AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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BATCH #43

1. SUBJECT CLASSIFICATION
A. PRIMARY: TEMPORARY
B. SECONDARY:

2. TITLE AND SUBTITLE
Study of the use of substitute materials in lesser developed countries, final report

3. AUTHOR(S)
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(101) Southwest Research Inst.

4. DOCUMENT DATE: 1976
5. NUMBER OF PAGES: 170 p.
6. ARC NUMBER: ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
SWRI

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

A review of possibilities for substituting indigenous raw materials for imported materials in six LDCs: Bolivia, Ghana, Guatemala, The Philippines, Tanzania, and Thailand. The candidate materials discussed include energy materials, paper and paperboard, concrete, iron and steel, fertilizer materials, gypsum-based materials, ceramics, animal feed materials, and bamboo. All of those are producible through established technologies, using resources indigenous to the countries. However, their production depends on many unanswered questions related to technical, economic, societal, and political factors. This initial identification of candidates for substitution is but a short first step. Questions of feasibility and benefits/costs need to be included in a plan for identifying and assessing specific import substitutions. This will provide a system or procedure for jointly assessing the substitution's desirable and undesirable features with appropriate groups, institutions, and decision-makers.

10. CONTROL NUMBER
PN-AAC-818

11. PRICE OF DOCUMENT

12. DESCRIPTORS

13. PROJECT NUMBER

14. CONTRACT NUMBER
AID/ta-C-1245 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

STUDY OF THE USE OF SUBSTITUTE MATERIALS IN LESSER DEVELOPED COUNTRIES

by
J. E. Funnell
E. J. Wolfe

FINAL REPORT
Contract No. AID/ta-C-1245
SwRI Project No. 02-4439

Prepared for
Agency for International Development
TA/OST
Washington, D. C. 20523

August 1976

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO CORPUS CHRISTI HOUSTON

PN-AAC-818
AID/ta-C-1245 Res.

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Approved:

U. S. Lindholm, Director
Department of Materials Sciences

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I. SUMMARY

Title: Study of Use of Substitute Materials in Lesser Developed Countries

Time Period: Three (3) Years

Total Estimated Cost: Approximately $281,000, first two years

Proposed Contractor: Southwest Research Institute
P. O. Drawer 28510
San Antonio, Texas 78284

Proposed Investigators: J. E. Funnell (Principal)
D. L. Black
E. J. Wolfe

Introduction: The proposed study is designed to establish the economic and technical basis and rationale for designing projects in materials substitution for developing countries. It will couple areas of high foreign exchange expenditures due to raw and semi-finished materials importation with techniques and processes that offer the potential for converting locally available materials into usable substitutes for the imported materials. This is expected to provide a systematic means of identifying substitution opportunities based on developing country needs which result from high foreign exchange expenditures or large volume of imports. In order to establish and verify the efficacy of this approach, one or more projects will be designed to analyze, test and provide the basis for the substitution of selected indigenous or other more appropriate materials for more costly imported materials. Successful substitution is expected to result in one or more of the following: lower capital and/or manufacturing costs, lower energy demands, better utilization of local labor and resources, and better access by the poorer segment of the population to materials appropriate for use in houses, roads, water and sewage systems, and other basic necessities.

II. RESEARCH PURPOSE AND EXPECTED PRODUCTS

A. Purpose

The purpose of this research is to provide an objective analysis of materials technology with respect to its possible application to reducing selected imports of developing countries by replacing them with materials and products that may be produced from indigenous resources. This will provide a basis for designing projects which take advantage of existing knowledge and of recent research and developments in the materials technology field, and which identify, analyze, appraise and test materials substitution possibilities. The general goal is to provide a technical basis for reducing LDC foreign exchange expenditures for imported materials through the use of more appropriate substitutes.

B. Expected Products

The principal products of this program will be 1) a systematic methodology for surveying the spectrum of materials substitution possibilities in developing countries, 2) a procedure for identifying substitution possibilities that are more relevant to developing country needs, 3) a basis for recognizing substitution opportunities among the possibilities and assigning priorities to those that hold particular promise for reducing foreign exchange expenditures for imports, and for identifying areas of deficiency and items in need of research, and 4) guidelines for the design of projects to analyze, test and undertake actual substitution of selected indigenous or other more appropriate materials for more costly imported materials.

The first product (above) will provide guidelines for linking imported materials with indigenous raw materials and techniques and processes for their conversion to substitutes for the imports. The second product narrows the field of substitution possibilities by screening the findings obtained for the broader range of possibilities, and identifies substitutions that are attuned to the needs of the developing country, as, for example, the alleviation of needs for imported fuels, or need to establish industries that make goods more available to the poorer segment of the population and provide employment. The third product continues the narrowing process and allows priorities to be placed on substitution possibilities so as to rank them according to the degree to which they hold promise for reducing foreign exchange costs for imports and/or reducing import volumes. A further objective is to provide a procedure for bringing into focus the capabilities and facilities required to produce the substitutes, based on the application of appropriate technology. The fourth product makes possible the orderly undertaking of projects to pursue the best substitution opportunities.

