from the logistics of importing. Twenty-five percent of the respondents cited longer lead or cycle times for imports. Overseas communications could be strained, and there was sometimes no local decision authority to deal with in the United States. Exchange rate fluctuations had caused problems for three importers. One importer expressed concern that specifications sent overseas could be reverse engineered.

Occasionally, some importers mentioned negative effects in areas where others had seen positive effects. While most respondents judged import prices and delivery favorably, four companies found their prices higher, "due to fewer suppliers," and a fifth expected prices to increase for the same reason. Two reported serious disruptions in delivery. Finally, a few companies saw negative effects on the U.S. market as a whole. "Domestic sources have ceased operations because of competition and reduced profit margins," said one company. Another added a further negative effect: "Perception that U.S. is lagging in technology and manufacturing expertise/quality."

Producers

Seven producers responded on the positive and negative effects of package imports. Three producers said that package imports had the positive effect of expanding markets for ceramic packages and for end products. Lower costs and higher quality were mentioned twice.

Companies cited negative effects experienced at the firm level and at the overall market level. Two companies mentioned losing orders and one reported laying off employees as a result of competition from imports. In response to a separate but related question, five firms reported 13 instances of losing sales to imports. In four of these cases, the loss led to lost revenue, and in two more the producer exited that product line. One producer stated that "U.S. producers have probably increased their share of the U.S. market" and that they "are well positioned and have the capability to produce any of the new ceramic package types and designs being developed." Another company was not as optimistic, observing that "Japanese suppliers have set a standard of quality and volume delivery that new market entrants will find difficult to equal."

Other producers were less optimistic -- and blunter. "Diminishing competition. Expect demand/price to increase," said one. "Some customers have expressed concern in switching suppliers because of possible retaliation of their main supplier (Japanese)," said another. "The concern is possibly increasing prices for other packages." A third producer stated, "Frankly, U.S. competitors in this marketplace supply product only in those cases where Kyocera has decided to let them do so ... imports have caused us to drop specific products in which we have invested significant engineering and start-up costs, and 'jockey' and 'probe' to find specific niches where we have a significant competitive advantage, or Kyocera has decided not to participate.

"This has been very expensive ... the investment community as a whole, and the venture capital community in particular, recognize that earning a return in the advanced ceramic market is very unlikely even though it is a market which most people acknowledge is high growth. Accordingly, companies are leaving the business in the U.S., and new companies are not entering."

Effect of Embedded Imports

Once respondents had assessed the positive and negative effects of ceramic package imports, they were asked to do the same for imports of foreign-assembled semiconductors which included ceramic packages. Again, both importers and producers responded.

Importer/End Users

Twenty-four importers deemed embedded imports not applicable to their operations, twice as many as said that about package imports. Twenty-one importers responded to the question. Almost half of those companies, 48 percent, said lower costs were a positive effect of embedded imports. Five importers attributed the lower costs to foreign volume producing; three of those five companies specifically cited the advantages to relatively low-volume defense customers of being able to tap into high commercial volumes.

Companies' responses sometimes contradicted each other, depending on a particular firm's situation. Three importers reported that embedded imports expanded their markets, but another thought they ate into market share, making expansion more difficult. Three companies mentioned shorter lead or delivery times as a positive effect of embedded imports, and three mentioned longer lead or delivery times as a negative effect. Two companies said the embedded imports were of high quality, while one company said they were of such poor quality that it had "to perform lot validation tests." Foreign dependency was cited as a negative effect by two companies. One company feared competition would force it offshore, while another had already retired onshore capacity. Finally, one company had closed U.S. assembly operations due to pressure from foreign-assembled semiconductors, although they noted this closing had "no relation to ceramic packages."

Producers

One producer said imports of foreign-assembled semiconductors expanded the U.S. market as a whole. Another producer said that its market was restricted because it did "not offer 'embedded packages' assembled in Japan." The remaining seven producers considered the question not applicable to their operations.

V. NATIONAL SECURITY CAPACITY ANALYSIS

Section 232 (d) of the Act directs DOC to evaluate "the capacity of domestic industries to meet (national defense) requirements," among other factors. In earlier Section 232 investigations, capacity was contrasted with anticipated demand for the product in question in a national security emergency. Due to the rapidly changing national security challenges facing our country, DOD has been unable to quantify anticipated demand for ceramic packages in a national emergency. Moreover, the nature of ceramic package use in defense systems makes this type of analysis unfeasible. Therefore, this report will focus on the economic strength of key sectors and their ability to compete in increasingly global markets. The following section will identify current capacity and recent changes to capacity, discuss capacity constraints and product fungibility, and focus on those national security concerns which are currently relevant.

Production Capacity

U.S. producers of semiconductor ceramic packaging were asked to provide information on their "practical production capacity" for the years 1990-1992 for the 17 sub-categories of ceramic packages. Practical production capacity was defined as the greatest level of output achievable in an establishment using a realistic work pattern, assuming the current product mix. Only machinery and equipment currently in place and ready to operate were considered, and subcontracting work to outside facilities was to remain at current levels. Unit production capacity for various product categories is presented in Table V-1 below, while Table V-2 presents production capacity expressed in millions of dollars.

The greatest volume production capacity has been in the cerdip category, while the MCM-C and hybrid package categories are by far the greatest by value. This is explained by the fact that the average price for a cerdip package is less than a dollar, while average hybrid packages are valued at over $2000, and MCM-C packages are priced in the hundreds of dollars. Trends in total capacity for the industry are thus inconclusive, as the individual categories show quite different activity over the period.

The cerdip category experienced a dramatic decrease in production capacity, in both units and value. In units, cerdip production capacity declined 98 percent between 1990 and 1992 (from 204 million to just three million). The comparable dollar decline was 87 percent. This decline can be traced to [one Japanese firm's] decision to end U.S. cerdip production in favor of increased imports from its parent company, as well as low profitability and the encroachment of other packaging technologies. Only one other U.S. company participates in this market and has been a minor supplier.

Other product categories showing smaller decreases in unit and value production capacity include cerquad, cerpack, sidebraze, and flat packs with more than 100 leads. In many cases, the decrease in capacity occurred in 1992 after slight increases in 1991 over 1990 levels. It should be noted that a major contraction in hybrid package production capacity occurred in late 1992 (Proprietary Information Withheld), and is not reflected in the tables below.

Table V-1
Practical Production Capacity 1990-2
(Millions of Units)*

Product Category	# of Estabs.	1990	1991	1992
Crystal Oscillator	1			
Cerdip	2			
Cerquad	4			
Cerpack	4			
SLAM <50 Terminals	3			
SLAM >50 Terminals	2			
Sidebraze	2			
Chip Carriers <50 Terminals	5			
Chip Carriers >50 Terminals	4			
Flat Packs < 100 Leads	4			
Flat Packs >100 Leads	2			
Pin Grid Arrays < 144 Leads	6			
Pin Grid Arrays > 144 Leads	5			
Other Area Arrays	3			
MCM-C	9			
Hybrid Packages	7			
Other	7			
TOTAL	**12**	**376.7**	**409.0**	**253.2**

* Proprietary Information Withheld

SOURCE: OIRA Producer Survey

Table V-2
Practical Production Capacity 1990-2
(Millions of Dollars)*

Product Category	# of Estabs.	1990	1991	1992
Crystal Oscillator	1			
Cerdip	2			
Cerquad	4			
Cerpack	4			
SLAM <50 Terminals	3			
SLAM >50 Terminals	2			
Sidebraze	2			
Chip Carriers <50 Terminals	5			
Chip Carriers >50 Terminals	4			
Flat Packs < 100 Leads	4			
Flat Packs >100 Leads	2			
Pin Grid Arrays < 144 Leads	6			
Pin Grid Arrays > 144 Leads	5			
Other Area Arrays	3			
MCM-C	9			
Hybrid Packages	7			
Other	7			
TOTAL	**12**	**$752.2**	**$905.1**	**$910.1**

* Proprietary Information Withheld

SOURCE: OIRA Producer Survey

(Proprietary Information Withheld)

Unit and dollar production capacity for chip carriers with less than 50 terminals also increased significantly between 1990 and 1992, (Proprietary Information Withheld)

Other product categories showing consistent increases in production capacity include (Proprietary Information Withheld) and the catch-all "Other" category. (Proprietary Information Withheld)

In some product categories, unit production capacity is increasing while dollar production capacity is decreasing, or vice versa. Categories where unit production capacity is increasing, but dollar capacity is declining include (Proprietary Information Withheld) and MCM-C. This implies decreasing or highly volatile values for these items. Similarly, unit production capacity decreased slightly while dollar capacity increased for pin grid arrays with less than 144 leads.

Capacity Utilization

Capacity utilization rates were calculated as unit and value production as a percentage of practical capacity in each product category for each year 1990-1992. Capacity utilization rates were also calculated for each firm across all ceramic package products. In 1992, the average capacity utilization rate (all firms, all types) was just 24 percent on a unit basis, down from 41 percent in 1990. Capacity utilization rates fell in 14 of 17 product categories. By establishment, capacity utilization rates for all product categories in 1992 ranged from just 16 percent to over 80 percent.

In general, products in which U.S. capacity had increased had relatively low utilization rates. Product categories with the highest capacity utilization rates in 1992 (unit basis) were (Proprietary Information Withheld). Those with utilization rates far below average were: chip carriers with less than 50 terminals (six percent), other area arrays (six percent), cerpack (28 percent), and (Proprietary Information Withheld). The remaining product categories had utilization rates ranging from 37 percent to 64 percent.

Table V-3
Capacity Utilization, 1990 & 1992
(Unit Basis)*

	1990	1992
Crystal Oscillators		
Cerdip		
Cerquad		
Cerpack		
SLAM < 50		
SLAM > 50		
Sidebraze		
Chip carriers < 50		
Chip carriers >50		
Flat Packs < 100		
Flat Packs > 100		
PGAs < 144		
PGAs > 144		
Other Arrays		
MCM-C		
Hybrid Packages		
Other		
TOTAL	**41.4**	**24.7**

* Proprietary Information Withheld
Source: OIRA Producer Survey

Capacity Gains and Losses

Survey respondents were asked to identify U.S. and foreign manufacturing establishments or product lines in which production was ended or contracted within the past ten years, as well as anticipated closings/contractions for the next three years. Seven survey respondents reported closing production lines in 14 different establishments; all but one of these closings occurred after January 1, 1991. (Proprietary Information Withheld) Substantial additional domestic capacity was closed during the 1980s by companies who no longer manufacture ceramic packages, and who therefore did not participate in our industry survey.

Eight of the 14 reported closings were in the United States; one was in Canada, while five were outside of North America. Total annual production capacity reported lost was $469 million, of which $354 million or 75 percent was lost from North American facilities. (Additional foreign capacity may have been closed by companies not responding to our producer survey.)

Table V-4 shows U.S. production capacity lost by ceramic package product groups. Since most of the reported losses were in 1991 or 1992, a comparison was made with production capacity for that product for 1991 so the relative importance of the capacity loss could be discerned.

Across all categories, nearly 39 percent of U.S. production capacity (by value) was lost or is expected to be lost in the next year. (Proprietary Information Withheld) Much of the remaining losses are not represented in Tables V-1 and V-2 above because they are too recent, or are anticipated.

Table V-4
Domestic Capacity Losses

Product Category	Annual Capacity Lost ($000s)	Year Lost	% Total U.S. 1991 Capacity
Cerdip	$39,517	1991	-88%
Cerpack/Cerquad	$9,000	1993/4	-34%
SLAM < 50	$25,000	1992	-66%
SLAM > 50	$30,000	1992	-24%
MCM-C	$550	1991/2	-1%
Hybrid Packages	$250,000	1992	-50%
TOTAL	**$354,067**	--	**-39%**

SOURCE: OIRA Producer Survey

(Proprietary Information Withheld)

Surveyed firms were also requested to report any planned gains in production capacity through 1996. Four firms listed six planned increases in domestic production capacity between now and 1996; all involve expansions to current facilities rather than greenfield construction. (In addition, one firm said that it will open facilities [abroad] for [certain products]. In total, the anticipated expansions will add an additional $27 million to U.S. annual production capacity (less than three percent of 1992 U.S. practical production capacity). (Proprietary Information Withheld) The table below specifies the planned expansions by product type, annual production capacity (dollars), and year.

Table V-5
Anticipated Additions to Domestic Capacity
1993-1996

Product Category	Annual Capacity ($000s)	Year	% of 1992 Capacity
(Proprietary Information Withheld)			
TOTAL	**$27,050**	--	**+3%**

SOURCE: OIRA Producer Survey

Capacity Constraints

- Time to Reach Capacity

Surveyed producers were asked to estimate how long it would take to reach capacity production levels at their largest U.S. production facility. In the absence of specific emergency requirements for ceramic packages, this question is important because it is one way of looking at a firm's capability to support a surge in production during a national emergency. It is especially critical for products like electronic packages, upon which so many other devices depend. With nine producer responses, the average estimated time to reach full capacity was 7.3 months. Answers ranged from zero for a firm operating near full capacity to as long as 15 months. As noted earlier, the average capacity utilization rate for domestic producers was just 24 percent.

- Lead Times

Respondents were further asked to estimate the time required, in weeks, for each of a list of production steps. The question was asked for firms' least and most complex packages, and also for packages of average complexity. Since some steps are concurrent, the cumulative total was also noted. Average responses are given in Table V-6 below.

Table V-6
Lead Times (in weeks)

	Least Complex		Most Complex		Average Complexity	
	New	Repeat	New	Repeat	New	Repeat
Tape Casting	1		1.7		1.2	
Design & Engineering	2.1		4.6		2.8	
Materials & Purchasing	2.3		2.9		2.4	
Tooling Preparation	3.9	.3	7.8	.3	4.5	2.3
Production Scheduling	1.1	.8	1.1	.8	1.1	.8
Queue Time	1.4	1.4	1.9	1.8	1.7	1.8
In-process Time	2.7	2.6	4.5	4.3	3.4	3.1
Inspection Time	.5	.4	1	.8	.6	.6
Packaging & Delivery	.3	.3	.4	.4	.4	.5
Other	.7	.7	.7	.7	2.6	.7
Average Cumulative Total	11.2	5.4	20.5	8.9	14	6.8

SOURCE: OIRA Producer Survey

- Bottlenecks

Producers were then asked to identify from a given list the top six bottlenecks which hamper their ability to move to capacity production. Also, firms were asked to estimate the cost and time required to correct these bottlenecks. Seven firms responded and the results are shown in Table V-7 below. "Labor costs and training" was the most frequently mentioned bottleneck, noted by all seven respondents, and cited by four of the seven companies as either first or second in importance. Tooling availability, cited five times, was always identified as second or third in importance.

Table V-7
Bottlenecks to Reaching Full Capacity

Bottlenecks (listed by frequency of mention and ranking by firms)	# of mentions	Average Cost to Correct ($000)	Time to Correct (Weeks)
Labor Costs/Training	7	705	19.4
Tooling Availability	5	3550	24
Equipment Availability	4	1250	32.3
Design and Engineering	4	850	32.5
Raw Materials Availability	3	25	12.7
Tooling Installation	3	2500	18
Assembly and Testing	3	100	16
Component Availability	1	No estimate	8
Component Testing and Inspection	1	500	26
Production Scheduling	1	225	10
Manufacturing Space	1	500	30
Other: Availability of Operators & Technicians	1	25/year	5
Other: High Cost of Capital Equipment	1	No estimate	10
Other: Availability of Professional Process Engineers	1	2000	78

SOURCE: OIRA Producer Survey

Imports of Equipment, Components, Parts, and Materials

Next, firms were queried about their imports of key manufacturing equipment, components, parts and raw materials. Firms were asked to identify what they were sourcing from abroad, and to explain why they chose to use foreign sources (from a list of nine possible reasons).

Equipment

The results for key manufacturing equipment are shown in table V-8 below. Five firms mentioned foreign-sourced equipment, while one other indicated that all key equipment is U.S.-made. In all cases for foreign-sourced key equipment, respondents cited one of four reasons:

1. Domestic source is inadequate;
2. Lower cost;
3. Faster delivery; or
4. Better quality.

Table V-8
Imports of Key Equipment

Item	Supplier	Country of Origin	Reasons (see discussion above)	
			Primary	Secondary
Tape Casters	Harano	Japan	1	4
	Yokiyama	Japan	-	-
Plating	Uyemura	Japan	1	4
	Uyemura	Japan	2	3
NC Punches	Ushio	Japan	1	4
Punching Machine	Dobby	Japan	2	4
Cutters	Hori	Japan	-	-
Printer	New Long	Japan	2	4
Cofire Furnace	Shiraishi	Japan	2	4
Bonder	Kaijo	Japan	4	2
Via Inspection	Sira	England	4	3
Line Inspection	Orbot	Israel	4	3

SOURCE: OIRA Producer Survey

The following five additional reasons were offered on the survey, but were not chosen by responding companies as the reason for their foreign sourcing of key equipment: no known domestic source, supplement domestic source, foreign parent's economies of scale, required to purchase from foreign parent and offset agreement.

In reviewing this data, it is worth noting the variety of machinery that is foreign-sourced. The extent to which U.S. ceramic package manufacturers rely on machinery imports from Japan for ten of the 12 products identified is also significant. If any foreign sources were unavailable in an emergency, U.S. firms would have to quickly identify alternate foreign or U.S. machinery suppliers.

Components, Parts, and Raw Materials

Firms also reported relying on foreign sources for a variety of components, parts and raw materials. (Results are shown in table V-9 below.) The four reasons cited above were again often cited, with three more reasons also mentioned: 5. No known domestic source; 6. Customer requirement; and 7. Economies of scale.

Table V-9
Imports of Parts, Components and Raw Materials

Item	Supplier	Country	Reason (see discussion above)	
			Primary	Secondary
Aluminum Nitride (AlN)	Tokuyama Soda	Japan	4	1
Alumina Oxide (Al_2O_3)	Alcan	Canada	4	-
Copper Tungsten	--	--	-	-
Raw Material (nonspec.)	Kyocera	Japan	2	7
Glass Powder	Iwaki	Japan	6	-
Plating Chemicals	Uyemura	Japan	1	2
Pins	Sumitomo	Japan	1	4
Heat Sinks	Sumitomo	Japan	5	-
Lead Frames	Toppan	Japan	1	-
	Toppan	Japan	4	3
	Suron	Israel	3	1
	--	--	2	1
Ceramic Packages	--	--	2	1
Dry Pressed Ceramics	MPI	Singapore	2	1

SOURCE: OIRA Producer Survey

Again, no respondents identified a requirement to purchase from a foreign parent or an offset agreement as being the reason for their foreign sourcing.

Material and Supply Shortages

Firms were asked if they had experienced any shortages or supply interruptions of materials, parts and components, or other essential supplies in the last five years, and if so, to describe these incidents and detail the impact on their firm's operations. Only three firms reported such interruptions.

One firm reported a problem in early 1993 with the quality of pins received from a Japanese supplier. (Proprietary Information Withheld) In another case, a Japanese equipment company reportedly advised a U.S. firm that it would no longer service existing Japanese equipment at the U.S. firm's facility and that the firm would have to purchase new equipment. The firm plans to replace existing Japanese equipment with U.S.-sourced equipment in the future. Finally, a third firm reported that they had always had problems with small quantity orders from [one foreign supplier]; this led them to add [another foreign] supplier for [a key component].

Fungibility/Conversion

Producers of ceramic packages were asked about their ability to alter the composition of their current product mix, specifically about their ability to produce larger or more complex packages. Could they, for example, convert from manufacturing packages of 3-4 layers to packages of 7-8 layers? Could they vary the number of interconnects and/or the circuit and interconnect line width? Could they move from manufacturing one inch packages to two inch packages? If so, how long would this process take and by what factors would it be influenced? Manufacturing packages with more layers or varying interconnect number or width is a function of package complexity, while moving to two inch packages from one inch depends more on having the necessary equipment.