III. SIGNIFICANCE AND RATIONALE FOR THE RESEARCH

As nations develop, demand for the products of the industrialized nations rises sharply. Most developing nations have difficulty in satisfying this demand without creating a serious drain on their foreign exchange reserves. Many nations have attempted to mitigate this problem by importing the technology required to produce the manufactured goods in greatest demand. Unfortunately, the imported technologies are often designed for conditions which prevail in the countries where they originated. They are likely to be capital intensive and based on resource availability and materials of accepted usage in those countries. As a result, the developing nations receive only partial satisfaction for their efforts when they find it necessary to import the raw or semi-finished materials required for the basic manufacturing industries.

Materials substitution has several advantages in addition to saving of foreign exchange. Locally made materials frequently offer significant cost advantages which permit greater availability of products internally, as well as increasing the possible competitive position on the world market. The use of locally obtained raw materials or intermediate products can create new industries that will generate local capital and increase employment. Also, the value added by manufacturing will reside in the locally made materials instead of having to be paid to a foreign producer whose goods were imported and which might even have had their origins in raw materials obtained from the developing country.

All developing nations import some raw materials. Some import raw materials which could be produced locally, but are not, for a variety of reasons. Some of these reasons are that the sources of local materials have not been discovered; the deposits have not been exploited; or the materials have not been identified as possible substitutes for the imported materials. The potential benefit of substitution and the interest of developing countries in it depend to a large degree upon the cost differential between imported materials and substitutes for them, plus the quantity of the imported materials consumed which determines their cost in terms of foreign exchange. One of the important early steps in this study will be to identify areas of materials substitution in which potential benefits are significant.

In recent years, there has been a noticeable trend away from materials specifications to performance specifications for use in many applications in areas of construction and manufacturing. Thus, in a given situation, the potential exists to substitute one material for another, provided the end product satisfies service and performance requirements. Much is known of thousands of different materials and products and how they behave and perform under the familiar conditions of particular applications. However, this knowledge provides only guidelines that have been established from many case histories of the use of materials of known properties and functional capabilities under reasonably well comprehended service conditions. Where the use of alternate materials is contemplated for those service conditions, detailed analysis and evaluation of the substitutes' suitability must be undertaken. The analysis and evaluation task becomes more

involved for developing countries that become interested in broad-scale import substitution; this is because the possibilities and opportunities for substitution will need identification and locally available materials suitable for use in each application will have to be found.

In addition to the potential for direct economic savings from substitution, due attention should also be given to identifying substitute materials that require less energy in their production than imported and/or presently used materials and products. This would increase economic savings even further by reducing the need for and dependence on foreign energy supplies.

Materials can be converted to usefulness by numerous mechanical, physical, chemical, and thermal procedures and processes. All of these require energy in some form and amount. For some the finite energy needs for conversion are relatively low, as, for a very simple example, in the harvesting of palm fronds and their use as roofing material. For others the energy requirements are high, as in the mining and conversion of iron ore to metallic iron and steel, or the production of burned brick from clays. In each of these cases, there are alternatives. For example, many materials can be used interchangeably in various types of roofing systems, and some of the demands for iron and steel can be satisfied with wood, concrete, plastics or other materials. Similarly, burned clay brick can be replaced in many instances with stone, adobe shapes (adobe can be stabilized by the addition of an emulsified bitumen), or concrete shapes, or autoclaved calcium silicate building products; all of these are less energy intensive than burned clay brick. The technologies for

accomplishing any of these substitutions are well known and commercially developed. Even so, the basic raw materials to be used in substitution must exist, their presence known, and their general characteristics determined before they can be considered for utilization.

The matter of what can be substituted for what poses numerous questions, as inferred above. These must be answered in order to satisfy technical, economic, commercial, and other requirements. In addition, consideration must be given to the capabilities for undertaking the kinds of activities necessary in substituting locally produced--or producible--materials for imports. If the capabilities are lacking, then they must be acquired or developed. An economic imbalance resulting from an excess of foreign exchange costs for imports over foreign exchange receipts for exports can provide the stimulus for doing this. Determination of where the best contributions can be made requires examination of the situation in any given country, specifically with regard to the nature and amounts of imports, the resources available to provide a base for producing substitutes for selected import items, and the technical and economic requirements for the substitution.

As indicated above, many specific possibilities for materials substitution have already been identified and examined. Almost all of these were first identified as a result of investigations concerned with specific products or materials. There has been no indication of comprehensive or systematic attempts to identify substitution opportunities based on developing country needs that are or can be directly related to high foreign exchange expenditures or large volume of

imports. What is needed, therefore, is a systematic survey of the entire range of substitution possibilities using as criteria for assigning priorities the level of foreign exchange expenditure and raw material availability. The knowledge thus gained will aid in identifying where the greatest potential for research in materials substitution lies, and in planning and designing projects which will explore those opportunities in detail.

IV. PLANS TO COORDINATE AND LINK RESEARCH--INCLUDING NETWORKS

Under its mandate to explore, on a selective basis, technological innovations that can greatly reduce the costs of economic infrastructure activities that are heavy users of public funds of the developing countries, the Office of Science and Technology has developed and managed several related projects which not only provide useful background data for this project, but which have developed linkages that will be useful in follow-up projects. Three projects which have been and/or are the most closely related are Sulfur Surface Bonding, Low Cost Roofing, and Reducing Cost of Public Works Construction. The first two deal directly with selected substitute materials and the third explores various opportunities for reducing costs of public works,including the substitution of less costly and/or locally produced materials. In addition to these projects are university grant programs that deal with industrial development in developing countries. The many foreign linkages that have been developed through these and other projects will be useful sources of data initially, and later will be potential sources of collaboration during testing of the findings and utilization of the results.

AID has some sixty engineers in field posts throughout the world, many of whom have had direct experience in the materials field. These engineers will be consulted and asked for advice at regular intervals. They will be the chief source of liaison between the contractor and the missions and country or regional counterparts during any field testing that is conducted as a follow-up to this study.

Southwest Research Institute, through years of work in product development and evaluation, process studies, industrial development programs, and other activities in the materials area, has also developed numerous linkages, both in the U.S. and abroad, which will aid in collecting data and developing a plan. The Institute has been the principal sponsor of a series of Inter-American Conferences on Materials Technology held to bring together specialists in this area from throughout the Western Hemisphere. In other activities, members of the Institute's staff have participated in programs for the United Nations in technology transfer in metallurgy and other materials areas throughout the world. Through its work in AID projects in Latin America and Africa, the Institute has made numerous contacts in a number of countries and had conferences with individuals and groups in governmental, institutional, research and industrial sectors; this is a continuing activity. Additionally, members of the Institute's staff have engaged in many projects for industries in developing countries, and they have also developed professional relationships with individuals in research and educational areas.

Appendix I contains a list of descriptive titles of some current and past projects of the Institute which relate to potential areas of materials substitution. The sponsors of these projects, and the recipients of the results already form an informal network of common interest which could be exploited later.

V. PLAN TO FACILITATE UTILIZATION OF RESULTS

The results of this study will provide the basis for the design of one or more projects to test the findings and stimulate utilization of the results among the LDCs. One example of a materials testing and utilization methodology which may be applicable has already been employed in the Sulfur Bonding Project. In this project, sulfur has been substituted for mortar in block wall construction, but with a different method of application. In order to test this method in a development setting, the project has undertaken the construction of test houses in selected developing countries. Economic and social data are collected during and for one year following construction. Results of the construction portion of Phase I indicate that the necessary test data can be obtained by this method and the completed houses provide visible evidence of achievement which in turn stimulates further interest in utilization.

The interest, participation and assistance of developing country personnel will be important to achievement of objectives, to the completion of the project and to the utilization of project findings. It is anticipated that information will be needed on such subjects as imports, resources, manufacturing capabilities and types, research facilities and personnel, infrastructure, and so forth; this may be available from local sources in developing countries. Also, a reasonable expectation is that training of local staff may be required in follow-on projects for analyzing and field testing of substitution opportunities. Further, it is

probable that regional demonstrations, workshops, and training sessions will be employed to transfer technology and acquaint professionals and others in developing countries with strategies, concepts methodologies, problems, and needs in identifying, evaluating, and pursuing materials substitution opportunities.

VI. MANAGEMENT CONSIDERATION

Technical management for this project will be by the AID Technical Assistance Bureau's Office of Science and Technology. Through the design and management of several closely related projects described in Section IV, TA/OST has gained considerable insight and experience in the public works and materials area that is directly applicable in this project.

The Office of Engineering, which will collaborate with TA/OST in the design and evaluation of this project, also has had extensive experience in this area. Engineers in the Office of Engineering have had years of practical experience in solving engineering problems in developing countries. Many of these problems have, by necessity, involved the substitution of materials.

The proposed contractor, the Southwest Research Institute of San Antonio, Texas, had had direct experience in studies involving materials substitution over the past twenty-five years, the bulk of which has dealt with engineering materials such as concrete, metals, sulfur, plastics, glass, and others. Some work has included the use of locally available materials as partial or total replacements for more costly, problematic, or less available ones. Among these have been cases that dealt with 1) using a natural pozzolanic material to replace up to 25% of the portland cement normally used in structural concrete, 2) using lignite in lieu of wood for the manufacture of activated carbon, 3) using sulfur to replace cement mortar as a bonding agent in building construction, 4) using the sap from Ponderosa pine trees instead of that from long leaf and other pine species for

production of turpentine and other naval stores materials, 5) using ceramics and polymers instead of metals for the fabrication of bone implants, 6) using hydrothermally cured building products to replace burned clay brick and tile which require much higher energy to manufacture, 7) using lightweight aggregates in concrete to decrease loads on structure, with attendant reduction in steel requirements, 8) using sun-cured stabilized adobe building brick and block in lieu of other construction materials, 9) using plastics for production of synthetic marble and porcelain enameled steel sanitary ware (bathroom wash basins), and 10) using a wide variety of industrial and mineral wastes for making products to substitute for numerous materials either imported or available only at higher costs, and others. All of the preceding required the use of existing knowledge in areas of materials technology, processing, and research methodology, and often employed multidisciplinary and interdisciplinary know-how and experience.