Eight producers responded to these questions. One company stated that its "flexible production processes and equipment are designed to accommodate a complete range of all the factors mentioned in this question." It and four other companies are either already capable of producing packages of at least seven layers, or are currently moving in that direction. The remaining three estimate needing from two months to two years to shift production. Tooling, labor training and process development are the primary factors influencing conversion time. One company further explained that "each specific package conversion will take a certain amount of time;" the actual engineering hours required for this would create a bottleneck.

Two firms currently have the capability to vary the number of interconnects and/or the circuit and interconnect line width; an additional firm has an ongoing effort to attain this

capability. One company was unable to estimate the time needed for such a conversion. While one producer estimated needing only one to two weeks for "design, screen and programming changes," three others projected at least a year, possibly a year-and-a-half to two years for the conversion effort. Again, engineering hours, training, tooling and process development were cited.

Four producers are currently capable of manufacturing two inch packages. A fifth can produce them in small lots, but would require new equipment and complete retooling to achieve economies of scale, a process it estimates would take a year to accomplish. Another company figures on four to eight weeks for "design, fixture and programming changes" to make the switch. The seventh company thought it would take six to nine months "to become cost competitive for these larger size packages." The last firm judged that the change would take 18-24 months to complete.

Employment[1]

Employment Information

The following employment trends in the ceramic package industry were calculated from Commerce's U.S. producer survey data. Employment data were received from ten out of the 11 companies responding to the producer survey. This information is valuable because no specific data on the ceramic package industry are available from the Bureau of Labor Statistics (BLS). Standard Industrial Classifications (SIC) correspond only to selected broad industry groupings; ceramic semiconductor packages fall under SIC 3674, semiconductors and related devices, which is part of SIC 367, electronic components and accessories. BLS data covering these broader groups are used for comparison.

The ceramic package industry reported that it experienced an estimated 27 percent decline in employment in 1993 from its 1990 employment totals, dropping from 4,789 employees in 1990 to 3,493 employees in 1993. As evidenced by our survey results, there is a significant projected downward shift in the percentage of administrative personnel and scientists and engineers assigned to ceramic package production in the 1990-1993 time frame. The producer companies, the bulk of this decline, reported a 52 percent decline in administrative personnel, a 45 percent decline in scientists and engineers, and a 14 percent decline for the production workforce. The reported decline in administrative employment reflects a general trend across manufacturing and service industries during this period of significant corporate streamlining of white collar workers. The decline in engineer/scientist positions may reflect a paring down of research and development activities as reductions in military spending reverberated through the chain of defense contractors and subcontractors, and sales volumes

[1]The Department of Labor's Office of International Economic Affairs provided Bureau of Labor Statistics data, as well as the analysis of critical occupations and skills and information regarding Trade Adjustment Assistance. Labor's complete submission is attached as Tab E.

or revenues decreased. By 1993, the workforce included 67 percent production workers, 18 percent scientists and engineers, 11 percent administrative, and four percent other employees.

The declining employment in the ceramic semiconductor package industry exceeds drops that occurred in SIC 3674 (semiconductors and related devices) from 1990 through 1992. According to data from the BLS Current Employment Statistics Survey, average employment in SIC 3674 declined by about nine percent from 1990 to 1992, compared to 27 percent in the ceramic package industry.

The following table presents ceramic package producer survey data on average annual employment.

Table V-10
Average Annual Employment

	1990	1991	1992	1993 (est.)
Production Workers	2709	2736	2117	2335
Administrative	807	770	535	387
Scientist & Engineers	1136	1135	961	623
Other	137	154	152	148
TOTALS	**4789**	**4795**	**3765**	**3493**

SOURCE: OIRA Producer Survey

Although there was a steady decline in the number of employees in all of the major categories, companies reported that the average earnings, hours and compensation for the 1990 through 1993 period increased for production workers. The average annual compensation for production workers including holidays, paid vacations, paid sick leave and health care costs rose to $27,290 from $23,732, a 15 percent increase.

Average hourly earnings rose to an estimated $10.40 an hour from $9.67 an hour in 1990. Average hourly earnings in 1992 for SIC 3674, at $13.80, were 38 percent higher than in the ceramic package industry. This can be attributed at least in part to the fact that wages in the semiconductor industry tend to be higher than wages in the semiconductor parts and devices industries. Average hourly earnings for the broader industry grouping, SIC 367 (electronic components and accessories), are more in line with wages in the ceramic package industry, with a 1992 average of $10.93.

Table V-11
Production Workers: Earnings, Hours, Compensation

	1990	1991	1992	1993(est)
Average Hourly Earnings	$9.67	$9.70	$10.00	$10.40
Average Weekly Hours Worked	41.1	41.6	42.1	42.3
Average Annual Compensation	$23,732	$24,545	$26,090	$27,290

SOURCE: OIRA Producer Survey

The average weekly hours worked increased by two hours from 1990 to 1993. This increase indicates that as industry employment declined, those production workers remaining tended to work longer hours.

Companies were asked to report any labor shortages or labor supply disruptions that they had experienced in the last five years that affected their domestic operations. Most firms surveyed have not experienced any labor shortages in the past five years. The recent recession and relatively slow growth of job creation during this period have probably contributed to the relative ease with which firms have found employees with suitable credentials. However, two out of the ten companies surveyed reported labor shortages.

Both firms reported having difficulty in acquiring skilled labor, in particular engineers who have the proper education and experience in the ceramic package process. Such shortages could become more frequent in the future if U.S. firms continue to downsize, and workers possessing critical skills leave without being replaced. One respondent expressed a concern that shrinking market share due to foreign competition could lead to certain skill shortages in the future.

Nine of the ten ceramic package manufacturers reported that the number of their employees changed substantially during the 1990 to 1993 reporting period. They cited the following reasons for the change in employment: increased competition, reduced demand, a need for financial stability, decreased sales volume, decreased military spending, higher productivity, change in product mix, and plant expansion.

In addition, companies were asked to forecast any labor concerns that they might experience in the next five years. Two of the ten companies mentioned potential shortages of engineering designers and of workers with certain skills, caused as foreign competition shrinks the U.S. share of the global market.

Occupational Skills Analysis

The information in this section is based on a survey of U.S.-based ceramic package producers conducted by the North Carolina Occupational Analysis Field Center of the Employment Security Commission of North Carolina (NC OAFC) to support this investigation. The purpose of that survey was to identify critical occupations and skills that are unique to the ceramic semiconductor package industry.

Five producers returned a completed survey form to the NC OAFC out of eleven firms surveyed. (One of the firms that did not complete the survey indicated that it no longer produces ceramic semiconductor packages.)

- Critical Occupations

For the purposes of this investigation, a critical job was defined as one that is essential to maintaining production and requires a minimum of one year's training before a worker can effectively perform the duties and responsibilities of the specific position. Based on this definition, there appear to be 33 critical jobs in the ceramic package industry, including 12 engineering and scientist jobs, five supervisory/managerial jobs, nine technician/drafter/designer jobs and seven production line jobs.

These positions are critical in that, should a national security emergency call for a substantial ramping up of capacity or re-creation of once-existing capacity lost due to imports, extensive training of new hires would be required. Most critical jobs in the ceramic package industry are in technical and highly skilled occupations. Only 20 percent of critical jobs are in the production line.

Critical **engineering/scientist** jobs require at least a bachelor of science degree in an engineering or scientific field. New hires with degrees at this level but no prior work experience typically require up to five years[2] of on-the-job training (OJT) to be fully proficient, with many jobs requiring four to six years of training and some requiring as many as ten years. Engineers with work experience in a related industry typically require up to two years of OJT, with some requiring up to four years.

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[2] The NC OAFC expresses the amount of on-the-job training necessary for job proficiency as a range, which is often quite broad. For instance, the amount of training required for a manufacturing engineer with no prior job experience varies from three months to six years. The maximum amount of training listed to become proficient in each occupation is used as the appropriate indicator of the criticality of the job, and is averaged over occupational grouping to arrive at the typical figures mentioned in this analysis.

According to the criticality study, most **managerial/supervisory** jobs, as well as some support positions in professional and production areas, could be considered "critical" to the ceramic package industry in that they require "extensive and/or specialized training and education." The study did not, however, include all of these jobs in its list of critical occupations. Only five of these positions, including industrial organization manager and production superintendent, were cited in the study, because they require particularly extensive training and technical knowledge of the production process. For the most part, these jobs require a bachelor's degree (some an MBA). They also typically require up to eight years of OJT for an individual with no relevant experience. For a new recruit with related experience, up to five years of OJT are needed.

Critical **technician/drafter/designer** jobs include positions such as computer-aided design technician, electronic drafter, quality control technician, and calibration laboratory technician. These jobs require an associate degree from a technical school or some type of technical training beyond high school and up to six years of OJT for a worker with no prior experience. Apprenticeships exist for many of these occupations. For one job listed, machinist, up to ten years of OJT is needed to reach full proficiency.

Critical **production line jobs** include kiln technician, paste maker and plater. Most of these jobs are unique to the ceramic semiconductor package industry, and can require up to four years or more of OJT to be fully proficient. Certain industry estimates indicate that about two-thirds of the production work force is in relatively unskilled jobs.

The NC OAFC assigned a Specific Vocational Preparation (SVP) value to each critical occupation that closely resembled an occupation listed in the **Dictionary of Occupational Titles** (DOT). The SVP is defined as "the amount of time required by the typical worker to learn techniques, acquire the information, and develop the facility needed for average performance" in a specific occupation. SVP includes vocational education, apprenticeship training, in-plant training, OJT and essential experience in other jobs. DOT definitions existed for all but seven of the critical occupations. The average SVP value for those occupations was slightly over seven on a scale from one to nine. The seven rating means that a worker would require over two years and up to four years of SVP before being able to perform satisfactorily on his/her job.

- Skills Analysis

The analysis of the occupational skills data conducted by the NC OAFC indicates that most of the positions identified as critical are not unique "in the strictest sense." For most of these jobs, workers with similar skills can be found in related electronic components industries. These workers, under ordinary conditions, could theoretically be retrained to jobs in the ceramic package industries, and would require substantially less time to retrain than would hiring and training inexperienced workers. Even skilled workers transferred from related industries, however, would require a significant time investment to become fully proficient in the ceramic package industry. In addition, during a national security

emergency, it is likely that these related industries would also experience a demand surge, greatly reducing the supply of workers with similar skills.

Despite the existence of counterparts for most critical jobs, the criticality study concludes that knowledge and skills specific to this product and industry do exist. This is especially true in occupations related to research and development, and the design and manufacturing processes. A substantial amount of technical knowledge and manufacturing know-how is essential for effective production of ceramic packages. The industry is also characterized by a rapid rate of innovation and increasing customization. If the U.S. loses its ceramic package industry, the resulting loss of human capital with the requisite technical knowledge and manufacturing know-how would make the reconstruction of state-of-the-art production capabilities extremely difficult.

Trade Adjustment Assistance

Under Section 221(a) of the Trade Act of 1974, workers who lose their jobs or whose hours of work and wages are reduced because of increased imports may apply for Trade Adjustment Assistance (TAA). Workers who are certified for TAA by the Department of Labor's Employment and Training Administration, Office of Trade Adjustment Assistance, are eligible for a number of benefits and reemployment services including income support payments once unemployment benefits are exhausted.

Only two petitions have been filed for TAA by workers in the ceramic semiconductor package industry from 1975 to present. One of these petitions, involving workers producing multi-layer ceramic packages at Hoechst CeramTec North America of Providence, RI, resulted in an affirmative determination. Workers employed in Pennsylvania by Alcoa Electronic Packaging, who filed a petition with the Department of Labor this year, were denied certification.

VI. NATIONAL SECURITY TECHNOLOGY ANALYSIS

Section 232 (d) of the Act directs us to evaluate the "domestic production needed for projected national defense requirements, ... and the requirements of growth of (subject) industries ... including the ... development necessary to assure such growth," among other factors. Therefore, the following chapter focuses on an assessment of the industry's technological standing, an identification of defense use and needs, an examination of package supplier qualification issues, a review of industry R&D, and finally, a discussion of foreign sourcing and dependency issues.

Technology Assessment

Technology Standing

U.S. producers were asked to identify any technologies that foreign competitors have that the U.S. firms could use but cannot or have not been able to access. Respondents were further asked about the competitive impact of not having access to these technologies.

Three firms responded to this question. The first mentioned greenline processing, which would improve productivity and yield. Also mentioned as critical were patterning, printing, via fill, material handling and cutting operations know-how. The second firm stated that a lack of access to plating technology has impacted its business. This firm also mentioned that foreign firms have advantages in terms of tool design, tooling, some capital equipment, and economies of scale, since foreign firms receive high-volume military orders, while U.S. firms receive only prototype business. The third firm responding indicated that it had been unable to afford to purchase expensive latest generation manufacturing equipment without high-volume repeat business, but that it couldn't win the repeat business without the latest generation equipment. This firm complained that it was unable to compete with Kyocera's market and financial clout.

Alternative Package Technologies

Ceramic package manufacturers and importer/end users were queried about their knowledge of any recent substitution of plastic packages for ceramic packages in defense and commercial applications. They were also asked to predict the future trend for package materials. In addition, the Departments of Defense and Energy and the National Aeronautics and Space Administration (the leading defense-related customers for ceramic packages) were asked to provide their assessment of the anticipated future use of plastic packages in their defense-related applications.

- Manufacturers

Package manufacturers were basically unaware of any instances in defense applications where plastic packages are being or have been substituted for ceramic packages. In contrast, six of the seven respondents named commercial applications where plastic packages are being substituted for ceramic. One application mentioned by three producers was the substitution

of plastic by Intel in a portion of its 286, 386 and 486 microprocessor volume, (Proprietary Information Withheld). One of the three indicated that Japanese firms are supplying Intel with (Proprietary Information Withheld) units for its 486 microprocessor.

Another firm mentioned that plastic has replaced ceramic in about 15 to 20 percent of pager applications. However, this firm also mentioned that "demand for ceramic packages in the same time period for the same application has grown 40 percent." Finally, one manufacturer stated that it lost cerquad and cerpack business to plastic packages (for cost reasons) or to multi-layer ceramic (for performance reasons).

Next, manufacturers were asked to what extent they foresee that semiconductor package applications currently met by ceramics can be met by plastic packages and/or other technologies. They were then asked how such a substitution would affect the firm's market share and economic viability. Finally, firms were asked about the potential for future substitution of ceramics in semiconductor packages where plastic is being used.

Almost all of the respondents agreed that plastic's share of the semiconductor package market will increase, although plastic is not expected to ever fully replace ceramic materials. One stated that the adoption of plastic packages "will be governed by the thermal requirements of the chip,...the critical yield requirements, and lead count." This respondent added that "where yields are critical, e.g., early in a program when die yields are low and supply tight, ceramic will be used for optimum yield." Plastics will be used when they can meet speed and power-handling requirements because of their lower cost, according to another respondent.

In the context of the impact of plastic packages on ceramic firms' viability, one firm indicated that, while the majority of packages will continue to be non-ceramic in the future, there will be at the same time be an absolute increase in the use of ceramic packages, due to increased complexity, and the fact that larger dice and smaller packages will result in increased density and higher power. This firm commented that "the current crossover from non-ceramic to ceramic applications is at approximately three (3) watts. This trend is the key to our economic viability in the future."

Another firm predicted that it would remain economically strong because "most chips are initially packaged in ceramic," and the company sees itself at the "leading edge" of package technology. For higher volume devices, the market eventually becomes more competitive, and this will lead to the eventual substitution of less-expensive plastic packages.

- Importer/End Users

The majority of importer/end users indicated they weren't able to comment on or did not know of instances of the substitution of plastic in defense applications. Information is presented in table VI-1 below for those firms who knew of such replacement.

Table VI-1
Reported Defense Use of Plastic Packages

Substitute Package Product	Application	Date of Substitution
Flat pack	BAT	Designed in - not time related
LCC	BAT	
Cylix 87 DLC	Army SMC	1993
Plastic Analog ICs	Sonobuoys	1989
Plastic Analog ICs	Smart Munitions	1991

SOURCE: OIRA Producer Survey

As with defense applications the majority of respondents knew of no use of plastic packages in commercial applications. Still, a sizeable group provided several examples which are presented in Table VI-2 below.

Table VI-2
Reported Commercial Use of Plastic Packages

Substitute Package Product	Application	Date of Substitution
Plastic	DRAM memory	1988-1990
TSOP	DRAM, SRAM memory	1991-1992
TAB	Gate Arrays	1992-1993
Plastic PGA	Microprocessor	1991
Plastic Quad Flat Pack	ASICs	1991
22+28 Pin PDIP	Telecommunications	1992
Plastic	DIP Diode Arrays	1992
PQFP,DIP	Memory (SRAM, EPROM, Flash EEROM)	Continuous Evolution
PPGA, MM	MPU, ASIC Gate Array, FPGA	Continuous Evolution
DATEL Tooled Plastic Package	Desktop Scanner	1990
Intel 80386DX, 80486SX	CPU	1991-1992
Intel 80960	Microcontroller	1991
Cyrix 87 DLC	Math Co-Processor	1992

SOURCE: OIRA Producer Survey

Next, importer/end users were asked to predict the future for plastic packages, as well as the impact plastic packages will have on their firms. In terms of the extent to which plastic packages will replace ceramic, the predictions ran the gamut, from very little substitution possible (because of plastic's intolerance to heat) to totally interchangeable, with many variations in between. The only advantage of plastic packages that was mentioned was their cost, although in highly-competitive markets cost is critical. Many respondents expect that at least some permanent substitution will occur, particularly as improvements are made in plastic technology. Lastly, one respondent stated: "It is expected that there will [continue to] be demand for ceramics in high-end and next generation semiconductor products."

- Government Users

The Department of Defense was not optimistic about its ability to increase the use of plastic packages in the foreseeable future. DOD reported that "[w]e are moving to maximize our use of plastic encapsulated devices for DOD weapon systems, although this may take several years before military specifications allow it." DOE noted that it was working with the Air Force on its "Reliability without Hermeticity" project to provide a firm methodology for the use of plastic packages where appropriate. NASA reports that it "does not preclude the use of standard (plastic) parts, but that the use of plastic packages would have to be approved by a Non Standard Parts Approval process. NASA adds that "some areas where the use of plastic package parts would be very difficult would be: at temperature extremes and for very critical long life missions (i.e. greater than seven years). Additionally, modifications would have to be made for plastic parts in current high temperature processing and to allow a low moisture processing environment. [One] NASA [element] adds its view that "the potential for using plastic encapsulated devices in place of ceramic packaged devices is minimal to fair at this time. This is due to a number of factors such as wide variations in types of plastics, hermeticity, and unknown reliability in space and launch environments."

Stockpile Possibilities

Government users provided mixed views on the feasibility of maintaining a stockpile of ceramic packages. DOD reported that "DOD stockpiles integrated circuits including their ceramic packages for space applications on end-of-life buys -- when the source is going out of business. (However,) (s)tockpiling all semiconductor ceramic packaging would be impractical given the hundreds of variations and the rapid change in technology." Similarly, DOE reports that "(c)eramic hermetic packages can be stored without serious degradation in a dry nitrogen environment. Difficulties in creating a stockpile, however, are (1) performing extensive incoming inspection immediately upon delivery since about one-fifth of the packages delivered to DOE from Japanese companies have been out of specification, and (2) anticipating the exact package designs needed in a stockpile. ... Most packages in DOE systems have small but important changes (i.e. specific pins connected to the well metallization, or modification of well depth) which makes it hard to anticipate what to stockpile for the next system production." [One] NASA [unit] adds that a stockpile would "only serve a small percentage of the market effectively." Some of the reasons [the unit]

cites as limiting stockpile feasibility are: limited shelf-lives for conductor materials; rapidly evolving technology for high-performance packages such as ball grid arrays; difficulty of controlling inventory of the large number of custom packages; and difficulty of having to fabricate wafers and (semiconductor) dice to meet stockpile inventory.