Southwest Research Institute is well qualified to conduct the proposed program for AID by reason of its contacts generated in the Inter-American Conferences on Materials Technology, its work for the United Nations in technology transfer, the experience gained in Latin America in the Sulfur Surface Bonding Project, and the numerous past programs that it has carried out involving the use of existing knowledge to develop and use substitute materials. Further, the multidisciplinary makeup of the Institute's staff makes available a broad spectrum of capabilities, experience and knowledge for undertaking studies of virtually unlimited variety in the area of materials science and engineering, which encompasses materials substitution. Also, the Institute has extensive facilities

for undertaking investigations concerned with the occurrence and properties of raw materials, their treatment and processing for conversion to useful products, the design of processes and products, and determination of the economics of materials, processes and products. In view of these attributes and its reputable standing gained over nearly 30 years of activities in the materials technology field, it is felt that the Institute merits consideration as a sole source for procurements that develop in the area of materials substitution in developing countries, particularly as related to this report.

VII. TECHNICAL REVIEW

Import substitution as means of reducing foreign exchange outflow has been pursued on a policy basis in many developing countries for inducing domestic production through fiscal incentives, including tax exemptions, subsidies and tariff protection. The policy aims to ease the foreign exchange constraint facing developing countries by reducing import expenditures. Instead of importing a given commodity the country attempts to produce the commodity itself. Import substitution recently became a factor in Venezuela's industrial development program[1] and for a number of years has played a major role in Thailand's economic development strategy. One recent project involving replacement of imports by domestically made products established an electrolytic tinplate plant in Thailand to supply can-making materials to that country's large food processing industry; markets are both domestic and foreign. Another case of import substitution was Colombia's development of palm oil production beginning about 1960 to replace imported edible oils. This involved the planting of African oil palms and the eventual establishment of a palm oil industry based on acquired knowledge of appropriate technology.

The Thailand example reflects materials substitution wherein the utilization of an indigenous raw material (tin) made possible the replacement of

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(1)Dr. Rafael Sandrea, Foundation for Research and Industrialization, Caracas, Venezuela, at National Academy of Engineering/National Academy of Science Conference on Materials and the Development of Nations, Washington, D.C., April 28-29, 1976.

an import with a domestically made product (tinplate/tinsheet). The palm oil project in Colombia, while not based on a native raw material but rather on the exploitation of an introduced resource, accomplished a similar purpose. The economic aspects of these two programs are not fully known, but it is reasonable to assume that they were appraised ahead of any actual implementation of plans and found to be favorable. The concept of using indigenous materials through appropriate means and technology to provide domestically produced substitutes for imports would therefore appear to be a viable approach to economic development in developing countries. Whether the import substitutes are entirely consumed domestically or,once home demand is satisfied, partly exported, is indicated to be less important than whether their production serves to stem foreign exchange expenditures and, at the same time, expands the industrial base, and improves the quality of life, all over a sustained period. At present, the upsetting effects of high costs of imported energy materials, as compared to three (3) years ago, is an added stimulus to import substitution, especially where alternatives exist between low-energy intensive products and high-energy intensive products. The matter of what substitutes may be made for imports on a basis that is technically and economically feasible and practicable, and which is socially, politically and traditionally acceptable obviously requires considerable study. Also, the criteria for appraising and judging how well a given substitution meets these requirements need to be identified and defined in the light of a given country's situation.

Information on types and costs of developing countries' imports can provide a partial basis for selection of materials which, because of their high cost in foreign exchange, are candidates for substitution. If types of imports and the basic materials composing them can be correlated with resources of the countries, the basis for selection may be strengthened. Beyond this, detailed information on many technical and economic facets of individual substitution candidates must be utilized in making more complete appraisals of the possibilities. A portion of this information pertains to the technologies, methodologies, processes, and other means by which materials are extracted, refined, purified and converted to their first marketable form.

The following sections review and discuss the imports and resources of a number of developing countries and discuss the state-of-the-art and technology of materials substitution within the framework of the multidisciplinary field of materials science and engineering. The role of economic and other non-technical considerations in the state-of-the-art of materials substitution is recognized though not discussed in significant depth because they may not be the same from one situation to another. From an original eleven (11) lesser developed countries (LDCs) which were considered for review, six (6) were selected among the LDCs in Africa, Latin America and Southeast Asia. These six (6) are Ghana and Tanzania in Africa, Bolivia and Guatemala in Latin America, and The Philippines and Thailand in Southeast Asia. Although lying in widely separated areas of the world and having numerous distinctly different features, they are similar in many respects, particularly in terms of growing

populations, low gross national product (GNP) per capita, undeveloped resources, and the need to expand industrially and improve the quality of life.

A. Imports of Lesser Developed Countries

1. Value

Of the six (6) LDCs for which information was reviewed, one (1) imported materials and goods in 1973 with a value in excess of $2 billion (Thailand, at $2.09 billion) and another had imports valued at well over $1 billion (Philippines, at $1.6 billion). In 1974, total Philippine imports had a value almost twice that for 1973, reaching $3.1 billion. The total value of 1973 imports for the other four (4) counties were in the range of nearly $250 million to over $400 million--Bolivia, $249.5 million; Ghana, $426.7; Guatemala, $431; and Tanzania, $439.5 million. However, if the increases for 1974 over 1973 followed a pattern similar to that of the Philippines, then the total value of imports for the five (5) other LDCs can be presumed to have increased markedly. This presumption is supported by data showing that the value of materials and goods imported by practically all of the six (6) LDCs from the United States in 1974 was higher than in 1973, being more than triple in the case of Tanzania, almost double for Guatemala, and 77% higher for Thailand. In all except Bolivia, the increased costs of imported mineral fuels--petroleum and petroleum-based items--have impacted heavily and caused inordinate drains on foreign exchange, beginning in late 1973. For example, mineral fuels, lubricants and related materials accounted for nearly 21% of the value of all Philippine imports in 1974.

2. Types of Imports

Imports of the six (6) LDCs, as indicated by available data, include an extremely broad spectrum of goods and materials. Those obtained from the United States are identified in the ten (10) Commodity Groupings of the Schedule B Code published by the U.S. Department of Commerce's Bureau of Census. These groupings are:

000 Food and Live Animals
100 Beverages and Tobacco
200 Crude Materials - Inedible, Except Fuels
300 Mineral Fuels, Lubricants, etc.
400 Oils and Fats - Animal and Vegetable
500 Chemicals
600 Manufactured Goods by Chief Material
700 Machinery and Transport Equipment
800 Miscellaneous Manufactured Articles, N.E.C.
900 Items Not Classified by Kind

None of the few import listings obtainable from LDC agencies contacted in the U.S. was as detailed as the Schedule B Code lists that cover this country's exports with regard to kinds of goods and materials and their values. Also, information on the types and values of the LDC's imports from other countries was not readily available. Therefore, such listings of imports as were obtained provided only a part of the picture and, in some cases, a very small part. For example, only 3.1% of Tanzania's total imports in 1973 were supplied by the United States; for the other LDCs the percentages were: Guatemala-31%, Bolivia-28.3%, Philippines-28.1%, Ghana-16%, and Thailand-14%. The Schedule B Code lists 163 major commodity groupings and 268 sub-groupings for Philippine imports from the United States in 1974, but that accounted for only about 23% of the total Philippine imports from all countries

in that year. This represented the widest variety of goods and materials imported from the United States by any of the LDCs. Unknown Philippine imports undoubtedly were in the same categories as many of the items in the Schedule B Code groupings. Besides these, it can be assumed that some of the imports from other countries included items not obtained from the United States, among which are petroleum and related products. All things considered, listings of goods and materials imported from the United States by the LDCs are believed to provide a somewhat limited view of the total import picture, except for those cases in which such listings account for significant proportions of their total imports. A more complete picture would be necessary for comprehensive appraisal of substitution possibilities and identification of opportunities for high pay-off. It seems likely that an effective means for obtaining this would be through a cooperative effort with appropriate agencies in each of the LDCs.

Appendix II contains tables of data on the LDCs imports from the United States in 1974, by commodity groupings and value; also there are two tables from agencies of the Philippines (1974) and Thailand (1972-73) that list imports of those countries by commodity categories and value. Summaries of information on the six (6) LDCs reviewed for imports, resources, present state of industrialization, and import substitution possibilities are presented at the end of this section, after the following product/source materials correlations.

The imports of the LDCs cover a wide spectrum of foods for which the basic materials are easily identifiable--animal meats, dairy and poultry

products, cereal grains, fruits, beans, fish and shellfish, animal feedstuffs, etc. For imported wood pulp, paper and paperboard the basic raw materials are trees (mainly long fiber softwoods); however, paper making consumes substanti .l energy and considerable amounts of chemicals, including lime, sodium compounds, and others. Fertilizers are based on phosphate rock, potash (potassium mineral salts) and nitrogen; the bulk of the nitrogen produced today is based on natural gas, though coal is also a basic material of importance. Sulfuric acid and/or phosphoric acid are used for making regular superphosphate and triple superphosphate. Thread, yarn and textile fabrics are based on both natural cellulosic fibers, manmade cellulosic fibers, and noncellulosic manmade fibers. Cellulosic fibers are based on natural cellulose materials such as cotton, straw, wood, etc. The more common noncellulosic fibers are or can be based on petroleum, natural gas, coal, vegetable oils, etc. Primary iron and steel production requires iron ore either of acceptable equivalent iron content as-mined or amenable to beneficiation, limestone or dolomitic fluxstone, coke (from coal) or even charcoal (from wood) and much energy. Clay products and industrial refractories are based on fireclays (with aluminum oxide often added), kaolin, bauxite, magnesium minerals (or magnesia from seawater or brines), chrome ore, silica or quartz, kyanite, and other materials; the specific refractory application defines the raw material requirements. Organic and

inorganic chemicals, usually imported in large quantities, are based on numerous raw materials and need to be individually identified in order to determine traditional or conventional source materials. However, many organic chemicals are derived from petroleum and natural gas, coal, wood and agricultural materials. Many inorganic chemicals are based on sulfur, salt, limestone, various metallic mineral ores, phosphate rock, boron minerals, fluorspar, and others. Glass and glassware typically are made from high purity silica sand, limestone and/or dolomitic limestone, and sodium compounds (carbonate and sulfate), plus small amounts of special inorganic ingredients; energy requirements are relatively high. Ceramic sanitary ware (sinks, toilets) are based on feldspar, silica, kaolin and special, high-strength, white-firing clays. Numerous metal items can be related to their basic raw materials by their identifying names--copper wire, lead and lead alloys, zinc metal, tin plate and tin coated sheet, etc. Aluminum products are based on bauxite which is the common source of aluminum oxide; aluminum is highly energy intensive. Machinery, boilers, motors, road motor vehicles, railway locomotives and cars, aircraft, etc. are finished items based on many raw materials. For these, the realistic approach would be to associate individual components with basic raw materials.