Defense Needs

Defense Programs Supported

All respondents, both producers and end users of ceramic packages, were asked to identify the top ten defense programs, as applicable, for which they supplied imported or U.S.-manufactured ceramic semiconductor packages or for which they supplied semiconductor products which included ceramic packages in 1992. Thirty-four companies provided responses to these questions.

A total of 113 different defense systems were identified as recipients of ceramic packages or semiconductor products which include ceramic packages. Of these 113 systems, 93 were identified in detail, as will be shown later in this portion of the report. The remaining 20 were unspecified by the responding companies, although in most cases shipment values were provided.

Total shipments include three categories of responses: (1) ceramic packages or semiconductor products imported by an end user (49 percent of total defense shipments totalling $93.2 million); (2) packages or semiconductor products[1] sourced from domestic manufacturers by an end user (comprising 43 percent or $81.1 million of total defense shipments); and (3) defense shipments of packages by domestic ceramic package manufacturers (accounting for only eight percent of total shipments valued at $16 million).

The largest single military use for reported 1992 defense shipments was in various types of missiles, projectiles, and torpedoes. By value, these weapon types constituted 62 percent ($118 million) of total shipments. Within the missiles category, end-user purchases from domestic manufacturers accounted for 62 percent of the subtotal ($74 million), imports by end users an additional 26 percent ($29 million), and the remaining 13 percent ($15 million) were reported by domestic producers.

Computers and computer electronic equipment comprised the second largest defense system category, with $28 million of 1992 shipments. This constitutes 15 percent of total reported shipments. Imports made up the vast majority of shipments for this category, with 99 percent of reported shipments from abroad. Only one percent were sourced by end users from domestic manufacturers, while domestic producers reported no shipments for this

[1] The vast majority of these semiconductors are packaged in imported ceramic packages.

application area in 1992.

A similar distribution was seen in the reported shipments for radar and radar jamming systems, the third largest defense system category. Shipments of $11 million were reported, (six percent of total reported defense system shipments). Imports by end users accounted for $8 million of the subtotal (75 percent of ceramic shipments for this application category. End-user purchases from domestic manufacturers accounted for the remaining 25 percent ($3 million). Domestic producers reported no 1992 shipments for military radar applications.

Shipments of ceramic packages for explosives (other than missiles, projectiles, and torpedoes) accounted for slightly over two percent, or $4 million, of total reported shipments. These explosives include such items as cartridges, fuses, and mines. Imports accounted for 100 percent of the ceramic packages used in these applications.

The smallest defense system category by value was for military aircraft uses, with reported shipments of less than $4 million or almost two percent of total shipments. This category includes uses of ceramic packages other than the weaponry and computer electronics used in military aircraft. As was seen in most categories, imports account for the overwhelming majority, 83 percent, while end-user purchases from domestic manufacturers were only 17 percent or half a million dollars. Domestic producers reported no shipments for this application category.

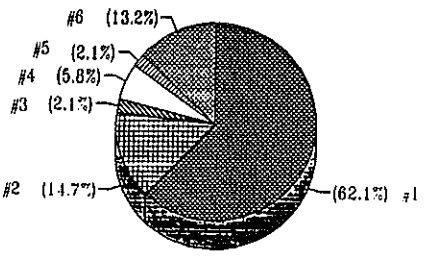
The remaining defense systems that did not fall into any of the above groupings were included in an "all other" category. This group accounted for 13 percent of total reported shipments, which represents $25 million. Ceramic package imports were dominant, with 83 percent of all shipments, while end-user purchases from domestic manufacturers were 14 percent. Domestic producers accounted for the remaining three percent.

The graph below illustrates the distribution of ceramic packages or semiconductor products containing ceramic packages by the military categories discussed.

- Imports by End Users

This was the largest of the three categories of shipments, both in value and in number of defense systems identified. Imports by end users accounted for 49 percent, or $93.2 million, of reported 1992 shipments. Missiles, projectiles, and torpedoes were the largest destination for imported ceramic packages with 31 percent of this group's shipments, or $29 million. There were 39 mentions of items included in this grouping, and 16 different weapons reported. Twelve of these 16 were missiles, three were torpedoes, and one was a projectile. The specific weapons are listed in Table VI-4 below.

Table VI-3
Distribution of Military Ceramic Package Applications



#1 = Missiles/Projectiles/Torpedoes
#2 = Computers & Related Electronics
#3 = Military Aircraft
#4 = Radars & Radar Jamming Systems
#5 = Explosives (Non-Missiles)
#6 = All Others

Total Reported Shipments = $190 million

SOURCE: OIRA Survey Data

Table VI-4

Missiles, Torpedoes, and Projectiles Using Imported Ceramic Packages*
AMRAAM Missile
BAT Projectile
HARM
Hellfire
Maverick Missile
Mark 46 Torpedo
Mark 48, Mark 48 ADCAP Torpedo
Mark 50 Torpedo
Patriot Missile
Peacekeeper Missile
Sidewinder Missile
Sparrow Missile
Standard Missile
Tomahawk Cruise Missile
TOW Missile
Trident Missile

* Note: Includes semiconductor products with embedded packages
SOURCE: OIRA Survey

Computers and electronic support systems were the second largest category by value of shipment reported, with 30 percent of the total shipments. There were a total of 33 mentions of 20 unique systems reported. These individual systems are listed in Table VI-5 below.

Table VI-5

Computers and Computer Electronic Support Systems Using Imported Ceramic Packages*
AAS-43 Electronic Warfare Program
Advanced Spaceborne Computer Module
Airborne Reconnaissance Support Program
AN/MRC-142 Radio Terminal Sets
Associative Processor Surveillance Sensor
BSY-2 Submarine Combat Management System
Carrier Aircraft Inertial Navigation System
Computer Desk Top III
Digital Screen Match Area Correlation
Enhanced Modular Signal Processor
F-16 Flight Data Recorder
Generic Very High Speed Integrated Circuit Spaceborne C.
Low Altitude Navigation & Targeting Infrared System
Military Strategic & Tactical Relay Satellite System
Single Channel Ground & Air Radio System
Tacfire Artillery Fire Control System
Target Acquisition System
Tactical Computer System
UYK-43/UYK-44 Computer System
UYQ-21 Shipboard Display Program

* Note: Includes semiconductor products with embedded packages

SOURCE: OIRA Survey

Radar and radar jamming systems were the third largest category of end-user imports by value, with almost nine percent of the total shipments or $8 million. There were 11 mentions of items in this grouping, and there were nine different reported systems. These nine systems are listed in Table VI-6 below.

Table VI-6

Military Radar and Radar Jamming Systems Using Imported Ceramic Packages*
AEGIS Radar Ship System
Airborne Self-Protection Jammer
ALR-67 Radar Warning Receivers
AN/ALQ-136 Quick Jam Radar Jammer
E-8C Joint Surveillance Target Attack Radar System
F-18 Radar System
Radar Data Converter
SQQ-89 Shipboard Sonar System
Tactical Communications Jammer System

* Note: Includes semiconductor products with embedded packages

SOURCE: OIRA Survey

Imports of ceramic packages for explosives production (other than missiles, projectiles, and torpedoes) accounted for over four percent of total import shipments, which corresponds to $4 million. There were three different explosives, as listed in Table VI-7 below.

Table VI-7

Explosives (Other Than Missiles, Projectiles, and Torpedoes) Using Imported Ceramic Packages*
FMU-139 Bomb Fuse
MK-216 Sea Gnat Cartridges
Wide Area Mine

* Note: Includes semiconductor products with embedded packages
SOURCE: OIRA Survey

Military aircraft and spacecraft accounted for three percent or $3 million of total import shipments. The spacecraft are listed because of dual sponsorship by the Air Force and NASA. There were 12 mentions of eight different aircraft and spacecraft.

Table VI-8

Military Aircraft and Spacecraft Using Imported Ceramic Packages*
B-2 Bomber
B-52 Bomber
Comanche Helicopter
F-4 Fighter
F-14 Fighter
F-14 135 Fighter Upgrade
F-18E Fighter
Space Station

* Note: Includes semiconductor products with embedded packages

SOURCE: OIRA Survey

Companies reported eight other defense systems for which they import ceramic packages that fall into an "all other" category. A number of these companies provided shipment information but did not specify the particular defense system. Shipments for these unspecified systems totaled $17 million of the $21 million in total import shipments for this category. This "all other" category accounts for 22 percent of total import shipments reported. The systems are listed in Table VI-9 below.

Table VI-9

Other Defense Systems Using Imported Ceramic Packages*
C-27A Spartan
M1-A1 Tank, Tank Upgrade
Meteorological Measuring Sets
Modular Avionics Packaging
Miscellaneous Spare Parts
Night Vision
Phalanx Point Defense Gun
Simulator Complexity Testbed

* Note: Includes semiconductor products with embedded packages

SOURCE: OIRA Survey

- End-User Purchases from Domestic Manufacturers

End users who purchase ceramic packages or semiconductor products with embedded ceramic packages from domestic manufacturers account for $81.1 million of 1992 shipments. These domestic purchases comprise 43 percent of the total shipments reported. Missiles alone were the largest destination for domestically-sourced ceramic packages with the vast majority, 91 percent ($74 million) of this category's shipments. There were 20 mentions of missiles, while there were eight different missiles reported. These are listed in Table VI-10 below.

Table VI-10

Missiles Using U.S.-Manufactured Ceramic Packages*
AMRAAM Missile
HARM Missile
Harpoon Missile
Hawk Surface-to-Air Missile
Patriot Missile
Standard Missile
Tomahawk Cruise Missile
Trident Missile

* Note: Includes semiconductor products with embedded packages
SOURCE: OIRA Survey

Shipments of ceramic packages or semiconductor products containing packages for radar and radar jamming system applications were the second largest category for domestically-sourced items, with $7 million. This accounts for three percent of total domestic sourcing by end users. There were nine radar mentions which identified seven different systems. These are listed in Table VI-11 below.

Table VI-11

Military Radar and Radar Jamming Systems Using U.S.-Manufactured Ceramic Packages*
Airborne Self-Protection Jammer
APG-66/68 Fire Control Radar
ERC/APS/P-90 Radar System
B-1B Aircraft Radar
Longbow Targeting Radar Sensor
Radar Data Converter
Single Channel Ground & Airborne Radar System

* Note: Includes semiconductor products with embedded packages
SOURCE: OIRA Survey

Aircraft and space vehicles were the next largest category by value of shipments, with less than one million dollars or slightly less than one percent of total domestically-sourced shipments by end users. The systems reported were the Advanced Tactical Fighter, the Space Station, and the Phoenix Remotely-Piloted Air Reconnaissance Vehicle.

A wider range of computers and computer electronic support systems were reported as recipients of domestically-sourced packages or products, but reported shipments totalled less than half a million dollars, only one half of one percent of total shipments. There were eight mentions in this category of a total of seven different systems, each of which is listed in Table VI-12 below.

Table VI-12

Computers and Computer Electronic Support Systems Using U.S.-Manufactured Ceramic Packages*
AAN/SPS-40 Transmitter
Airborne Reconnaissance Support Program
AN/BSY-1 Submarine Combat Management System
AN/MRC-142 Radio Terminal Sets
BSY-2 Submarine Combat Management System
Simulator Complexity Testbed
YUK-43/44 Computer Systems

* Note: Includes semiconductor products with embedded packages

SOURCE: OIRA Survey

The remaining systems reported are included in an "all other" category. These shipments total almost $4 million or four percent of total shipments. This category includes the shipment information for unspecified systems, which total $3 million of the $4 million. There were seven systems mentioned in this group, as listed below.

Table VI-13

Other Defense Systems Using U.S.-Manufactured Ceramic Packages*
Bradley Fighting Vehicle
C-27A Spartan
Comanche Helicopter Sensor
M1-A1 Tank
Miscellaneous Spare Parts
Navy Tactical Data

* Note: Includes semiconductor products with embedded packages

SOURCE: OIRA Survey

- Domestic Producers

As discussed earlier, domestic producers reported total 1992 shipments of $16 million for defense applications. Domestic producers account for the smallest shipment levels of the three categories discussed. The majority of their shipments, 96 percent, were for three different types of missiles and two types of projectiles that were cumulatively mentioned nine times. The identified missiles were the AMRAAM (Advanced Medium Range Air-to-Air Missile); the Hellfire antitank antiarmor missile; and the Trident missile.

The remaining four percent of shipments, less than a million dollars, were for a variety of defense systems: one Air Force fighter program; a submarine computer system; a simulation system; a thermal weapon sight; a laser weapon; a radar; and a developmental integrated circuit program.

Complexity of Defense Products

Ceramic semiconductor package manufacturers and importer/end users were asked whether the packages they provide to defense end users are more complex, less complex, or essentially equivalent to the packages they supply to commercial end users.

- Manufacturers

Of the seven manufacturers responding to this question, four said that their defense products are more complex than commercial products. One of these respondents stated that they supply new programs where MCM technology is employed, while the less complex, existing products for old programs are supplied by Japanese vendors. Another stated that the

packages supplied to defense end users are "larger with more leads and/or higher circuit density." A third respondent indicated that, while they no longer supply defense end users, the packages that they sold to the military in the past were "more complex because they were MCM-C rather than the PGA's we supply to our commercial customers."

One manufacturer replied that the packages sold to commercial end users are more complex, and defined complex as "higher lead count." This respondent also stated that "the complexity of ceramic packages is dependent on the customer's electronic device requirements and not on whether the customer is a commercial or defense end user." Finally, two ceramic package manufacturers reported that the packages supplied to the two kinds of end users were essentially equivalent.

- Importer/End Users

Importer/end users provided a wide range of answers, and the eventual conclusion differs from that for the package manufacturers. Thirty-one of these firms responded. Six indicated that the packages sold to defense end users are more complex than those sold to civilian customers. One of these respondents indicated that while physical differences are negligible, "ceramic-packaged ICs for defense use usually have more complex specifications. Military parts often have specifications on gold thickness, solderability, environmental capabilities, and other mechanical variables. Commercial specifications are generally less complex." Another mentioned that commercial parts are not made to meet either radiation or hermeticity requirements, and are less complex electrically and mechanically.

Only one importer/end user stated that ceramic packages destined for defense use are less complex than those produced for commercial markets. The majority of respondents to this question indicated that the products for the two end-use markets are essentially equivalent. Within this group of twenty importer/end users, several indicated that the quality standards and specifications for the two kinds of products are identical. Others within this group noted that while the packages are essentially the same, defense packages must be tested more extensively, particularly for operation in extreme environments.

Finally, four companies responded that the answer depended on the specific situation. Complexity varies across the range of products, according to one firm. Another mentioned that while low pin-count packages are basically the same, "the higher pin-count packages for pin grade arrays, chip carriers and MCM's are somewhat unique to defense products due to operating (temperature) requirements of the military specification." One respondent stated that "typically, commercial applications require higher layer counts which is more complex in process. But in some cases defense products require very high reliability and this results [in] design complexity."

Impact of Defense Cuts on R&D and Production

Ceramic package manufacturers were asked to describe the impact that defense spending cuts have had or are anticipated to have on their ceramic semiconductor package research and development (R&D). Eight firms responded, and five of these firms indicated that they had experienced or expected no impact. One of these firms explained that they expected the areas where they had received funding to remain critical to DOD, and that funding might even increase. Another firm indicated that they are not currently doing defense-related research and therefore expect no effect.

The remaining three firms expected an impact on their R&D activities. Two had requested funding through MANTECH, but funds to that program were cut and they never received the requested allocation; one reported that defense cuts would limit funding for prototype testing, a critical portion of its R&D program. A third firm replied that the potential impacts were not yet identifiable.

Next, ceramic package manufacturers were asked to describe the impact that defense spending cuts have had or are anticipated to have on their ceramic semiconductor package operations (e.g., production, sales, employment). Six firms producing packages for defense reported past or potential impacts. Some discussed effects caused by specific program cuts.

(Proprietary Information Withheld)

Others discussed impacts from general declines in defense spending. One indicated that, "to the extent to which defense cuts will apply pressure on prime contractors to reduce the cost of procured items, the market position of giant producers in the industry will be strengthened unless the government intervenes in other ways. This is true because they have the...scale advantage, ...tooling inventory, and...ability to 'buy' the initial business." Another firm reported that defense cuts will impact orders and revenues, but the extent of the impact is unknown. For this firm, identifiable defense orders are a small part of their unit shipments but a more significant share of their revenues.

Gulf War Experience

Importers were asked whether their orders for ceramic semiconductor packages placed with foreign or domestic suppliers had increased during Operation Desert Shield/Desert Storm and, if so, whether those suppliers were able to meet any surge in orders. Thirty-nine establishments responded; of those, only nine reported an increase in orders during Desert Shield/Desert Storm. Six of those companies indicated that they had increased their ceramic package orders placed with foreign suppliers only; three companies mentioned that they had increased orders placed with both foreign and domestic suppliers. All nine companies expressed confidence in their suppliers' ability to meet their firms' increase in demand; however, most reported that increases in orders were "mild" and not a marked "surge." Only one company related "lead-time delays experienced due to offshore facilities."

However, it is important to note that the Gulf War was a limited engagement which did not rely a great deal on new production.

Ceramic Package Supplier Qualification

Thirty-six importer/end users responded when asked to describe the processes they used to qualify suppliers of ceramic semiconductor packages. Military Standard Quality Requirements (MIL STD) were the criteria used by 13, or 36 percent, of the companies. Six companies cited in-house quality programs by name. One firm used an in-house procedure if the packages were destined for commercial applications and in-house plus MIL STD procedures for defense applications. Sixteen firms provided a detailed outline of the steps they take. Based on these descriptions, a typical qualification process included the following procedures: a plant audit; evaluation of qualifying lots; and tests of such characteristics as reliability, solderability and performance parameters. Business as well as technical or production issues were sometimes a concern, as five companies specifically mentioned using a financial analysis of the supplier as a qualification criterion.

In most cases, the importer paid for the qualification process. Over three quarters of the respondents said they were responsible for the costs. Of the remainder, four companies had the customer bear the cost; two shared costs; and three reported varying payment arrangements, depending on the product in question.

One importer declined to estimate the time required to qualify new ceramic package suppliers and existing suppliers for new packages. Another company required only a few days, concentrating more on aspects such as the supplier's financial condition than on the more extensive steps outlined above. The remaining 34 responded in more detail. The most important factors which determine the amount of time needed to qualify suppliers were: package complexity, special tooling, and testing (reliability and life testing). Sixty-five percent of the companies reported that they required more time to qualify a new supplier than an existing supplier, although 12 firms said they used the same procedures and the same amount of time to qualify both. The amount of time that these procedures took for each individual importer varied widely; from two weeks to over a year for a new supplier, and from under a week to up to a year for an existing supplier.

For the entire range of qualifying times as well as those required by each importer, qualifying new suppliers did, on balance, require more time than qualifying existing suppliers for new packages. Thirty-five percent of the importers needed from six months to over a year for new suppliers, while only eight percent needed that amount of time for an existing supplier. One company noted that when qualifying an existing supplier, the amount of time required depended on the differences between the new packages and existing qualified technology. Table VI-14 summarizes this information.

Table VI-14
Supplier Qualification Times

SUPPLIER	> 3 Months	3-6 Months	< 6 Months
New	11	11	12
Existing[1]	16	14	3

[1] One process varied with the product.