Summaries follow for the six (6) LDCs reviewed. These show profiles with regard to area, population, Gross National Product (GNP), etc.; imports/exports, major trade partners, imports susceptible to substitution, and resources. The data and information given are for years covered by available published statistics and literature.

BOLIVIA

A. Profile

°Area: 424,000 square miles (compares to the total combined area of Texas, Oklahoma, Arkansas and Louisiana)
°Population: 5,329,000 (1973)
°GNP (1973): $1,185,700,000
°GNP per capita: $222
°Labor Force: 2.5 million (1973) of which 69% are in agriculture.

B. Imports/Exports

°1973:	Exports	-	$268,300,000
	Imports	-	249,500,000
	Balance	-	+$ 18,800,000

°Major Trade Partners (1973

Exports: United States, 24%; United Kingdom, 41%; Latin American Free Trade Association (LAFTA), 12%.
Imports: United States, 28.3%; Japan, 17.1%; LAFTA, 13.5%.

Note: Bolivia is a land-locked country with no direct access to the sea. Transportation, therefore, constitutes a large portion of the cost of imports and exports.

°Imports Most Susceptible to Substitution

Paper and Paper Products (Based on 1974 imports from U. S. only.)

...Pulps and waste paper	$ 530	
...Paper and paperboard	814,437	
...Paper, paper pulp and paperboard articles	188,136	
	$1,003.103	(1,318 tons)

BOLIVIA (Continued)

Iron and Steel (Based on 1974 imports from U. S. only. Unknown quantities imported from Japan, West Germany and the United Kingdom.)

...Iron and steel scrap	$ 190,650	
...Pig iron and ferroalloys	158,648	
...Primary forms	3,409	
...Bars, rods, angles	334,142	
...Plates and sheets	571,158	
...Hoop/strip	3,648	
...Rails/track material	55,787	
...Wire	13,200	
...Tubes, pipes, fittings	424,511	
...Castings, forgings, rough	60,384	
	$1,815,534	(5,085 tons)

C. Resources

•Agriculture

In 1973, products of agriculture were valued at $179.9 million; 15.2% of GNP. Principal crops are cotton, sugar, corn, potatoes, wheat and rice. Currently, the production of coffee, bananas and livestock is increasing. Crops showing the greatest increase during the period 1970-73 were cotton and sugar. Sugar production is mainly in the hands of the state. Agriculture has been growing slowly in recent years, reflecting a low level of investment and a structure based on small landholdings and subsistence farming.

°Industry

In 1973, products of industry were valued at $163.7 million; 13.8% of GNP. Handicrafts and small industry constitute 80% of enterprises in operation, while 77% of manufacturing production consists of nondurable consumer goods.

Principal manufactures include food products, textiles, leather goods, cement and glass ceramics. Bolivia's industry is in an incipient phase of development, with a predominance of small production units oriented toward the domestic market. The level of investment is low, production techniques are not too far advanced and, above all, the magnitude of the domestic market is insufficient to accommodate economies of scale.

BOLIVIA (Continued)

°Minerals

In 1973, the mining sector (metallic, nonmetallic, petroleum and natural gas) contributed $148.2 million, or 12.5% of the GNP, while accounting for 89% of total export income.

Tin production in 1973 accounted for $89 million, or 40.3% of the total mineral production. Other metals produced included antimony, bismuth, cadmium, copper, gold, silver, iron ore, lead, manganese ore, tungsten and zinc. Nonmetallic mineral production included cement, gypsum, calcite, salt, and a variety of construction materials such as clays, stone, sand and gravel. Cement production in 1973 was 166,000 tons.

°Forests

About 45% of the total land area of Bolivia (180,000 sq. mi.) is covered with natural tropic and subtropical forests of excellent species of hardwoods. The heights of the Yunga region are covered with great forests of green pine, black walnut, aliso, laurel, cedar, tarco, cauco and quina. The tropical area of the great plains, dividing the Amazon and La Plata River basins is covered with tall trees consisting of rubber, Brazil nut and mahogany. All in all, Bolivian forests have more than 100 types of trees suited to the wood industry, while there are 14 kinds of palm trees, many of which have fruits suited to the extraction of oils, as well as 11 varieties of resinous trees. Limited access and long distances to the nearest seaports have delayed the development of the rich forest resources.