SOURCE: OIRA Importer/End User Survey

The primary reason cited for existing package supplier's shorter qualifying time was the similarity between new and already qualified packages. Clearly, suppliers with a broad product mix will have a competitive advantage over firms with a more narrow product line. Familiarity with the supplier's manufacturing process, obviating the need for a facility inspection, similarly contributed to the shorter qualification time.

Among the advantages of qualifying second sources for package requirements, however, can be a substantial decrease in package cost brought about through increased competition. [One] engineer at [a U.S. importer/end user], for example, described a situation in which a decision was made to qualify a second source to a leading offshore supplier for a ceramic package used in [one part for a DOD] program. [This firm] believed that the offshore supplier's prices were too high and did not decrease as expected with the length of a production run. [The firm] and the Navy also did not want to be dependent on a sole source for this part. After qualification (at a cost to [the firm] of about $30,000), an American ceramic package company submitted a bid that was slightly less than half of the per-unit the original supplier's price (Proprietary Information Withheld). [The firm] expects to ultimately purchase 100,000 units of this package.

In an additional case, [another respondent supplying a DOD program] confirmed that he believes that his offshore supplier charges "monopoly prices" for ceramic packages, and that introducing competition pressures his offshore supplier to lower its prices. He also indicated that the offshore supplier was reluctant to produce the package in question, and had to be coaxed by [the prime] to do so because the production volume was smaller than the offshore supplier normally accepts.

Research & Development

- Commercial R&D Expenditures

The following table presents aggregate commercial research and development expenditures by the surveyed producers for the years 1990-1993. As is shown in Table VI-15 below, commercial R&D expenditures peaked in 1991 and slipped in 1992. For 1993, expenditures are projected to drop 80 percent from 1992 expenditure levels and be 83 percent below 1991 peak levels.

Table VI-15
U.S. Commercial Research & Development Expenditures
($000s)

	1990	1991	1992	1993[1]
Materials	60,994	77,278	64,899	8,490
Processing	69,159	78,485	69,141	16,452
Product Development	47,603	62,722	52,842	11,804
TOTAL	**177,756**	**218,487**	**186,884**	**36,748**

[1] Company Estimates
Source: OIRA Producer Survey

Nine surveyed producers reported allocation of expenditures for commercial R&D from 1990-1992, with an estimate of their 1993 R&D spending. In 1990, 34 percent of commercial expenditures was allocated to materials, 39 percent to processing, and 26 percent to product development. By 1992, this allocation of expenditures was practically identical: 35 percent of commercial expenditures was allocated to materials, 37 percent to processing, and 28 percent to product development. With the available estimated data for 1993, 23 percent of commercial expenditures was allocated to materials, 45 percent to processing, and 32 percent to product development.

Total commercial R&D expenditures increased by $41 million between 1990 and 1991, from $177.8 million to $218.5 million. However, 1992 expenditures declined $31 million from the previous year. For 1993, estimated expenditures for commercial R&D amounted to $36.7 million, a mere 20 percent of the previous year's expenditures.

Total commercial R&D expenditures as a percentage of the value of package shipments was 29 percent in 1990; decreased to 27 percent in 1991, and increased to 38 percent the following year. Package producers reported spending an average of $37,480 per employee in 1990, $45,680 per employee in 1991, and $50,520 per employee in 1991. In comparison, package producers estimated spending an average of $158,020 per scientist in 1990, $192,990 in 1991, and $198,070 in 1992. It should be noted that [one firm] consistently accounted for [a majority] of the total reported commercial R & D expenditures for any given year.

- Defense R & D Expenditures

The following table presents defense research and development expenditures by the surveyed producers for the years 1990-1993. In sharp contrast to commercial R & D expenditures, defense expenditures increased each year of the period. However, it is important to note that for the years 1990-1992, defense R&D expenditures never accounted for more than two percent of commercial expenditures. From 1990 to 1991, expenditures for defense R&D more than doubled. By 1993, expenditures are expected to be more than double those from the previous year. With the dramatic decline projected for 1993 commercial R&D expenditures, defense expenditures will account for 17 percent of R&D spending. Seven surveyed producers reported expenditures for defense R & D for 1990-1993. Once again, survey recipients were requested to estimate their expenditures for 1993.

In comparison to commercial expenditures, defense expenditures fluctuated widely between materials, processing, and product development over the four year time period. In 1990, 19 percent of defense expenditures was allocated to materials, 52 percent to processing, and 29 percent to product development. In 1992, 20 percent of defense expenditures was allocated to materials, 34 percent to processing, and 46 percent to product development. Given the available estimated figures for 1993, 29 percent of defense expenditures will be allocated to materials, 33 percent to processing, and 38 percent to product development.

Table VI-16
Defense Research & Development Expenditures
($000s)

	1990	1991	1992	1993[1]
Materials	291	620	527	2,049
Processing	806	704	914	2,317
Product Development	456	1,995	2,310	3,714
TOTAL	**1,553**	**3,319**	**3,751**	**8,080**

[1] Company Estimates
Source: OIRA Producer Survey

- Sources of R & D Funding

Table VI-17 below presents reported sources of R & D funding for the ceramic package industry. For the first three years, funding was overwhelmingly found within companies (99 percent for each year). In 1993, however, it is estimated that 89 percent of reported funding will be done in-house. Funding from domestic and foreign customers and the federal government comprised one percent for the first three years, but will equal an estimated 11 percent of 1993 R & D funding. Total R&D funding equalled $180 million in 1990. By 1991, total funding increased 22 percent to $219 million. Total funding decreased to $190 million in 1992, a 13 percent decrease from 1991. Survey respondents estimated total funding for 1993 to be only $44.2 million, a substantial 77 percent drop from 1992 levels. Once again, it should be noted that [one firm] consistently accounted for [the majority] of total R & D funding for each given year.

Table VI-17
Sources of R & D Funding
($000s)

FUNDING SOURCES	1990	1991	1992	1993[1]
In-House	177,765	217,183	188,140	37,250
Customer				
Domestic	40	544	1,478	1,317
Foreign	650	320	--	--
Federal Government	1,050	997	728	5,683
TOTAL	**179,505**	**219,044**	**190,346**	**44,250**

[1] Company Estimates
SOURCE: OIRA Producer Survey

- Joint Venture Participation

Survey respondents were requested to provide information regarding their ceramic semiconductor package-related joint ventures. Three producers reported currently participating with other domestic firms in ceramic semiconductor package-related joint ventures.

- Government Sponsored Programs

Five firms reported involvement in a total of eight government sponsored ceramic package development programs. Three were sponsored by the Navy, two by (D)ARPA, and one each by the Air Force and NASA. In addition, one reported doing development work as a subcontractor to a prime. Total reported funding was $14.5 million, an average of $1.8 million per project. Funding per project ranged from $200,000 to $9.6 million.

Most of the projects were concerned with package development. Two firms were involved in proving the feasibility of and developing packages for air, sea and general defense use. One respondent indicated that lowering production costs of lightweight packages was the goal of its project. Another stated that involvement in a non-package program had provided the firm with greater experience in injection molding technology which could be applied to package production. Another mentioned the development of packages capable of holding substrates up to 4" square. The others indicated that the projects allowed them to experiment with and demonstrate the state-of-the-art technology available for ceramic packages, and to make improvements in the manufacturing process.

Firms were asked for their opinion of the program in which they were involved. Comments were received for seven of the eight programs, and the opinions were overwhelmingly positive. One respondent indicated that the program focused on "real, near-term DOD needs" and promoted cooperation between the systems manufacturer and the package supplier. Another commented on the benefits of working with systems producers, saying that it allowed them to "influence the design improvements on the system level." One firm stated that the project had generated "real value" for DOD while developing U.S. skills in producing advanced packages. Another indicated that involvement in the program had helped the two manufacturers establish themselves as leaders in manufacturing technology. Lastly, one firm reported that the program was beneficial to the entire U.S. industry, focusing on technologies that would improve the time and lower the cost of manufacturing. Next, respondents were asked if the program(s) had introduced them to any new technologies. Four firms responded, all indicating that they had acquired new technology. New technologies mentioned included MCM-Cs, metallization of hybrid packages for defense applications, and interconnect technologies.

In addition, firms were asked if the programs had resulted in any related improvements, such as reduced lead time, lowered production cost, lowered prices to DOD, improved yields, or improved quality (leading to greater competitiveness). Five responded, indicating positive outcomes; most reported more than one. One stated that turnaround times would be shortened. Two reported lower manufacturing costs; one indicated that because of new technology gained they would be able to sell to DOD at a lower price. Three mentioned improved yields; one of these indicated that their experience in the project would enable them to improve yields in all of their packaging products. Four mentioned improved quality, and one indicated that, overall, the program had contributed to making the company a "world leader in the area of AlN housings."

Finally, we asked firms what problems still exist that the programs did not address. Three responses were received. One mentioned that its program did not address market development - the firm had exited the market because market "size did not warrant continued participation." Another indicated that the feasibility of volume production for the relevant technology had not been addressed. Finally, one firm stated that thermal management problems and development of quick turnaround techniques were not resolved.

- Focus of Future Research Efforts

Survey respondents were asked to assess the anticipated payoff (low, moderate, high) for the competitiveness of the U.S. ceramic semiconductor package industry's investments in various areas. Thermal management, design to tool automation, flexible tooling, and in-process feedback each received mentions by five or more firms, as areas of potential investment thrusts which might reap high payoffs. Plating systems and metallization optimization each received mentions by five or more firms as potential investment thrusts with anticipated moderate payoffs. Results are contained in the following table:

Table VI-18
Impact of Potential Investment on Domestic Ceramic Package Industry Competitiveness

Thrust	Low Payoff	Moderate Payoff	High Payoff
Integrated Information Systems	3 firms	4 firms	1 firm
Thermal Management	--	3	6
Design to Tool Automation	1	3	5
Flexible Tooling	1	1	6
Greenline Processing	4	1	4
Plating Systems	1	6	2
Flexible Brazing	3	4	2
In-process Feedback	1	2	6
Metallization Optimization	2	5	2

Source: OIRA Producer Survey

- Dual Use of R&D

Survey respondents were queried as to what extent R&D conducted for defense projects is applicable to their commercial operations, and to what extent commercial R&D is of use in their defense operations. Eight producers provided a variety of responses to these questions. A majority of respondents echoed the view (with differing levels of intensity) that R & D conducted for defense projects has commercial applications, as well as the view that

commercial R & D has defense applications. One producer stated, "[Our firm is] currently concentrating on commercial capability. We have no defense operations at this time. We believe a significant portion of our commercial R & D would be applicable to defense." Another firm responded, "We have found that in packaging, DOD related research has commercial applicability and vice versa. This is somewhat a function of our focus in the high performance, high density segments of these markets."

One firm mentioned, "[R&D] is 100 percent interchangeable, truly dual-use." Another firm commented along the same lines, "A great extent at this point in our R&D program. R&D in materials and process development for ceramic MCM-C and Hybrid Packages still in early stage. Most developments are still needed for both defense and commercial products." Another producer mentioned, "R&D projects are directly applicable to both commercial and defense operations. Since all packages use the same processes and production equipment, [we] conduct no R & D projects that are solely directed towards defense applications." Finally, one firm bluntly summed up its feelings on R & D and commercial and defense applications, "No difference." Only one respondent gave a dissenting view on this topic. This producer commented, "Most defense R & D is not closely related to needs in the commercial arena."

Major Customers

Importers of ceramic packaging were asked to identify their major U.S. customers for both imported and U.S.-manufactured ceramic semiconductor packages. Major customers were defined as those to whom the importers shipped the largest dollar value of each type of package in 1992. Respondents could list up to five customers in each category.

The major customers for imported ceramic packaging were companies whose core business is semiconductor manufacturing. (Proprietary Information Withheld) By contrast, the primary consumers for U.S.-manufactured packaging were (Proprietary information Withheld), defense systems rather than semiconductor producers.

Purchase Commitments

In our survey, package end users were asked whether they had any purchase commitments as a result of business relationships, contracts, or other reasons by which they were required to purchase ceramic packages from specific foreign or domestic sources. All but three respondents denied that they were party to any such agreements, or stated that their "commitments" were limited only to the length of individual purchase orders. Two of the three companies citing commitments (Proprietary Information Withheld) stated that they had agreements to purchase only U.S.-built packages for some defense programs. On the other hand, [another company] noted that its ceramic packages are procured by its offshore parent. Since this question focused on end users, it did not address the circumstances of foreign-owned U.S. firms who purchase from their offshore parents (Proprietary Information Withheld).

Foreign Sourcing/Foreign Dependency

Not every instance of foreign sourcing represents a foreign dependency. In some cases, an item may be purchased from foreign sources for reasons of price, business relationship, or the like, while viable domestic suppliers remain available should the foreign supplier be unable or unwilling to continue supply. Similarly, not every foreign dependency represents a national security concern. The item in question may have little national security significance, or there may be alternative products or technologies available to perform the required function. As the drafters of Section 232 recognized, however, there can be reasons for national security concern in cases where insufficient domestic supply exists for products with a vital national security function or the economic welfare of the subject industry is threatened.

Writing in the December 1992 issue of the Japanese defense journal Boei Gijutsu, Mr. Kazuo Wakasugi, General Manager of Mitsubishi Electric's Electronic Parts and Systems Group, underscores the widespread international agreement with the above concept. Mr. Wakasugi states that:

> No advanced industrial nation would rely on foreign nations for the production of military equipment. ... It is often said that 'technical strength is deterrent strength,' but this is not simply having advanced technology. One cannot have deterrent strength that is not accompanied by the structure and ability to use advanced technology to build, efficiently manufacture, evaluate, and improve effective equipment.

As demonstrated earlier, ceramic packages are a vital component of virtually every military system, and foreign sourcing of ceramic packages for defense use is extremely high, accounting for 92 percent by value of identified U.S. defense demand. As the Semiconductor Industry Association (SIA) stated in its June 1993 Technology Position Papers, "integrated circuit packaging is viewed by many as the Achilles heel of the U.S. technology base, having been virtually forfeited to foreign practitioners and suppliers."

This investigation confirms that remaining U.S. suppliers have experienced a precipitous drop in profitability, employment, and capacity utilization, (Proprietary Information Withheld). Further, with Hoechst's (Germany) recent exit from the ceramic package business and the minimal level of activity elsewhere, Japanese companies, and particularly Kyocera, are the only potential foreign sources for this defense-critical product. Kyocera by itself supplies about [the majority] of identified U.S. defense demand.

(National Security Classified Information Withheld)

Importers and end users were asked in the DOC survey whether they had in the past five years been denied access to a supply of ceramic packages by a foreign or domestic producer, and none of the companies responding identified such a situation.

(National Security Classified Information Withheld)

Dependence on Kyocera

The degree of U.S. dependence on Kyocera for military ceramic packages noted above is similar to that found in a 1992 Department of Commerce study of sourcing patterns for three Naval weapon systems. That study found that ceramic packages exhibited the highest percentage foreign sourcing (in excess of 90 percent) for any of the hundreds of manufactured inputs into these systems. In that study, most subcontractors believed that they were sourcing packages produced by Kyocera in San Diego, when in fact, nearly all Kyocera packages supplied to these systems were manufactured by their parent company in Japan.

The danger of dependence on such a concentrated supply can be illustrated by the worldwide scramble to obtain sufficient epoxy resin -- a critical input for plastic semiconductor packages -- which resulted from the recent explosion at Sumitomo's factory in Ebimo, Japan. Following this explosion, epoxy resin prices have sharply increased. The Japanese government and Japanese suppliers may control the allocation of limited supplies. The inability to obtain epoxy resin translates into an inability to produce plastic semiconductor packages, and a further inability to manufacture DRAMs and many other integrated circuits.

Should the supply of ceramic packages be similarly cut off semiconductor companies would be unable to produce chips requiring ceramic packages for either military or advanced commercial products. Just as in the epoxy resin example above, the availability of a ceramic packages, currently taken for granted, could become a pacing item which could determine companies' ability to produce and supply semiconductors.

Further, despite its commanding share of the U.S. defense market, Kyocera has at times been reluctant to acknowledge the extent to which its packages are exported for military applications. Just after the filing of this Section 232 petition, for example, in a statement to the Kyodo news service, Kyocera "denied that the company has so far exported to the United States any ceramic products for military products."[2] Similarly, in an interview with the Wall Street Journal in 1991, Shunji Nosaka, a Kyocera managing director, stated "[w]hat we do is sell packages to chip makers, we don't know how they use them. If Kyocera products

[2] KYODO News Service, November 16, 1992.

happen to end up on a weapon, can you accuse us for that?"[3]

In its public comment brief, Kyocera claims that it can meet U.S. defense demand solely from its U.S. facility. This proposition overstates Kyocera's San Diego capabilities, and pays insufficient heed to the extent to which Kyocera San Diego is dependent on its parent company for critical inputs. For packages built in this country, Kyocera sources all of its green tape -- the critical unfired ceramic input -- [and several other very critical inputs] from its foreign parent. Green tape, the basic ceramic material, is a critical determinant of a company's capabilities and of the ultimate quality of its production. Each company's green tape formula is a closely-guarded secret consisting of a unique recipe of inputs and resulting in distinctive shrinkage during the subsequent firing process. Kyocera San Diego is similarly dependent on its parent company for [several other very critical inputs].

Kyocera America stated to the Department of Commerce that "Green tape should not be a controlling issue of the ceramic package Section 232 investigation." (Proprietary Information Withheld)

The SIA also notes in its 1993 paper on the U.S. Semiconductor Manufacturers:

> Although foreign owned subsidiaries in the United States provide employment for Americans, they do not contribute as much to the U.S. economy as U.S. firms. Foreign owned companies perform most of their R & D and state-of-the-art production in their home country, as do American capital affiliated companies. Foreign owned firms also tend to import directly from their home market suppliers, bypassing U.S. suppliers. Foreign firms also cannot be relied upon as the sole suppliers for our nation's defense capabilities.
>
> (Proprietary Information Withheld)

Domestic Alternatives

We asked respondents to our importer/end user survey whether domestic alternatives are available for the imported ceramic packages purchased by their firms. We further asked whether they had ever unsuccessfully requested a bid from domestic suppliers, and lastly, why they had rejected bids received from potential domestic suppliers.

Eleven of 15 companies responding reported that at least some of the packages they purchase from offshore could not be obtained from U.S. suppliers. Relatively low-technology packages such as cerdip and sidebraze were most often cited as being unavailable domestically (although producer survey results show U.S. capacity and production of both

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[3] Jacob M. Schlesinger, "Kyocera's Ambivalent Role in Weapons," Wall Street Journal, January 31, 1991.

these products). Two of the 11 companies focused on higher technology products, citing a perceived inability to obtain U.S.-built ceramic multi-chip modules and hybrid packages, although both products are built domestically. One multinational end user with a small U.S. operation went so far as to say that it was unaware that there were any U.S. ceramic package suppliers.

Only six of the 15 companies responding stated that they had unsuccessfully sought bids from domestic suppliers. One company stated that U.S. suppliers attempted to sell them packages that would not meet their needs, while others reported that U.S. companies were unable to supply the packages required.

Finally, 11 of 15 companies reported why they had rejected bids from potential U.S. suppliers. The reasons cited here closely tracked comments cited earlier in the competitive assessment section of the survey. Respondents cited such factors as perceived lower quality, higher prices, and long delivery times.

On a similar note, the SIA in its public comment brief provided a list of packages that its members identified as being unavailable from U.S. suppliers, (Proprietary Information Withheld).

Finally, domestic producers were asked to identify any foreign dependencies they had experienced in accessing key production inputs. Only two producers stated that any such dependency had led to an interruption of their production. Both companies cited difficulty in obtaining aluminum nitride powder, and one of the companies further cited delays in obtaining imported copper tungsten bases.

VII. FINDINGS AND RECOMMENDATIONS

Findings

The Department of Commerce finds that ceramic semiconductor packages are not being imported into the United States in quantities and or under such circumstances as to threaten to impair U.S. national security. Although current conditions in the ceramic package industry do not present an immediate threat to national security, improving the capabilities of the domestic ceramic package industry is desirable for both economic and national security reasons.

The Department of Commerce found that:

- Ceramic semiconductor packages are a key component of the microelectronic element of virtually every military system. Survey respondents identified 113 distinct defense systems which require ceramic packages, and industry experts were unable to identify any system which does not include this product. In addition, ceramic packages are the medium of choice for latest-generation semiconductor products such as the Intel Pentium and the DEC Alpha microprocessors.

- Defense uses account for about 20 percent of the ceramic packages consumed in the United States, substantially above the five percent of GNP represented by defense.

- Imports now account for 85 percent by value and 92 percent by units ceramic packages identified as defense use; some product categories are nearly 100 percent dependent on foreign firms' packages.

- Import penetration has increased from 78 percent in 1990 to 91 percent in 1992, and concerns are heightened by the high degree of dependence (Proprietary Information Withheld) on one foreign producer with a limited number of production facilities.

- The eight domestic producers reporting lost $65 million in 1990 (20 percent of sales), lost an additional $96 million in 1991 (28 percent), and lost a further $90 million in 1992 (27 percent of sales). At least four of these eight firms were unprofitable for each of the three years of the survey period.

- Overall, U.S. production of ceramic packages declined 60 percent on a unit basis and 24 percent on a value basis between 1990 and 1992. The biggest declines occurred in high volume cerdip and cerpack product categories. Industry experts indicate that this trend is likely to continue.

- Survey respondents reported closing eight U.S. production lines since January 1991. The total annual production capacity lost due to these closings was $354 million, representing 39 percent of U.S. production capacity. In addition, several U.S. producers exited the ceramic package market altogether in recent years.

- In 1992, the average capacity utilization rate (all firms, all types) was 52 percent on a unit basis. Capacity utilization of non-captive production was [much lower], however, and capacity utilization has (Proprietary Information Withheld) decreased in 1993 for the leading captive producer.

- Surveyed firms reported that employment fell 21 percent from 1991 to 1992, and is expected to decrease an additional seven percent in 1993. Nevertheless, two companies reported having difficulty in acquiring skilled labor, in particular engineers with proper education and experience in the ceramic package process.

- Domestic customers rate Japanese suppliers as superior on a wide range of competitive factors. Their dominant position in the U.S. and world markets will make difficult any attempt at resurgence by U.S. producers even in areas where U.S. firms have a technological lead.

- Based on U.S. firms' production and capacity declines and their tenuous financial condition, several U.S. firms and leading U.S. government industry experts predict that the continued survival of U.S.-owned firms in the ceramic package business is problematic. (Proprietary Information Withheld)

- The danger of dependence on a concentrated ceramic package supply can be illustrated by the worldwide scramble to obtain sufficient epoxy resin for plastic semiconductor packages resulting from the recent explosion at Sumitomo's plant in Ebimo, Japan.

- While DOD cannot identify its exact quantitative requirements for ceramic packages in a national emergency, it believes "that it is important to maintain a national security capability to produce semiconductor ceramic packaging, particularly custom packages and those used in space applications and in heavily corrosive environments."

- Commerce industry analysts note that defense is simultaneously a leading customer for older-generation technologies and a leading customer for next-generation technologies.

- The largest domestic merchant supplier of ceramic packages is foreign-owned. In 1992, imports accounted for [the vast majority of] the units and the value of packages sold in the United States by this company. Further, this firm depends on its foreign parent for all green tape (i.e., unfired ceramic) [and several other critical inputs] for the limited amount of packages produced by this firm in the United States.

- The basic steps of the manufacturing process are well understood by several companies, any one of whom could produce a certain package given sufficient time and money. Only very few companies, however, have mastered the art of increasing manufacturing yields, and are able to reliably produce multiple copies of a given package at competitive cost within tight delivery time.

- The DOD reported that while they are willing to use plastic semiconductor packages where feasible, a substantial number of ceramic packages will be required for DOD weapon systems for the indefinite future. DOD's continuing commitment to ceramic packages is demonstrated by the Advanced Research Projects Agency's funding of multi-chip module R&D.

RECOMMENDATIONS

-Action Plan

Based on the finding that imports do not threaten to impair the national security, we do not recommend that the President take any import adjustment measures authorized under Section 232 authority. However, to address the manufacturing, technical, and financial shortfalls in the domestic ceramic package industry that were identified through the DOC survey and described in detail in this report, we have developed an Action Plan consisting of four elements. Implementation of these recommendations will strengthen the viability and technological standing of the domestic ceramic package industry to support U.S. national security requirements in the future.

This plan was developed with extensive input from representatives of a number of government agencies and laboratories with expertise in ceramic package material and manufacturing issues, and is a cost-effective, broad-based industry/government effort to address the challenges facing this key sector. The Action Plan consists of the following four elements, each of which addresses unique issues facing the domestic ceramic package industry:

(1) **Manufacturing Center of Excellence**

A "Center of Excellence" should be established with the goal of improving the **manufacturability** of ceramic packages. This Center should include a fully-integrated ceramic package production facility. Common problems that affect production yield rates should be addressed, with resulting solutions transferable to all participants. In addition, the Center should address other design and processing issues, such as environmental concerns, labor training issues, process automation, and economies of scale, and should devise a manufacturing technology "roadmap" to guide the evolution of this industry. Through work conducted at the Center and in private companies, the U.S. industry will be able to lower unit production costs and increase productivity.

The Department of the Navy, Office of the Chief of Naval Research, acting through the San Diego-based Naval Command, Control and Ocean Surveillance Center should take the lead in establishing this Center, building upon existing facilities and expertise. The Navy should coordinate this effort with the National Institute of Standards and Technology, Sandia and Oak Ridge National Laboratories, the U.S. Ceramic Package Consortium of U.S. firms and universities (includes IBM, Alcoa, Raytheon, Coors, MPA, GM Hughes Electronics, University of Illinois, W.R. Grace, and Martin Marietta) and other eligible U.S. firms. The estimated cost of this initiative is $8 million per year, which would cover building, salaries, and some equipment. It is anticipated that participating firms would provide additional equipment and/or services in kind.

(2) **Ceramic Materials Research and Development Program**

A Ceramic Materials Research and Development Program should be established with the goal of advancing the state of the art in ceramic **materials** and materials processes. Development of advanced materials has been determined to be a driving factor in ensuring the continued qualitative superiority of ceramic packages for the Department of Defense, as well as the key to competitive advantage in commercial markets. The Department of Commerce's National Institute of Standards and Technology and the Department of Energy's Oak Ridge National Laboratory should take the lead on this program.

Using both federal and company laboratories, the program would benchmark current and future material alternatives as to their performance, cost, and ease of manufacture. The program would also focus on application-specific research to accelerate the acceptance and deployment in the private sector of emerging package material technology. Since developing materials with desirable manufacturing characteristics is essential, this program should be closely coordinated with the manufacturing-oriented Center of Excellence and eligible firms as described above. The estimated cost of this element is $5 million per year.

(3) **Product and Process Qualification**

A program to assist industry in product and process **qualification** should be implemented. Among the most costly impediments to the growth of the U.S. industry are process site qualification, and work in characterizing the electrical parameters of an individual package and qualifying its reliability. Sandia National Laboratory and the National Institute of Standards and Technology should work with the Department of Defense to assist members of the U.S. Ceramic Package Consortium and other eligible U.S. ceramic package producers in obtaining full site qualification to certify production processes for high reliability military, space and commercial markets. Thus, the majority of this program's activities will be carried out in the facilities of participating firms.

Using existing equipment, Sandia and NIST could further assist in product qualification process by performing computer-simulated modeling on thermal and mechanical properties of multi-layer structures; designing and qualifying unique ceramic multichip module configurations for nonstandard applications; and performing detailed analysis of green tape

starting material through in-depth chemical analyses, microphysical analysis, visceoelastic analysis, and fracture analysis of fired materials. Overall costs for on-site and laboratory work is an estimated one time $3 million.

(4) **Government-Industry Working Group on Ceramic Packages**

A Working Group on Ceramic Packages should be established to foster a **Government-Industry Partnership**. The Working Group will be made up of representatives from all of the above programs and the industry consortium, and will be coordinated by the Department of Commerce. The main purpose of the Working Group will be to measure the effectiveness of each element of the Action Plan and the contribution of industry to meeting program objectives. The Working Group should also seek the participation of related industry user groups, such as SEMATECH, SEMI/SEMATECH, the Computer Systems Policy Project and the Semiconductor Industry Association. By meeting on a regular basis, the continued commitment of all involved parties will be maintained and obstacles can be addressed as they arise.

-Other Recommendations

In addition, the Department of Commerce will review the financial and production status of the domestic industry one year from now, including IBM's success in entering the merchant market. If the situation warrants, the Department of Commerce will initiate another Section 232 investigation.

The Department of Commerce, Bureau of Export Administration will also examine further the criteria for determining in future Section 232 investigations what "threaten[s] to impair the national security" in the post-Cold War environment. BXA will seek other agencies' views on this and report to the President by December 31, 1993.

TAB A
SUMMARY OF PETITION

- The petitioners begin by stating that U.S. security no longer depends on mere military might, but rather on high-technology superiority dependent upon microelectronics. This shift forces industry and government to focus on supply and demand factors on microelectronic components.

- Ceramic packages are critical to defense systems because practically all weapons, telecommunications and computer systems used for national security contain these components. Ceramic packages are used to protect semiconductors from extreme heat, humidity, radiation and dust, and to enhance conductive capabilities. The value of the package can exceed 25 percent of the value of the housed integrated circuit.

- A number of studies since 1985 have identified foreign and national security dependencies in ceramic package supply. A crisis exists in the ceramic package industry - precipitated by increased imports from Japan and the "monopoly" stranglehold of one Japanese company with related unfair trade practices. This situation should be addressed through action under Section 232. A recent Department of Commerce study highlighted the high level of foreign-sourced ceramic packages in three Naval weapon systems.

- U.S. vulnerability is clear in view of past actions by foreign sources to restrict the supply of defense materials including: Kyocera's 1987 decision to discontinue supply to the U.S. National Security Agency for defense programs, and 1986 debate within the Japanese Diet over supply of ceramic packages for the Tomahawk cruise missile.

Petitioners

- Coors Electronic Package Company manufactures and sells cofired ceramic packages and substrates. It conducts all R&D, design, product development and manufacturing in the United States.

- Ceramic Process Systems Corporation (CPSC) is a spinoff from the Massachusetts Institute of Technology which supplies high-end ceramic packages to military and commercial customers. CPS also conducts all ceramic package operations in the United States.

Product/Production Process/Product Lines

- The petition describes applications where it is appropriate to use ceramic packages, the detailed production process, and divides product offerings into six product categories.

- Ceramic packages do not have their own HTS tariff classification number, but rather are entered in one of three "basket" categories.

National Security and Commercial Uses of Ceramic Packages

- Petitioner reiterates ceramic package usage in hostile environments. Examples of systems using ceramic packages include: nuclear- and diesel-powered submarines; fighter planes; missiles; telecommunications systems; and in virtually every other weapon system which contains electronic circuitry.

- Ceramic packages are also widely used in commercial applications including cellular telephones and telecommunications satellites potentially threatening U.S. economic security.

Domestic Ceramic Package Industry

- Foreign-owned U.S.-located facilities continue to be subject to foreign laws. However, Defense Priorities and Allocations authority cannot be used by the U.S. government to require delivery of foreign-produced components for sale through U.S.-located facilities to U.S. defense contractors.

- The petition provides descriptions of Coors, CPSC, Diacon, Kyocera America, Alcoa Electronic Packaging, and General Ceramics Inc. Captive producers are also part of the domestic industry.

Foreign Competition

- The petition provides descriptions of Kyocera Japan, Narumi/SMI, and NTK/NGK.

- Japanese competition focuses on increasing imports and underpricing U.S. competitors, and is assisted by Japanese government targeting efforts.

- Prices of imported packages often do not cover cost of production. Kyocera allegedly instructs its sales force never to lose an order on price.

- However, Japanese companies raise their prices to recoup costs once competition has been driven from the market.

- Japanese government's "Three Principles" on Arms Exports has been interpreted broadly to cover military-related technology.

- Japanese government would not hesitate to deny needed items to military end users - including the United States - in an armed conflict, and petition cites several examples where Japanese companies were unable or unwilling to supply products to U.S. military end users.

- Since 1980, Japanese government has targeted the ceramic package industry through R&D and commercialization assistance.

Political and Economic Considerations

- United States cannot guarantee that an ally today will be an ally tomorrow, or that our political postures will continue to coincide.

- The U.S. Semiconductor Industry Association has stated that "the real choke point (of dependence on Japan) is packaging."

- The U.S. government and U.S. companies have been denied access to defense-relevant technology based on Japanese companies' commercial or economic considerations.

- The U.S. General Accounting Office reported that Japanese companies were said to supply state-of-the-art parts and equipment to Japanese customers before U.S. or other foreign customers.

- Japanese companies also may waive tooling and design costs thereby lowering their bid price in an attempt to increase market share.

- Japanese competition is forcing Coors to freeze its hiring and lay off workers.

- Since 1983, at least 21 U.S. companies have failed in the ceramic package market - including many large companies such as General Electric and 3M.

Relief Requested

- The petitioners request:

  1) government support for additional research and development leading to commercialization of advanced materials;

  2) qualification assistance to enable domestic suppliers to participate on existing military programs being supplied with ceramic packages from Japan; and

  3) any (additional) relief the President deems appropriate to stop the further deterioration of the U.S. ceramic package industry.

TAB B

FEDERAL REGISTER NOTICES

Wednesday, November 25, 1992; Vol. 57, No. 228: "Initiation of National Security Investigation of Imports of Integrated Circuit Ceramic Packages."

Wednesday, December 23, 1992; Vol. 57, No. 247: "Extension of Public Comment Period for National Security Investigation of Imports of Integrated Circuit Ceramic Packages."

This is issued pursuant to authority delegated by the Secretary of Agriculture.

Authority: Sec. 1324(c)(2), Public Law 99-198, 99 Stat. 1535, 7 U.S.C. 1631(c)(2); 7 CFR 2.18(e)(3), 2.56(a)(3), 55 FR 22795.

Dated: November 19, 1992.

Virgil M. Rosendale,

Administrator, Packers and Stockyards Administration.

[FR Doc. 92-28838 Filed 11-24-92; 8:45 am]

BILLING CODE 3410-20-M

Soil Conservation Service

Allison Draw Watershed, Wyoming

AGENCY: Soil Conservation Service, USDA.

ACTION: Notice of intent to prepare an environmental impact statement.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act of 1969; the Council of Environmental Quality Rules (40 CFR part 1500); and the Soil Conservation Service Rules (7 CFR part 650); the Soil Conservation Service, U.S. Department of Agriculture, gives notice that an environmental impact statement is being prepared for the Allison Draw Watershed, Laramie County, Wyoming.

FOR FURTHER INFORMATION CONTACT: Frank S. Dickson, State Conservationist, Soil Conservation Service, Federal Building, 100 East B Street, room 3124, Casper, Wyoming 82601, telephone (307) 261-5201.

SUPPLEMENTARY INFORMATION: The environmental assessment of this federally assisted action indicates that the project may cause significant local, regional, or national impacts on the environment. As a result of these findings, Frank S. Dickson, State Conservationist, has determined that the preparation and review of an environmental impact statement are needed for this project.

The project concerns flood prevention with flood channel construction. Past development has eliminated the stream channel of Allison Draw through business and residential areas of South Cheyenne. The plan includes construction of a flood channel thru the affected area and collection dikes.

Alternatives under consideration to reach these objectives include: 3 miles of flood channel, two collection dikes to guide water to the channel, road crossing enlargements at intersected roads and highways, and relocation of residences and businesses currently located in the flood channel right of way.

A draft environmental impact statement will be prepared and circulated for review by agencies and the public. The Soil Conservation Service invites participation and consultation of agencies and individuals that have special expertise, legal jurisdiction, or interest in the preparation of the draft environmental impact statement.

Two scoping meetings were held on March 19, 1991, and March 19, 1992, to determine the scope of the evaluation of the proposed action. One or more additional meetings will be widely publicized locally and direct meeting notices will be sent to all who have indicated an interest in the project. Further information on the proposed action, or the scoping meetings may be obtained from Frank S. Dickson, State Conservationist, at the above address to telephone (307) 261-5201.

(This activity is listed in the Catalog of Federal Domestic Assistance under No. 10.904—Watershed Protection and Flood Prevention—and is subject to the provisions of Executive Order 12372 which requires intergovernmental consultation with State and local officials)

Dated: September 10, 1992.

Frank S. Dickson,

State Conservationist, Wyoming.

[FR Doc. 92-28629 Filed 11-24-92; 8:45 am]

BILLING CODE 3410-16-M

DEPARTMENT OF COMMERCE

Agency Form Under Review by the Office of Management and Budget

DOC has submitted to the Office of Management and Budget (OMB) for clearance the following proposal for collection of information under the provisions of the Paperwork Reduction Act (44 U.S.C. chapter 35).

Agency: Bureau of the Census.

Title: Plant and Equipment Expenditures Survey.

Form Number(s): PE091, PE092, PE093, PE094, PE094(P), PE095, PE096.

Agency Approval Number: 0607-0641.

Type of Request: Extension of the expiration date of a currently approved collection without any change in the substance or in the method of collection.

Burden: 27,175 hours.

Number of Respondents: 15,000.

Avg Hours Per Response: 42 minutes.

Needs and Uses: The Bureau of the Census conducts the Plant and Equipment Expenditures Survey (P&E) on a quarterly and annual basis to obtain data on planned and actual investment in new plant and equipment from nonagricultural business firms. These estimates are one of the most important indicators used by business and public officials in assessing near-term economic activity. Census collects data quarterly from most respondents and annually from small companies and from chronic non-respondents to the quarterly forms.

Affected Public: Businesses or other for-profit organizations, Non-profit institutions, Small businesses or organizations.

Frequency: Quarterly and annually.

Respondent's Obligation: Voluntary—Quarterly forms, Mandatory—Annual forms.

OMB Desk Officer: Maria Gonzalez, (202) 395-7313.

Copies of the above information collection proposal can be obtained by calling or writing Edward Michals, DOC Forms Clearance Officer, (202) 482-3271, Department of Commerce, room 5312, 14th and Constitution Avenue, NW, Washington, DC 20230.

Written comments and recommendations for the proposed information collection should be sent to Maria Gonzalez, OMB Desk Officer, room 3208, New Executive Office Building, Washington, DC 20503.

Dated: November 20, 1992.

Edward Michals,

Departmental Forms Clearance Officer, Office of Management and Organization.

[FR Doc. 92-28706 Filed 11-24-92; 8:45 am]

BILLING CODE 3510-07-F

Bureau of Export Administration

Initiation of National Security Investigation of Imports of Integrated Circuit Ceramic Packages

AGENCY: Office of Industrial Resource Administration, Bureau of Export Administration, Department of Commerce.

ACTION: Notice of initiation of an investigation under section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862), and request for public comments.

SUMMARY: This notice is to advise the public that an investigation is being initiated under section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862), to determine the effects on the national security of imports of integrated circuit ceramic packages. Interested parties are invited to submit written comments, opinions, data, information, or advice relative to the investigation to the Strategic Analysis Division, Office of Industrial Resource Administration, U.S. Department of Commerce.

DATES: Comments must be received not later than January 15, 1993.