°Energy

Bolivia has tremendous energy resources in its hydro potential and its reserves of oil and natural gas. The great differences in altitude between the snow-capped peaks, which rise to 21,000 feet, and the plains, which are nearly at sealevel, offer a great potential for the future development of hydroelectric power. In 1973, installed electric generation capacity in Bolivia was an estimated 277,000 kilowatts, of which 172,000 kilowatts were hydroelectric. Gross electric production (1972) was 884 million kilowatt hours, or consumption of 166 Kwh per capita.

In 1973, Bolivia produced 17.3 million barrels of crude oil and 151.2 million Mcf of natural gas, of which 55.4 million Mcf was exported (via pipeline) to Argentina. Also, Bolivia exported crude oil to both Argentina and Peru. Known reserves (1973) were 286 million barrels of crude oil and 10 billion Mcf of natural gas.

GHANA

A. Profile

°Area: 92,000 square miles (compares in size to Oregon)
(Area characteristics: grassy coastal plain, wet forest belt, and northern dry savanna covering 2/3 of the country.)
°Population (1973): 9,600,000
°GNP (1973): $2,900,000,000
°GNP per capita: $291
°Labor force: Estimated at 3.4 million, with 1.3 million wage earners and 3 million under-employed or unemployed.

B. Imports/Exports

°1973:	Exports -	$573,000,000
	Imports -	457,600,000
	Balance -	+$115,400,000

°Major Trade Partners (1973)

Exports: United Kingdom, 19%; Japan, 12%; W. Germany, 10%.
Imports: United Kingdom, 19%; United States, 16%; West Germany, 12%; Japan, 7%.

°Imports Most Susceptible to Substitution

Chief imports include machinery and transportation equipment, cloth and yarn, crude petroleum, cereals, sugar, agricultural chemicals, pharmaceuticals, and paper products.

Some Examples of Major Imports in 1973

	Value	% of Total
Total Imports	$457,600,000	100.0
Fish and fish preparations	25,839,000	5.6
Chemical elements and compounds	37,932,000	8.3
Paper, paperboard & manufacturers	12,876,000	2.8
Iron and steel	13,311,000	2.9

GHANA (Continued)

Imports from United States in 1974 Included

Ammonia, inorganic bases, hydroxides	$	15,734,252
Paper products:		
..Paper & paperboard	$	824,798
..Paper, paper pulp and paper-board articles		132,819
..Pulps and waste paper		9,565
	$	967,182
Clay Products		
..Bricks & other refractory construction materials	$	592,025
..Pottery		5,613
	$	597,638
Iron and Steel		
..Pig iron & ferroalloys	$	39,055
..Bars, rods, angles		751,258
..Plates and sheets		737,421
..Hoop and strip		46,602
..Rails and railway track materials		648
..Wire		24,711
..Tubes, pipes, fittings		956,129
..Castings and forgings, rough		1,203
..Nails, bolts		50,585
	$	2,607,612

C. Resources

°Agriculture

In 1973, $1.3 billion, or 45% of GNP was represented by agriculture, including forestry and fishing.

The Ghanaian economy is based primarily upon small-scale subsistence agricultural production. Approximately 60% of the population is engaged agriculture, forestry and fishing.

The major commercial crops include cocoa, fats and oils, kola nuts, coffee and rubber. The main food crops include corn, sorghum, millet, yams and plantain.

GHANA (Continued)

Ghana's agricultural policy is centered around a government self-reliance program called "Operation Feed Yourself." The overall objective of this program is to accelerate self-sustained growth to produce food for domestic consumption and for export. Expatriate firms are being encouraged to invest in agricultural projects with offers of accelerated conversion of profits into foreign exchange as an incentive.

It is interesting to note that fish is a major source of protein to the Ghanaian diet with fish consumption exceeding that of meat. (The total value of food produced for domestic consumption in 1970 was about $200 million; fish accounted for $20 million, or 10% of the total.)

°Industry

In 1973, industry represented $435 million or 15% of the GNP.

The industrial base in Ghana is more sophisticated than in most African countries and includes, in addition to the usual range of consumer-oriented import plants, an aluminum smelter, steel mill, tire factory, vehicle assembly plants, and an oil refinery. Some manufactured goods are exported.

Ghana's principal industrial groups by value are wood, paper, textiles, tobacco, food and beverages.

There is currently a variety of new industrial projects at relatively advanced stages of preparation and include such diverse ventures as the manufacture of soap, pencils and stationery, nuts and bolts, high pressure water and sewage pipes. The establishment of rice and vegetable oil mills are also under consideration.

Ghana's National Investment Bank (NIB) provides major support to the government's efforts to encourage private initiative in the economy. It also supports the priority the government has given to investments that provide raw materials for local industries, or utilizes local raw materials; increases foreign exchange earnings through exports and enables substitution of imports.

GHANA (Continued)

°Minerals

The mining industry is third in importance to cocoa and timber.

By African standards, Ghana has a diversified and beneficial mineral resource base. Gold, manganese, diamonds and bauxite are important mineral exports. Cheap hydroelectric power has justified the construction of a huge aluminum smelter. Bauxite deposits are estimated at 1 billion tons, and include 300 million tons at Kibi, and 700 million tons at Nyinahin in the Ashanti region. Ghana is also believed to have rich untapped deposits of iron ore in the Upon Manso area of Western Ghana and limestone in the Tano basin.