ADDRESSES: Send all comments to Brad L Botwin; Director, Strategic Analysis Division, Office of Industrial Resource Administration; Attention: Section 232 Comments; room 3878; U.S. Department of Commerce; 14th Street and Constitution Avenue, NW.; Washington, DC 20230.

FOR FURTHER INFORMATION CONTACT: Edward Levy, Section 232 Program Manager, Strategic Analysis Division, Office of Industrial Resource Administration, room 3878, U.S. Department of Commerce, 14th Street and Constitution Avenue, NW., Washington, DC 20230, (202) 482–3795.

SUPPLEMENTARY INFORMATION: In a petition jointly submitted by Coors Electronic Package Company and Ceramic Process Systems Corporation on November 10, 1992, the Department of Commerce was requested to initiate an investigation under section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862), to determine the effects on the national security of imports of integrated circuit ceramic packages.

On November 18, 1992 the Department of Commerce formally accepted the application and initiated an investigation. The findings and recommendations of the investigation are to be reported by the Secretary of Commerce to the President no later than August 16, 1993 (*i.e.*, within 270 days).

The items to be investigated do not have distinct Harmonized Tariff System (HTS) tariff classification numbers, but rather are contained in the following 'basket' HTS numbers:

8914.90.0000 Articles of Ceramics, Not Otherwise Specified
8542.90.0000 Parts of Electronic Integrated Circuits and Microassemblies
8546.20.0000 Electrical Insulators of Ceramics, Other than Used in High-Voltage, Low Frequency Electrical Systems

This investigation is being undertaken in accordance with part 705 of title 15 of the Code of Federal Regulations (15 CFR 705) ("Regulations"). Interested parties are invited to submit written comments, opinions, data, information, or advice relevant to this investigation to the Office of Industrial Resource Administration, U.S. Department of Commerce, not later than January 15, 1993.

The Department is particularly interested in comments and information directed to the criteria listed in § 705.4 of the regulations (15 CFR 705.4) as they affect national security, including the following:

(a) Quantity of and circumstances related to the importation of the articles subject to the investigation;

(b) Domestic production and productive capacity needed for these articles to meet projected national security requirements;

(c) Existing and anticipated availability of human resources, products, raw materials, production equipment, and facilities to produce these items;

(d) Growth requirements of domestic industries to meet national security requirements and/or requirements to assure such growth;

(e) The impact of foreign competition on the economic welfare of the domestic industry; and

(f) The displacement of any domestic products causing substantial unemployment, decrease in the revenues of government, loss of investment or specialized skills and productive capacity, or other serious effects.

All materials should be submitted with 10 copies. Public information will be made available at the Department of Commerce for public inspection and copying. Material that is national security classified information or business confidential information will be exempted from public disclosure as provided for by § 705.6 of the regulations (15 CFR 705.6). Anyone submitting business confidential information should clearly identify the business confidential portion of the submission and also provide a non-confidential submission which can be placed in the public file. Communications from agencies of the United States Government will not be available for public inspection.

The public record concerning this investigation will be maintained in the Bureau of Export Administration's Freedom of Information Records Inspection Facility, room 4525, U.S. Department of Commerce, 14th Street and Constitution Avenue, NW., Washington, DC 20230, telephone (202) 482–5653. The records in this facility may be inspected and copied in accordance with the regulations published in part 4 of title 15 of the Code of Federal Regulations (15 CFR 4.1 *et seq.*). Information about the inspection and copying of records at the facility may be obtained from Ms. Margaret Cornejo, the Bureau of Export Administration's Freedom of Information Officer, at the above address and telephone number.

James M. LaMunyon,
Acting Assistant Secretary for Export Administration.

[FR Doc. 92–28549 Filed 11–24–92; 8:45 am]
BILLING CODE 3510–DT–M

[Docket No. 921187–2287]

National Security-Based Controls on Pyrolytic Boron Nitride (PBN), Certain Sputtering Equipment, Certain Polyimides and Certain Side Scan Sonar Systems Removed With the Publication of Commerce Control List

AGENCY: Office of Foreign Availability, Bureau of Export Administration, Commerce.

ACTION: Notice.

SUMMARY: The purpose of this notice is to inform exporters that national security-based validated licensing requirements on pyrolytic boron nitride (PBN), certain sputtering equipment, certain polyimides and certain side scan sonar systems were removed by the publication of the Commerce Control List, effective September 1, 1991 (56 FR 42824, August 29, 1991).

The Department of Commerce made positive determinations of foreign availability for these four items based on assessments conducted by the Office of Foreign Availability (OFA) in 1990 and 1991.

Under the provisions of section 5(f) of the Export Administration Act, as amended (EAA), and section 791 of the Export Administration Regulations (EAR), the Department of Commerce may not continue to require a validated license for national security reasons for items for which a positive determination of foreign availability has been made.

This publication clarifies for exporters that the Commerce Control List already reflects the results of the positive determinations of foreign availability for these four items. Therefore, this notice does not change any entry in the Commerce Control List or any licensing policy.

FOR FURTHER INFORMATION CONTACT: Steven C. Goldman, Director, Office of Foreign Availability, room 1087, Department of Commerce, Washington, DC 20230; Telephone: (202) 482–0074.

SUPPLEMENTARY INFORMATION:

Background

Although the Export Administration Act expired on September 30, 1990, the President invoked the International Emergency Economic Power Act and

Soil Conservation Service

Lower Little River and South Yadkin River Watershed; Alexander County, NC

AGENCIES: North Carolina Department of Environment, Health, and Natural Resources and the United States Department of Agriculture, Soil Conservation Service.

ACTION: Notice of finding of no significant impact.

SUMMARY: Pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969; the Council of Environmental Quality Guidelines (40 CFR part 1500); and the Soil Conservation Service Guidelines (7 CFR part 650); the Division of Soil and Water Conservation, North Carolina Department of Environment, Health, and Natural Resources and the Soil Conservation Service, United States Department of Agriculture, give notice that an environmental impact statement is not being prepared for the Lower Little River and South Yadkin River Watershed, Alexander County, North Carolina.

FOR FURTHER INFORMATION CONTACT: David W. Sides, Director, Division of Soil and Water Conservation, North Carolina Department of Environment, Health, and Natural Resources, P.O. Box 27687, Raleigh, North Carolina 27611, Telephone (919) 733–2302 or Coy Garrett, State Conservationist, Soil Conservation Service, 4405 Bland Road, Suite 205, Raleigh, North Carolina 27609, Telephone (919) 790–2888.

SUPPLEMENTARY INFORMATION: The Environmental Assessment of this federally assisted action indicates that the project will not cause significant adverse local, regional, or national impacts on the environment. As a result of these findings, Coy Garrett, State Conservationist, has determined that the preparation and review of an environmental impact statement are not needed for this project.

The project concerns a plan for watershed protection. The planned works of improvement include accelerated technical and financial assistance to apply land treatment measures on 3,100 acres of cropland and install 21 animal waste management systems.

The Notice of A Finding of No Significant Impact (FONSI) has been forwarded to the Environmental Protection Agency and to various federal, state, and local agencies and interested parties. A limited number of copies of the FONSI are available to fill single copy requests at the above address. Basic data developed during the environmental assessment are on file and may be reviewed by contacting David W. Sides.

No administrative action on implementation of the proposal will be taken until 30 days after the date of this publication in the **Federal Register**.

("This activity is listed in the Catalog of Federal Domestic Assistance under No. 10.904—Watershed Protection and Flood Prevention—and is subject to the provisions of Executive Order 12372 which requires intergovernmental consultation with state and local officials.")

Dated: December 15, 1992.

Coy Garrett,

State Conservationist.

[FR Doc. 92–31081 Filed 12–22–92; 8:45 am]

BILLING CODE 3410–16–M

DEPARTMENT OF COMMERCE

Bureau of Export Administration

Extension of Public Comment Period for National Security Investigation of Imports of Integrated Circuit Ceramic Packages

AGENCY: Office of Industrial Resource Administration, Bureau of Export Administration, U.S. Department of Commerce.

ACTION: Notice of extension of public comment period for investigation under section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862).

SUMMARY: This notice is to advise the public that the Department of Commerce will extend until February 1, 1993 the formal public comment period for its investigation of the effects on the national security of imports of integrated circuit ceramic packages being conducted under section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862).

ADDRESSES: Send all comments to Brad I. Botwin; Director, Strategic Analysis Division; Office of Industrial Resource Administration; Attention: Section 232 Comments; room 3878; U.S. Department of Commerce; 14th Street and Constitution Avenue, NW.; Washington, DC 20230.

FOR FURTHER INFORMATION CONTACT: Edward Levy, Section 232 Program Manager, Strategic Analysis Division, Office of Industrial Resource Administration, room 3878, U.S. Department of Commerce, 14th Street and Constitution Avenue, NW., Washington, DC 20230, (202) 482–3795.

SUPPLEMENTARY INFORMATION: In the November 25, 1992 Federal Register (Vol. 57, No. 228, p. 55507), the Department of Commerce announced its initiation of a Section 232 investigation of the effects on the national security of imports of integrated circuit ceramic packages under section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862). This case was initiated November 18, 1992 in response to a petition jointly submitted by Coors Electronic Package Company and Ceramic Process Systems Corporation. The Department has decided to extend the formal public comment period until February 1, 1993 in order to allow interested parties a sufficient time to prepare their comments while ensuring that the investigation proceeds expeditiously.

Interested parties are invited to submit written comments, opinions, data, information, or advice relevant to this investigation. The Department is particularly interested in comments and information directed to the criteria listed in § 705.4 of the regulations (15 CFR 705.4) as they affect national security, including the following:

(a) Quantity of and circumstances related to the importation of the articles subject to the investigation;

(b) Domestic production and productive capacity needed for these articles to meet projected national security requirements;

(c) Existing and anticipated availability of human resources, products, raw materials, production equipment, and facilities to produce these items;

(d) Growth requirements of domestic industries to meet national security requirements and/or requirements to assure such growth;

(e) The impact of foreign competition on the economic welfare of the domestic industry; and

(f) The displacement of any domestic products causing substantial unemployment, decrease in the revenues of government, loss of investment or specialized skills and productive capacity, or other serious effects.

All materials should be submitted with 10 copies. Public information will be made available at the Department of Commerce for public inspection and copying. Material that is national security classified information or business confidential information will be exempted from public disclosure as provided for by § 705.6 of the regulations (15 CFR 705.6). Anyone submitting business confidential information should clearly identify the business confidential portion of the submission and also provide a non-confidential submission which can be placed in the public file.

Communications from agencies of the United States Government will not be made available for public inspection.

The public record concerning this investigation will be maintained in the Bureau of Export Administration's Records Inspection Facility, room 4525, U.S. Department of Commerce, 14th Street and Constitution Avenue, NW., Washington, DC 20230, telephone (202) 482–5653. The records in this facility may be inspected and copied in accordance with the regulations published in part 4 of title 15 of the Code of Federal Regulations (15 CFR 4.1 *et seq.*). Information about the inspection and copying of records at the facility may be obtained from Ms. Margaret Cornejo, the Bureau of Export Administration's Freedom of Information Officer, at the above address and telephone number.

Dated: December 17, 1992.

John A. Richards,

Deputy Assistant Secretary for Industrial Resource Administration.

[FR Doc. 92-31113 Filed 12-22-92; 8:45 am]

BILLING CODE 3510-DT-M

Foreign-Trade Zones Board

[Order No. 612]

Resolution and Order Approving the Application of the Indianapolis Airport Authority for Special-Purpose Subzone Status; Endress + Hauser, Inc. (Process Control Instrumentation), Greenwood, IN

Proceedings of the Foreign-Trade Zones Board, Washington, DC.

Resolution and Order

Pursuant to the authority granted in the Foreign-Trade Zones Act of June 18, 1934, as amended (19 U.S.C. 81a–81u), the Foreign-Trade Zones Board (the Board) adopts the following Resolution and Order:

The Board, having considered the matter, hereby orders:

After consideration of the application of the Indianapolis Airport Authority, grantee of FTZ 72, filed with the Foreign-Trade Zones (FTZ) Board (the Board) on October 15, 1991, and amended on October 5, 1992 (to indicate steel mill products will not be admitted to the proposed subzone in foreign status), requesting special-purpose subzone status for the industrial control instrumentation manufacturing facility of Endress + Hauser, Inc., in Greenwood, Indiana, the Board, finding that the requirements of the Foreign-Trade Zones Act and the Board's regulations are satisfied, and that the proposal, as amended, is in the public interest, approves the application, as amended.

The approval is subject to the FTZ Act and the FTZ Board's regulations (as revised 56 FR 50789–50808; 10–8–91), including § 400.28. The Secretary of Commerce, as Chairman and Executive Officer of the Board, is hereby authorized to issue a grant of authority and appropriate Board Order.

Grant of Authority for Subzone Status

Whereas, by an Act of Congress approved June 18, 1934, an Act "To provide for the establishment * * * of foreign-trade zones in ports of entry of the United States, to expedite and encourage foreign commerce, and for other purposes," as amended (19 U.S.C. 81a–81u) (the Act), the Foreign-Trade Zones Board (the Board) is authorized to grant to corporations the privilege of establishing foreign-trade zones in or adjacent to U.S. Customs ports of entry;

Whereas, the Board's regulations (15 CFR part 400) provide for the establishment of special-purpose subzones when existing zone facilities cannot serve the specific use involved;

Whereas, an application from the Indianapolis Airport Authority, Grantee of Foreign-Trade Zone No. 72, for authority to establish a special-purpose subzone at the industrial control instrumentation manufacturing facility of Endress + Hauser, Inc., in Greenwood, Indiana, was filed by the Board on October 15, 1991, and notice inviting public comment was given in the Federal Register on October 31, 1991 (FTZ Docket 69–91; 56 FR 56053, 10–31–91);

Whereas, the application was amended on October 5, 1992, to indicate that steel mill products will not be admitted to the proposed subzone in foreign status; and

Whereas, the Board has found that the requirements of the Act and the Board's regulations are satisfied and that its approval of the application, as amended, is in the public interest;

Now, Therefore, the Board hereby authorizes the establishment of a subzone (Subzone 72I) at the Endress + Hauser, Inc., plant in Greenwood, Indiana, at the location described in the application, subject to the FTZ Act and the Board's regulations (as revised, 56 FR 50790–50808, 10–8–91), including § 400.28.

Signed at Washington, DC, this 11th day of December, 1992, pursuant to Order of the Board.

Alan M. Dunn,

Assistant Secretary of Commerce for Import Administration, Chairman, Committee of Alternates, Foreign-Trade Zones Board.

Attest:

John J. Da Ponte, Jr.,

Executive Secretary.

[FR Doc. 92-31159 Filed 12-22-92; 8:45 am]

BILLING CODE 3510-DS-M

[Order No. 614]

Expansion of Foreign-Trade Zone 22, Chicago, IL

Pursuant to its authority under the Foreign-Trade Zones (FTZ) Act of June 18, 1934, as amended (19 U.S.C. 81a–81u) (the Act), and the FTZ Board Regulations (15 CFR part 400), the FTZ Board (the Board) adopts the following Resolution and Order:

Whereas, an application from the Illinois International Port District, Grantee of Foreign-Trade Zone No. 22, for authority to expand its general-purpose zone in the Chicago, Illinois, area, within the Chicago Customs port of entry, was filed by the Board on September 18, 1991, and notice inviting public comment was given in the Federal Register on September 24, 1991 (Docket 53–91, 56 FR 48157);

Whereas, the application was amended on September 14, 1992 to request a time extension of authority (to 12/31/94) for FTZ 22-Site 4 (57 FR 43693, 9/22/92);

Whereas, an examiners committee has investigated the application in accordance with the Board's regulations and recommends approval;

Whereas, the expansion is necessary to improve and expand zone services in the Chicago area; and

Whereas, the Board has found that the requirements of the Act and the Board's regulations are satisfied, and that approval is in the public interest;

Now, Therefore, the Board hereby orders:

That the grantee is authorized to expand its zone in accordance with the application filed on September 18, 1991 and amended on September 14, 1992, subject to the Act and the Board's regulations (as revised, 56 FR 50790–50808, 10–8–91), including § 400.28.

Signed at Washington, DC, this 11th day of December, 1992.

Alan M. Dunn,

Assistant Secretary of Commerce for Import Administration; Chairman, Committee of Alternates, Foreign-Trade Zones Board.

Attest:

John J. Da Ponte, Jr.,

Executive Secretary.

[FR Doc. 92-31187 Filed 12-22-92; 8:45 am]

BILLING CODE 3510-DS-M

TAB C
QUESTIONNAIRES

Copies of the questionnaires will be made available for public review and duplication in the Bureau of Export Administration's Public Reference Room, Room 4525, U.S. Department of Commerce, Washington, DC 20230, (202) 482-2593.

TAB D
SUMMARY OF PUBLIC COMMENTS

On November 25, 1992, the Department of Commerce published a notice in the Federal Register to initiate this investigation, and invite interested parties to submit their comments by January 15, 1993. On December 23, 1992, the DOC published a supplemental Federal Register notice extending the end of the formal public comment period until February 1, 1993. (Copies of these notices are attached at Tab B.) The following 23 organizations submitted comments during this period. Some commenters were explicit in their support or opposition to the petitioners' claims, while others expressed a more mixed view (e.g. the government should assist the industry, but should not restrict imports under Section 232). In such cases, we have attempted to characterize comments as primarily supportive or primarily opposed to the petition.

Supportive of petition:

- Carborundum Company
- Detomasi & Grupp Inc.
- Diacon Inc.
- Institute of Electrical and Electronics Engineers
- International Micro Industries
- Lanxide Electronic Components
- Microelectronic Packaging America
- Micron Technology
- Teledyne Microelectronics
- W. R. Grace & Co.

Opposed to petition:

- Advanced Micro Devices
- Aerospace Industries Assoc.
- Computer Systems Policy Project
- Cypress Semiconductor
- Cyrix Corporation
- Electronic Industries Assoc.
- Integrated Device Technology
- International Business Machines Corporation
- Kyocera America Inc.
- Kyocera Corporation (KC)
- NGK Spark Plug and Shinko Electric Industries
- Semiconductor Industry Association
- Sumitomo Metal Industries

Supportive of Petition

Carborundum Company: The Microelectronics Division of the Carborundum Company, a wholly-owned subsidiary of British Petroleum, is a manufacturer and supplier of high technology ceramic packages for both military and commercial markets. Its substrates division manufactures aluminum nitride substrates for the hybrid industry.

Carborundum concurs with the petition's assertion that U.S. ceramic package users are currently dependent upon Japanese suppliers, and maintains that the United States should not depend completely on a single foreign source for critical components for U.S. military systems.

Carborundum asserts that we would be crippled if the Japanese were to cease selling or become unable to supply ceramic packages to U.S. users. Several such instances have already occurred within the past five years, and there is no indication that those instances will not be repeated.

Detomasi & Grupp Inc. (DGI): DGI is a California-based electronics, parts and equipment distributor.

DGI is concerned about U.S. dependence on Japanese-made ceramic packages. They believe that ceramic package technology is vital to maintaining our nation's lead in sophisticated weaponry, and therefore, should not be entrusted completely to any foreign nation.

DGI is disturbed about the number of American dollars which are needed right now in this country that are being exported to Japan to buy products we can produce here. DGI contends that we should stop buying foreign when we can buy domestic. DGI notes that Japanese companies strongly support home country suppliers. DGI urges the DOC to recommend to the President that DOD increase its procurement of U.S. integrated circuit packages, and decrease its dependence on Japan, thereby also improving our economy.

Diacon Inc.: Diacon is a privately-owned U.S. company which manufactures ceramic packages. Diacon has been a major supplier of high-reliability packages for military programs such as Trident I and II, the MX Missile, and the National Security Agency (NSA) COMSEC programs.

Diacon maintains that the United States must take whatever action necessary to allow the domestic integrated circuit package industry to regain its position to supply the military needs. Diacon argues that its ability to maintain the capacity to produce the glass/ceramic type packages - mainstay of the Trident and other missile programs - will depend on its ability to penetrate the multilayer co-fired ceramic package market.

Diacon contends that the domestic industry's ability to supply glass/ceramic packages and multilayer co-fired ceramic packages in the event of a national emergency depends on maintaining domestic suppliers with high-volume production during non-emergency periods. This has been impossible to achieve due to the high market share enjoyed by Japanese suppliers.

Institute of Electrical and Electronics Engineers, Inc. (IEEE): IEEE-USA promotes the career and technology policy interests of the 250,000 electrical, electronics, and computer engineers who are its members.

IEEE endorses the Section 232 investigation into excessive defense dependence on foreign-supplied ceramic semiconductor packages. They urge the government to take positive steps to promote the competitiveness of the domestic ceramic package industry. IEEE notes that government and industry studies confirm that DOD is dependent on foreign-sourced ceramic packages for more than 90 percent of its ceramic package needs.

IEEE contends that national security in the technological age requires the maintenance of a strong competitive domestic industry able to meet defense needs in the event foreign supplies are disrupted. The lack of a viable domestic ceramic package industry can allow Japanese suppliers, who dominate the ceramic package market, to retaliate against the U.S. semiconductor industry.

International Micro Industries, Inc. (IMI): IMI designs and acquires ceramic packages to meet NSA's requirements for classified products and applications.

IMI is concerned about U.S. dependence on foreign sources for the ceramic packages required to fulfill DOD requirements. IMI believes that yielding the current market for single chip ceramic packages to foreign suppliers will lead to abandoning our future stake in ceramic substrates for multichip modules, and ultimately our computer industry. IMI has sought bids from ceramic package suppliers, and was surprised to learn that American sources are non-existent. IMI asserts that allowing foreign suppliers to dominate the future multichip module ceramic substrate market will reveal classified information since substrates contain chips' interconnect circuitry.

Lanxide Electronic Components, L.P. (LEC): LEC is a limited partnership between the Lanxide Corporation and DuPont created to design and fabricate high performance electronic components for the electronic systems industry including electronic packages.

LEC supports the Coors/CPSC petition and the relief that can be granted under Section 232. LEC believes that current U.S. dependence on one Japanese source for almost all of its electronic ceramic package needs threatens U.S. national security.

LEC contends that it has tried unsuccessfully to sell its competitive components to Kyocera for incorporation into Kyocera ceramic packages that currently use Kovar or tungsten/copper bases. LEC states that Kyocera would not consider LEC products because they are built in the United States, and further that Kyocera asked LEC to produce in Japan or to license its technology to a Japanese company.

LEC contends that we must develop U.S. suppliers to break the hold that Japanese ceramic package producers have on the U.S. defense establishment. LEC reports, for example, that it was advised that a very large U.S. electronics company was unable to diversify its ceramic package sources for fear that Kyocera might retaliate and delay required deliveries.

LEC argues that foreign companies have unequal access to innovative ideas developed in this country, citing Kyocera's interest in funding new U.S. research ventures in the ceramic package business. To get a venture funded, however, one must write a very complete business plan that includes an explicit description of the new technology or product. While less than one percent of these business plans are ever funded, venture companies are able to review their proposed plans in detail without a written agreement of confidentiality.

Microelectronic Packaging America (MPA): MPA is a manufacturer and supplier of ceramic packages for both military and commercial markets. MPA is a new corporation formed in August 1991 upon the acquisition of Cabot Ceramics which has been supplying ceramic packages to Trident II and other defense projects for ten years.

MPA agrees that the United States has an unhealthy dependence on Japanese sources for critical components of many advanced weapons, computer and communications systems. MPA believes that electronic packages are evolving from commodity-type standard products to products custom-designed and engineered for specific applications, providing package suppliers with more design information. MPA argues that U.S. national security must not continue to be threatened by a dependence caused by the commercial and political policies of one Japanese company and the Japanese government.

Micron Technology Inc. (Micron): Micron is a major manufacturer of dynamic random access memory (DRAM) chips and other semiconductors. Micron has invested significant time and resources to develop and maintain an American DRAM supply base for national security and economic security reasons.

Micron believes that U.S. dependence on foreign semiconductors would be intolerable and dangerous. As a result, Micron and other U.S. chip producers have sought government support to prevent the deterioration of the semiconductor base when it was threatened by unfair foreign trade practices and targeting.

Micron is also opposed to U.S. dependence on foreign ceramic packages. Micron believes that the U.S. government should take appropriate steps to ensure that the domestic ceramic package industry achieves a sufficient market position to guarantee its long-term viability.

Micron asserts that traditional trade remedies such as tariffs, mandatory content quotas, or voluntary restraint agreements won't produce the desired effect. Micron believes that the most effective remedy would be the use of existing federal and industry programs, or the establishment of a new industry-specific program to support reestablishment of a world class U.S. ceramic package industry. Micron notes that ceramic, and micro chip integration technologies have been included on the National Critical Technology List because they are central to our national defense and integral to other technologies.

Teledyne Microelectronics (TM): TM is a diversified manufacturer of custom hybrid microcircuits and multichip modules. TM is almost totally dependent upon Japanese sources for ceramic materials and associated technology to support its requirements for high-density custom ceramic packages.

TM supports the Section 232 investigation of imports of circuit ceramic packages. TM asserts that there are currently no viable domestic sources for the critical ceramic components used in its products, however, TM would welcome U.S. sources, given equivalent technology and price. TM has been unsuccessful in past attempts to cultivate U.S. ceramic package sources. TM supports the establishment of joint ventures with Japanese partners to establish market access in high technology markets, and believes that U.S. government support is essential.

W. R. Grace & Co.: Grace has formed a strategic alliance with Coors to develop and manufacture advanced ceramic package products.

Grace believes that U.S. dependence on foreign-made ceramic packages threatens national security, and believes that the Section 232 investigation can help ensure a continued U.S. ability to provide ceramic packages. Grace is concerned by Kyocera and the Japanese Diet's past efforts to delay or withhold ceramic package products needed for U.S. defense systems.

Opposed to Petition

Advanced Micro Devices, Inc. (AMD): AMD manufactures integrated circuits and microprocessors, and hopes to expand the market for its microprocessors by starting a new customer specific integrated circuit business unit.

AMD opposes the Section 232 petition, believing that it and its customers will be hurt if ceramic package imports are restricted. AMD's costs will increase, and these costs will have to be passed on to its customers.

AMD says that it has received bids from Coors, but has found Coors' quality and service to be uncompetitive. Therefore, AMD's only viable option to meet customer requirements is to purchase from international sources.

Aerospace Industries Association (AIA): AIA is a trade association which represents the manufacturers of aircraft, aircraft engines, helicopters, spacecraft, and other products associated with the aerospace industry. AIA members incorporate ceramic packages into a wide variety of weapon systems.

AIA believes that limiting the foreign suppliers' access to our market could create a larger U.S. national security risk, and could also lead to retaliation from countries which are major aerospace customers.

AIA members believe that U.S. ceramic package suppliers cannot currently provide the level of service that the aerospace industry requires. AIA prefers that the government find ways to bring our domestic industry up to world class standards, rather than to restrict U.S. ceramic package consumers.

Computer Systems Policy Project (CSPP): CSPP is a coalition of 13 leading U.S. computer systems producers.

CSPP is concerned that imposition of restrictions on ceramic package imports under Section 232 will lead to short supply of these products in the United States. Current domestic ceramic package suppliers would not be able to quickly produce the variety, quality, or quantity of products necessary to fill the disruption of supply that would result from import restrictions. CSPP contends that import restrictions would serve one narrow U.S. interest, but would have a magnified adverse effect on every downstream sector.

CSPP advises against trade restrictions in the present situation, as they would have an effect opposite to that intended. The U.S. ceramic package industry should focus on improving its own competitiveness; and harming its domestic customer base is not the way to achieve this goal. CSPP believes that any government action to assist American industry should benefit overall U.S. competitiveness.

Cypress Semiconductor: Cypress produces high-speed chips for niche markets. Cypress reported a profit for several years, and notes that when its earnings decreased, it responded by moving assembly to Thailand and reducing its workforce.

Cypress reports that it has encountered many problems with existing U.S. ceramic package manufacturers, (i.e., poor quality, high price, and arrogance). In contrast, Cypress states that Kyocera America (KAI) helped Cypress to grow to a billion dollar concern. KAI was customer-oriented and gave Cypress what it needed speedily and effectively.

Cyrix Corporation: Cyrix is an international supplier of semiconductors and a manufacturer of microprocessors and math coprocessors.

Whenever possible, Cyrix sources materials and equipment from domestic suppliers. Cyrix reports that over half of the value of its products are made here, while the other half is exported from the Asia/Pacific region. However, Cyrix opposes restrictions that would increase its manufacturing costs, and hamper its ability to compete internationally. Cyrix believes that such restrictions would penalize the U.S. electronics industry.

Cyrix has been unable to find competitive domestic sources for ceramic packages, reporting that U.S. sources quoted prices more than twice those of offshore suppliers.

Electronic Industries Association (EIA): EIA is the oldest and largest electronics industry trade association, comprised of more than 1,000 member companies involved in the design, manufacture, distribution and sale of electronic parts, components, equipment and systems for use in consumer, commercial, industrial, military and space applications.

EIA believes that import restrictions on ceramic packages would impair the competitiveness of both U.S. package suppliers and the U.S. semiconductor industry. EIA contends that U.S. ceramic package suppliers have been unable to meet the needs of U.S. semiconductor manufacturers. EIA suggests that a focus on quality and productivity will eventually enable U.S. ceramic package suppliers to compete effectively in the global market.

Integrated Device Technology (IDT): IDT is a purchaser of ceramic package materials. IDT deals with both U.S. and Japanese ceramic package suppliers (in particular Kyocera).

IDT contends that Kyocera has been a valued and extremely important supplier that provides leading-edge technology products that support the semiconductor industry. Conversely, they contend that U.S. ceramic package suppliers have demonstrated that they are unable to provide required service, quality of product, and technical capability. IDT warns that any government action which would increase prices or restrict purchases of ceramic packages would have a significant negative impact on the U.S. semiconductor industry.

International Business Machines Corporation (IBM): IBM has historically developed and manufactured leading-edge ceramic packages for captive use in its own computer products. Recently however, IBM began to market its ceramic technology products and related services in the commercial market.

IBM provided two submissions during the formal comment period, the second of which opposed Coors' 232 petition. IBM states that it does not believe that remedies available under Section 232 would result in increased competitiveness for this industry and might be counter-productive.

IBM believes that the long-term health of the U.S. microelectronics industry requires a viable, state of the art ceramic package industry as a building block. IBM notes that the inability of American companies to attain sufficient market share could lead the United States to lose ceramic technology.

IBM contends that government-industry efforts to bolster a strong domestic ceramic package industry are appropriate. They urge the government to: 1) modify government purchasing procedures to assure a level playing field; 2) accelerate the redefinition of governmental qualification activity for replacement of current or new product requirements; 3) fund R&D for unique product development, and; 4) establish domestic supplier marketplace participation goals to measure progress.

Kyocera America Inc. (KAI): KAI is a U.S. corporation owned by Kyocera International, Inc. (KII) a wholly-owned subsidiary of Kyocera Corporation (KC) of Japan. KAI produces ceramic packages for integrated circuit devices. In addition KAI imports ceramic packages from KC and resells them to U.S. customers.

KAI states that the petition misrepresents the facts by claiming that there currently exists a "crisis" in the ceramic package industry, and that the U.S. industry is being "crushed" by imports. KAI believes that imposing import restraints could raise the price of important semiconductor components, and could have the unintended impact of driving U.S. semiconductor assembly operations offshore.

KAI contends that KC and KAI have served the U.S. semiconductor industry reliably and faithfully since the very beginning of ceramic package usage in the mid-1960s. Kyocera has always enjoyed a leading position in the industry due to outstanding customer relations, superior product quality, and long-term dedication to the U.S. semiconductor market. KAI argues that Coors exhibits a totally opportunistic attitude to the ceramic package market, entering the market when times are good and exiting during downturns. KAI contends that Coors is simply seeking a government bail-out to compensate for its own misjudgments.

KAI states that it unequivocally is a U.S. producer that is subject to U.S. law, including the Defense Production Act and is part of the national security resource base. KAI states that it has never interrupted supplies, and has been and will continue to be a fully integrated, reliable supplier.

KAI contends that its success is attributed to the high quality of its ceramic packages. KAI states that it has applied technology readily-available to all ceramic package manufacturers, and believe that there is no intrinsic reason why KAI's competitors should not perform as well as KAI.

KAI reports that available data indicates that Japanese ceramic package imports have not increased in recent years. They believe that imports from Japan could not be the cause of any difficulties the petitioners are experiencing.

KAI concludes that if import restrictions are placed on Japanese ceramic packages, the U.S. semiconductor industry will have no choice but to use plastic where possible, and to move even more of its assembly operations offshore where there will be no barriers to a proven, steady supply of ceramic packages.

Kyocera Corporation (KC): KC of Japan has supplied the semiconductor industry with ceramic packages for more than 25 years. Through KII and later through KAI, KC has been a significant part of the U.S. semiconductor industry from its earliest days, and largely owes its success to the U.S. semiconductor industry's support.

KC feels that the competitive sword petitioners have selected, Section 232, is totally inappropriate as it is not a trade regulation statute. KC views the fact that an importer has earned market share as irrelevant, and states that this market share does not constitute imports which impair national security.

KC contends that Coors has repeatedly jumped in and out of the U.S. market, and that KC, in contrast, has been supplying ceramic packages, through good times and bad, to the domestic integrated circuit industry. KC further states that CPSC appears to be experiencing the typical problems of a start-up while expanding its customer base.

KC reports that it has made its technology available to customers and competitors alike. KC feels that it has advanced ceramic package technology in the United States and has not, contrary to petitioners' allegations, reserved the most advanced technology for Japanese customers.

KC reports that imports of ceramic packages have been declining and U.S. producers are gaining domestic market share. They believe that the United States now enjoys more than an adequate ceramic package base -- both in technology and capacity -- to support emergency requirements.

KC states that it has never engaged in unfair trade practices and does not sell ceramic packages below its cost of production. KC does admit that its prices increased in 1986, 1987, and 1988 but that such price increases were driven by the increase in the dollar value of KC's Japanese production costs caused by realigning exchange rates.

KC states that less than ten percent of its U.S. sales of KC and KAI products end up in U.S. military items. KC advises that U.S. ceramic package production capacity far exceeds U.S. military requirements. KC notes that previous investigations emphasize the importance of considering the quantity of reliable imports that can supplement domestic capacity in a time of crisis. They contend that Japan is a reliable importer who can, standing alone, meet national security needs. In addition, ceramic packages are usually transported by air, which means that supply will remain uninterrupted during mobilization. KC has proven in peace and war to be a reliable supplier to the defense industry.

KC cautions that neither the national security interests of the United States nor the competitive position of U.S. industries in developing state-of-the art package technologies are advanced by permitting petitioners to become the beneficiaries of punitive policies against Japanese ceramic package producers. KC urges Commerce to consider the international legal and foreign policy implications of the relief requested.

NGK Spark Plug and Shinko Electric Industries (joint comments): NGK is a Japanese company that manufactures technical ceramics, adopting the name NTK Technical Ceramics for this portion of its business. NTK is second to Kyocera in worldwide sales of ceramic packages. Shinko is a smaller Japanese manufacturer of ceramic packages which also produces a variety of other electronic components. Both NTK and Shinko manufacture ceramic packages only in Japan.

NTK and Shinko compete with each other as well as with other ceramic package manufacturers. NTK/Shinko state that imports of ceramic packages from Japan present no threat to the national security of the United states. They contend that ceramic packages are a general use product not subject to any national security export controls in Japan or the United States, and that most ceramic packages are used for civilian products such as video recorders and personal computers.

NTK/Shinko believes that import restrictions would boost DOD procurement costs and also increase costs to U.S. integrated circuit manufacturers. This adjustment would constitute an "anti-industrial policy" by making business harder for U.S. companies. NTK/Shinko further warn that import restraints could lead target nations to retaliate against U.S. exports to these countries. They emphasize that reliable imports are available from Japan to cover any shortfalls in U.S. productive capacity.

NTK/Shinko reports that for more than 20 years, worldwide sales of ceramic packages have been dominated by Japanese manufacturers. NTK/Shinko believes that DOC should expand the scope of its investigation to include plastic packages, and multichip module products. NTK/Shinko states that plastics are replacing cerdip at the low end, and MCM and other technologies are challenging ceramic packages at the high end. They believe that more than 80% of total integrated circuit package is now plastic, and that percentage is growing rapidly. NTK/Shinko reports that DOD is spending millions studying the use of plastics and other technologies to replace ceramic package. They contend that the Pentagon is close to changing its policy to incorporate plastic packages into defense systems. NTK/Shinko suggests that the U.S. stockpile ceramic packages and chips in packages since they have extremely long shelf lives and take up very little space.

NTK/Shinko report that the U.S. government provides more than $30 million in R&D grants in support of the U.S. integrated circuit package industry, a level that may well exceed the total annual sales of the petitioners, and that Coors is a major participant in several of these programs. Although Japan does not subsidize its ceramic package industry, NTK/Shinko doesn't object to the U.S. Government subsidizing its ceramic package industry.

NTK/Shinko complains that the petition contradicts itself by criticizing Japanese ceramic package manufacturers both for their predatory pricing and rapid and consistent price increases. NTK/Shinko advises that U.S. national security policy should take advantage of the best global technologies to meet the needs of the U.S. armed forces.

Semiconductor Industry Association (SIA): SIA represents U.S.-based semiconductor manufacturers. Through a coordinated industry/government effort, SIA has led the industry's response to other nations' unfair trade practices such as targeting and dumping of certain semiconductor products. SIA is working with the federal government and the nation's universities to promote pre-competitive technological capabilities in research, development, design, manufacturing, and marketing which are necessary to ensure America's competitive success in the field of semiconductors. SIA believes that all of these efforts contributed to the turnaround in U.S. semiconductor worldwide market share in 1992, and are therefore worthy of consideration for emulation in resolving the ceramic package industry's problems.

SIA cautions that the imposition of any type of traditional trade remedy to support the U.S. ceramic package industry will not fix the basic problems facing the industry, and may harm U.S. national security and economic interests. SIA believes that trade remedies may force U.S. semiconductor producers to increase their prices and/or produce lower quality semiconductors.

SIA members state that they have attempted to qualify second sources for many ceramic packages, but have found instances where quality, customer service, and product availability were barriers. They remark that many U.S. ceramic package producers have long lead times, low yields, poor commitment to delivery, poor engineering support, and higher material design and tooling costs that are unacceptable from any supplier whether foreign or domestic. SIA believes that the entire electronics industry would benefit from a strong U.S. ceramic package industry. SIA would support government measures which focus on improving the competitiveness of the U.S. ceramic package industry without imposing import restrictions.

SIA believes that the U.S. government could counter its dependence upon foreign-supplied ceramic packages by strengthening existing federal research programs, using programs similar to Defense Production Act Title III, and/or by developing a new government-industry program to focus on increased domestic production of competitive ceramic packages.

SIA opposes import restrictions as a remedy because they do not address the basic problems of serving either military or commercial package needs. SIA would like to ensure that the supply of quality packages is not interrupted if the U.S. Government determines that ceramic package imports are threatening national security. They believe that remedies directed towards expanding capacity and speeding up the design and qualification process should be considered. SIA recognizes that the success of the U.S. electronics industry depends on free international trade in semiconductors and other basic components supplying the electronics industry.

Sumitomo Metal Industries, Ltd. (SMI): SMI, a subsidiary of Sumitomo Metal Ceramics Inc. (SMCI), manufactures integrated circuit ceramic packages, and believes that the vast majority of its packages are used for non-military applications. SMI contends that the product lines that it and other Japanese suppliers offer to U.S. customers have both a wider variety of packages and more sophisticated packages than those offered by the petitioners.

SMI states that there is no credible reason to believe that Japanese companies or the Japanese government would ever take steps to artificially restrict the supply of integrated circuit ceramic packages to the United States. SMI further contends that supply by Japanese companies of integrated circuit ceramic packages to the United States presents no national security risk for the United States. They state that possible U.S. Government restriction of imports of Japanese integrated circuit ceramic packages in the name of national security will have a significant impact on the U.S. semiconductor industry.

TAB E

LABOR ASPECTS
of the
Section 232 Investigation on the Effect of
Ceramic Semiconductor Packaging Imports
on the National Security

Submitted by
The Office of International Economic Affairs
U.S. Department of Labor

July 1993

Labor Aspects of the Section 232 Investigation

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This paper addresses labor force aspects of the ceramic semiconductor package industry. Excerpts from it will become part of a full report that is being prepared on this industry by the Department of Commerce as part of a national investigation under Section 232 of the Trade Expansion Act of 1962, as amended.

On November 10, 1992, Coors Electronic Package Company and Ceramic Process Systems Corporation, both U.S.-owned domestic producers of ceramic semiconductor packages, filed a Section 232 petition. These two producers allege that imports of ceramic packages are seriously harming U.S. manufacturers and reducing domestic capacity, resulting in a situation that threatens to impair national security.

In assessing the impact of imports on national security, the Secretary of Commerce is directed to conduct an investigation of, among other factors, existing availabilities of human resources and any anticipated loss of skills in the industry. The Department of Labor was asked to address these issues in the following report, the main points of which are summarized below:

- About 20 percent of ceramic semiconductor packages sold in the U.S. are used in defense applications, from weapons systems to computers and navigational equipment. About 90 percent of ceramic semiconductor packages used in defense applications are bought from Japanese companies, raising serious concerns about foreign dependence.

- There are 33 critical occupations in the ceramic semiconductor industry, where a critical occupation is defined as essential to maintaining production and requiring a minimum of one year's training.

- Highly skilled technician/craft worker, scientist/engineer and supervisory positions represent the majority of critical occupations in the ceramic package industry. Production jobs represent only 20 percent of critical occupations, and two-thirds of production jobs are relatively unskilled positions.

- While most critical jobs are not identified as unique since counterparts exist in other related industries, there are skills, knowledge and manufacturing know-how specific to the ceramic package industry that could make reconstruction of that industry difficult in the event of a national security emergency. The rapid rate of innovation that characterizes the industry in the higher technology end of the market would add to this difficulty.

- Average industry employment has fallen by 27 percent from 1990 to present. In comparison, average employment declined by about ten percent within SIC 367 (electronic components and accessories) from 1990 through 1992; and only by seven percent within the narrower SIC 3674 (semiconductors and related devices) within which semiconductor packages are found.

- Respondents to a Department of Commerce survey most frequently attributed declines in employment to the intensity of domestic and foreign competition. Other reasons that were cited include declining sales volume, decreased revenue and falling U.S. military spending.

- While most respondents have not generally experienced labor shortages, some respondents cited difficulty finding workers with certain skills or technical knowledge specific to the industry.

Based on this evidence, the report concludes that while there currently does not seem to be great cause for concern regarding human resource deficiencies in the ceramic package industry, recent trends do point to possible future problems, especially in the event of a national security crisis. If current import trends and declines in industry employment continue and certain important domestic manufacturers are forced to pull out of the industry, the supply of workers with the required skills, knowledge and manufacturing know-how may not be adequate to meet needs in a national security emergency.

The U.S. ceramic package industry can only be viable if revenues are ample enough to support continuous investment in research and development, equipment and training that will enable advances in not only the defense market, but the commercial and dual-use ceramic package markets as well. If a positive determination is made by the Department of Commerce, the Labor Department may consider assisting in the human resource aspects of any future remedies.

Preface

In February of 1993, the Department of Commerce asked the Department of Labor to provide assistance in its ongoing investigation under Section 232 of the Trade Expansion Act of 1962 on the effect on U.S. national security of ceramic semiconductor package imports. This investigation was initiated in response to a petition filed on November 10, 1992 by Coors Electronic Package Company of Chattanooga, Tennessee and Ceramic Process Systems Corporation of Milford, Massachusetts, both U.S.-owned producers of ceramic semiconductor packages.

Under Section 232, the President is authorized to take action deemed necessary to adjust imports of a particular product if it has been determined that these imports threaten to impair U.S. national security. The Secretary of Commerce is directed to conduct an investigation, consulting with other appropriate federal agencies, and to submit a report to the President. This report should include a recommended course of action or inaction, based on the results of the investigation.

Among other factors, the statute directs that "existing availabilities of human resources" and any "substantial unemployment" or "loss of skills" should be taken into account in assessing the impact of imports on national security. The following report, prepared by the Office of International Economic Affairs, addresses the labor and workforce aspects of the national security investigation. Excerpts will be incorporated into the Department of Commerce's final submission to the President.

Section I of this report provides a brief product description and evaluates the relevance of ceramic semiconductor packages to U.S. national security. Section II presents an analysis of the criticality of skills and occupations found in the ceramic package industry and describes potential skill shortages which may be anticipated in the event of a national security emergency. Section III contains work force information, including an analysis of survey data on employment, labor shortages, average compensation and hours worked in this particular industry. Section IV reviews the history of ceramic package employees' application for Trade Adjustment Assistance. Section V contains a conclusion, with suggestions on possible Department of Labor contributions to potential remedies to be considered if it is found that ceramic package imports threaten to impair national security.

Section I: The Product

A. Product description

Ceramic packages are the visible part of an integrated circuit, providing a protective covering to the chip and enabling it to interface with the rest of the electronic circuit board. A ceramic package usually consists of several layers of ceramic material and metal conductors. After these layers are laminated and co-fired, the multi-layer ceramic becomes a monolithic body with the metallization buried in the ceramic. While the complexity of the package varies greatly with the sophistication of the chip it houses, its basic function remains the same: to enhance the thermal conducting capability of the chip (i.e., prevent overheating) and to protect it from dust, humidity and radiation.

Semiconductor packages can alternatively be made of plastic or metal, but ceramic generally provides superior performance and is therefore the preferred material when an application requires especially high hermeticity, package strength or heat resistance. Ceramic packages add significantly to the value of an integrated circuit, generally representing 20 to 25 percent of the value of the housed unit; even more for advanced, custom-made packages.

The rate of innovation in semiconductor packages is rapid, keeping apace with innovations in chip design. One of the latest advances, multi-chip modules, which house multiple chips in one package, allow for greater degrees of system integration.

Ceramic packages tend to be more expensive than their metal or plastic counterparts and represent only some 5 percent of the total integrated circuit packaging market by unit. About 20 percent of ceramic packages sold in the U.S. are used in defense applications. Packages used for defense purposes must meet rigorous qualification requirements, a process that is both timely and costly, especially for low-volume producers. Most packages are custom-designed to meet the specifications required by the customer-- usually a semiconductor manufacturer.

B. Importance of ceramic packages to U.S. national security

According to a 1990 report by the Defense Science Board Task Force on defense semiconductor dependency, electronics technology is the foundation upon which much of U.S. defense strategy and capabilities are built. Semiconductors, which could be considered the most vital building block of modern electronics technology, are widely used in weapons systems, computers and telecommunication and navigational equipment.

Because ceramic packages provide unmatched protection and durability, they are overwhelmingly chosen over plastic or metal for military-grade semiconductors, and can therefore be considered a vital part of U.S. defense capabilities. (In addition to their military relevance, ceramic packages could also be considered vital to U.S. economic security. Ceramic packages are utilized in a number of commercial or dual-use applications such as mobile telephones and personal computers.)

From chips to packages on down to the finished systems, the various industries that comprise the U.S. defense industrial base are closely interdependent. Weakness anywhere in this chain of manufacturing could have serious ramifications and consequences in the event of a national security crisis. Should the U.S. lose the skilled workforce, manufacturing base and technology necessary to make ceramic packages and become entirely dependant on foreign sources, the semiconductor and other downstream industries would be vulnerable to foreign supply restrictions or interruptions.

While the highest volume of the defense market for ceramic packages tends to be in lower technology packages, defense needs are also driving the high-tech end of the ceramic packaging industry. Ceramic package manufacturers need to have strong footing in the high volume, low-tech end of the market in order to support the investments in research and development necessary to keep up with innovations in high-tech packaging.

At present, the U.S. already relies heavily on foreign sources for the ceramic packages used in many of its defense systems. The vast majority of ceramic packages used in U.S. defense applications is produced by foreign corporations. Kyocera of Japan and Kyocera America, based in San Diego, together supply the majority of U.S. defense ceramic package needs, with less than 25 percent coming from Kyocera America. While Kyocera America claims to be a dependable "domestic" supplier, questions arise concerning Kyocera America's independence from its parent company and its ability to independently maintain production in the event of a crisis situation.

One source of such concerns is the fact that Kyocera America imports all of its "green tape"-- the unfired ceramic material from which the packages are made-- from its parent company in Japan. The quality of green tape varies greatly, depending on its chemical make-up. If Kyocera America is required to make its own green tape or find a U.S. supplier, at least three to six months would be required to re-tool and integrate a new type of green tape into the overall production process. The reliability of Kyocera America is a key aspect of this investigation, and raises the sensitive issue of to what extent foreign-owned corporations in the U.S. that produce strategic products should be considered "domestic".

Section II: Occupational Skills Analysis

The information in this section is based on a survey of U.S.-based ceramic package producers conducted by the North Carolina Occupational Analysis Field Center of the Employment Security Commission of North Carolina (NC OAFC). The purpose of that survey, the results of which are summarized in the Field Center's Criticality Study (see Attachment A), was to identify critical occupations as well as skills that are unique to the ceramic semiconductor package industry.

Five producers returned a completed survey form to the NC OAFC out of eleven firms surveyed. (One of the firms that did not complete the survey indicated that it no longer produces ceramic semiconductor packages.)

A. Critical Occupations

For the purposes of this investigation, a critical job is defined as one that is essential to maintaining production and requires a minimum of one year's training before a worker can effectively perform duties and responsibilities of the specific position. Based on this definition, there appear to be 33 critical jobs in the ceramic packaging industry; including twelve engineering and scientist jobs, five supervisory/managerial jobs, nine technician/drafters/designer jobs and seven production line jobs. (See Attachment B for a listing of critical jobs broken down in this manner).

These positions are critical in that should a national security emergency call for a substantial ramping up of capacity or re-creation of once-existing capacity lost due to imports, extensive training would be required of new hires. Most critical jobs in the ceramic package industry are in technical and highly skilled occupations. Only 20 percent of critical jobs are in production line jobs.

Critical **engineering/scientist** jobs require at least a bachelor of science degree in an engineering or scientific field. New hires with degrees at this level but no prior work experience typically require up to five years[1] of on-the-job training (OJT) to be fully proficient, with many jobs requiring four to six

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[1] The NC OAFC expresses the amount of on-the-job training needed for job proficiency as a range, which is often quite broad. For example, the amount of training required for a manufacturing engineer with no prior job experience varies from three months to six years. The maximum amount of training listed to become proficient in each occupation is used as the indicator of the criticality of the job, and is averaged over the occupational grouping to derive the typical figures mentioned in this analysis.

years of training and some as many as ten years. Engineers with work experience in a related industry typically require up to two years of OJT, with some requiring up to four years.

According to the criticality study, most **managerial/supervisory** jobs, as well as some support positions in professional and production areas, could be considered "critical" to the ceramic package industry in that they require "extensive and/or specialized training and education." The study did not, however, include all of these jobs in its list of critical occupations. Only five of these positions, including industrial organization manager and production superintendent, were cited in the study because they require particularly extensive training and technical knowledge of the production process. For the most part, these jobs necessitate a bachelor's degree (some an MBA). They also typically require up to eight years of OJT for an individual with no relevant experience. For a new recruit with related experience, up to five years of OJT are needed.

Critical **technician/drafters/designer** jobs include positions such as computer-aided design technician, electronic drafters, quality control technician, and calibration laboratory technician. These jobs require an associate degree from a technical school or some type of technical training beyond high school and up to six years of OJT for a worker with no prior experience. Many of these occupations are apprenticeable. For one job listed, machinist, up to ten years of OJT is needed to reach full proficiency.

Critical **production line jobs** include kiln technicians, paste maker and plater. Most of these jobs are unique to the ceramic semiconductor package industry, and can require up to four years or more of OJT to be fully proficient. Certain industry estimates indicate that about two-thirds of the production work force is in relatively unskilled jobs.

The NC OAFC assigned a Specific Vocational Preparation (SVP) value to each critical occupation that closely resembled an occupation listed in the **Dictionary of Occupational Titles** (DOT). The SVP is defined as "the amount of time required by the typical worker to learn techniques, acquire the information, and develop the facility needed for average performance" in a specific occupation. SVP includes vocational education, apprenticeship training, in-plant training, OJT and essential experience in other jobs. DOT definitions existed for all but seven of the critical occupations. The average SVP value for those occupations was slightly over seven on a scale from one to nine. The seven rating means that a worker would require over two years and up to four years of SVP before being able to perform satisfactorily on his/her job.

B. Skills Analysis

The analysis of the occupational skills data conducted by the NC OAFC indicates that most of the positions identified as critical are not unique "in the strictest sense." For most of these jobs, workers with similar skills can be found in related electronic components industries. These workers, under ordinary conditions, could theoretically be retrained to jobs in the ceramic package industry, and would require substantially less time to retrain than would hiring and training inexperienced workers.

Even skilled workers transferred from related industries, however, would require a significant time investment to become fully proficient in the ceramic package industry. In addition, during a national security emergency, it is likely that these related industries would also experience a demand surge, greatly reducing the supply of workers with similar skills.

Despite the existence of counterparts for most critical jobs, the criticality study concludes that knowledge and skills specific to this product and industry do exist. This is especially true in occupations related to research and development, design and manufacturing processes. A substantial amount of technical knowledge and manufacturing know-how is essential for effective production of ceramic packages. The industry is also characterized by a rapid rate of innovation and ever-increasing customization. If the U.S. loses its ceramic package industry, the resulting loss of human capital with the requisite technical knowledge and manufacturing know-how would make the reconstruction of state-of-the art production capabilities extremely difficult.

Section III: Work Force Data

No specific data on the ceramic package industry are available from the Bureau of Labor Statistics (BLS). Standard Industrial Classifications (SIC) correspond only to selected broad industry groupings. For the purposes of this report, all work force data is compiled from a Department of Commerce survey of known U.S.-based producers, but BLS data on SIC 3674 and SIC 367 are used for comparison, where useful. Ten ceramic package producers completed the employment portion of Commerce's survey out of a sample size of 12 producers.

A. Industry employment

The survey data in Table 1 show that the ceramic semiconductor package industry employed close to 4.8 thousand workers in both 1990 and 1991. This represents the peak employment level for the period covered by the survey. The total employment figure for 1991 masks a trend of declining employment that characterizes this entire period. While most firms surveyed did decrease or stabilize employment from 1990 to 1991, the entry into the market of a new company that year raises the 1991 figure to slightly above the 1990 level. Total employment declined by 21 percent from 1991 to 1992, and by a further seven percent from 1992 to 1993 estimates. The total decline during the survey period is 27 percent.

Table E-1
Average Industry Employment, 1990-1993*

	1990	1991	1992	1993*
Production	2,709	2,736	2,117	2,335
Admin.	807	770	535	387
Scientist/ Engineer	1,136	1,135	961	623
Other	137	154	152	148
Total	4,789	4,795	3,765	3,493

* 1993 data is year-to-date through June

The declining employment in the ceramic semiconductor package industry exceeds decreases that occurred in SIC 3674 (semiconductors and related devices) from 1990 through 1992. According to data from the BLS Current Employment Statistics Survey, average employment in SIC 3674 declined by about nine percent from 1990 to 1992, compared to 27 percent in the ceramic package industry.

Respondents listed a variety of reasons for declining employment during this period. The most frequently cited reason, noted by three respondents, was the intensity of domestic and foreign competition in the ceramic package industry. Other reasons, each noted by two respondents and often inter-related, were: declines in demand, reductions in U.S. military spending, increased productivity brought about by automation, decreases in sales volume or revenue, and the exit from certain high-volume markets.

The preponderance of high-skilled jobs in the ceramic package industry is in certain production-related technical jobs and engineering/scientific positions. Using a rough estimate given by industry representatives that about one-third of production jobs are highly skilled, about 1400 jobs, or forty percent of the total work force, are currently in these high-skilled production or engineering/scientist positions.

When industry employment is broken down into occupational groupings, the decline in employment is not equally distributed among each area. The biggest decline over the survey period, 52 percent, was experienced by administrative staff. This large decline reflects a general trend across manufacturing and service industries during this period of significant corporate streamlining of white collar workers, as well as the above factors. The next biggest decline was in engineer/scientist positions, with a 45 percent decline over the survey period. This may reflect a paring down of research and development activities as reductions in military spending reverberated through the chain of defense contractors and subcontractors, and sales volumes or revenues decreased. Production workers declined by only 14 percent, while the "other" category, which includes sales and marketing positions, actually slightly increased, by eight percent.

B. Labor shortages

Most firms surveyed have not experienced any labor shortages in the past five years. The recent recession and relatively slow rate of job creation during this period have probably contributed to the relative ease with which firms have found employees with suitable credentials. A few respondents, however, did indicate some problems finding employees for certain highly skilled occupations, especially engineer positions requiring specialized knowledge (such as ceramics metallization) specific to the ceramic semiconductor package industry. One respondent expressed a concern that shrinking market share due to foreign competition could lead to certain skill shortages in the future.

C. Production worker compensation

Hourly earnings in 1992 for production workers varied from $6.87 to $12.56, with an average of $10.01 for the ten respondents. Hourly earnings averaged $10.46 for the current year, representing a 4.5% increase from 1992.

Average hourly earnings in 1992 for SIC 3674, at $13.80, were 38 percent higher than in the ceramic package industry. This can be attributed at least in part to the fact that wages in the semiconductor industry tend to be higher than wages in the semiconductor parts and devices industries. Average hourly earnings for the broader industry grouping, SIC 367 (electronic components and accessories), $10.90 on average in 1992, are more in line with wages in the ceramic package industry.

The table below lists average annual compensation amounts for production workers in the ceramic package industry. Annual compensation includes health care costs, paid sick leave and vacations and holidays.

Table E - 2
Average annual compensation, 1990-1993*

1990	1991	1992	1993(est)
$23,732	$24,545	$26,090	$27,290

*1993 data is year-to-date through June

Average annual compensation increased most rapidly, at 15 percent, from 1990 to 1991. From 1991 to 1992, average annual compensation rose by six percent, and the increase is expected to be only 4.5 percent from 1992 to 1993.

D. Average weekly hours-- production workers

During the period from 1990 to 1993, the average work week for production workers increased each year. From 1990 to 1992, the yearly increase was one half of an hour. From 1992 to 1993, the increase is slightly less. These increases in average weekly hours indicate that as industry employment declined, those production workers remaining tended to work longer hours.

Table E - 3
Average weekly hours worked, 1990-1993*

1990	1991	1992	1993*
41	41.5	42	42.3

* 1993 data is year-to-date through June

E. Unions

Production workers are organized in only one of the ten firms manufacturing ceramic semiconductor packages that responded to the survey. These workers are represented by the Allied Industrial Workers and the International Association of Machinists and Aerospace Workers.