In 1972, available data indicate that Ghana produced 415 metric tons of cement, exported 415 metric tons and imported 5,877 metric tons of portland cement and 347,189 metric tons of clinker. It was announced in late 1975 that Ghana and neighboring Togo and Ivory Coast have joined efforts for integrated cement production facilities near Tabligo, Togo. Initial production of 1.2 million tons per year is planned.

°Forests

Timber ranks second to cocoa as a leading contributor to Ghana's foreign exchange earnings. Its importance may be reduced, due mainly to the gradual depletion of the primary species of timber and Ghana's inability to utilize non-primary species. In an attempt to alleviate this potential danger, the government has allocated nearly $3.2 million towards the development of reforestation programs.

°Energy

At present over 90% of Ghana's electrical power is provided by the Volta River Authority. The electric power system includes the main hydroelectric powerplant, located at Akosomo, which contains six 147 Mw generators - a total of 882 Mw. In 1972, the Akosomo plant began supplying electrical power to the neighboring countries of Togo and Dahomey. The Ivory Coast will eventually be included.

GHANA (Continued)

In January, 1976 the Volta River Authority invited proposals from qualified construction companies for a new hydroelectric project at Kpong on the Volta River. The Kpong station will accommodate four 40 Mw (160 Mw total) generating units. In 1972, Ghana's gross production of electricity was 3,344,000,000 Kwh or 348 Kwh per person.

In 1972, Ghana imported 8,971,000 barrels of crude and partly refined petroleum. A number of companies, most of which are American-owned, are presently exploring for oil both onshore and offshore. They are hoping to supplement the small find of oil at Saltpond in 1970 by the Signal/Amoco/Occidental Consortium.

GUATEMALA

A. Profile

°Area: 42,040 square miles (compares in size to Tennessee)
°Population (1974): 5,623,000
°GNP (1974): $2,340,000,000
°GNP per Capita: $420
°Labor Force: In 1974, it was estimated that 56% was dependent on the agricultural sector and 11% on industry.

B. Imports/Exports

°1973:	Exports -	$436,100,000
	Imports -	431,000,000
	Balance -	+$ 5,100,000

°Major Trade Partners (1973)

Exports: United States, 33%; Central American Common Market (CACM), 30%; Federal Republic of Germany, 6%; Japan, 6%.
Imports: United States, 31%; Federal Republic of Germany, 10%; Japan, 10%; Venezuela, 6%.

°Imports Most Susceptible to Substitution

Value (based on 1974 imports from U.S. only)

...Paper and paper products	$16,527,774
...Fertilizers	7,717,664
...Iron and steel manufactured goods	8,184,708
...Clays and clay products	1,854,026
	$34,284,208

Volume (1971 import data)

...Fertilizers (primarily nitrogenous)

From:	Metric Tons
El Salvador	33,930
West Germany	23,121
United States	20,475
Various countries	37,126
	114,652

GUATEMALA (Continued)

...Steel and Iron

Types:	Metric Tons
Steel, primary forms	19,847
Bars, rods, angles, shapes	16,140
Universals, plates/sheets	39,444
Hoop and strip	904
Wire	5,649
Tubes, pipes, fittings	3,386
	85,370

...Clays/Clay Products	Metric Tons
Bricks & other refractory construction materials	1,606
Crude clays	1,761
	3,367

C. Resources

°Agriculture

In 1973, products of agriculture were valued at $654.7 million; 28.2% of GNP.

Principal crops are corn, beans, sugar cane, coffee, cotton, cattle, bananas and essential oils.

°Industry

In 1973, products of industry were valued at $367.2 million; 15.8% of GNP.

Industrial activities included cement, sugar refining, flour, alcoholic beverages, soft drinks, canned food, textiles, tobacco, tires, medicines, chemical products, lumber, and vegetable oils.

°Minerals

Mineral resources in 1973 contributed $1.8 million to the economy; 0.1% of GNP. Mineral resources are in the process of being developed. Exploratory/development work is actively progressing and indicates sizable deposits of copper, lead, zinc, and nickel. Cement production (1971) was 251,000 tons, of which 5,072 tons were exported. Gold, silver, antimony, chromium, asbestos, and sulfur deposits have been reported.

GUATEMALA (Continued)

°Forests

60% of land area (25,200 sq. miles) is forested. Tree varieties include cedar, mahogany, and pine. Presently not exploited primarily because of inaccessibility of the forested areas. Also, capital requirements to develop are lacking.

°Energy

Guatemala has large hydroelectric potential in its rivers and mountains. Imports all crude oil, primarily from Venezuela; in 1971, some 2,678,000 barrels were imported. Oil was recently discovered in the Peten Basin. Also, some coal reserves are indicated. Gross production of electric energy in 1972 was 910 million Kwh - about 160 Kwh per person.

PHILIPPINES

A. Profile

Area: 115,075 square miles (slightly larger than Arizona). The archipelago consists of 7,100 islands and islets.
Population: 40,200,000 (1973)
GNP (1973): $8,620,000,000 (U.S. Dollars, 1973)
GNP per capita: $220
Labor Force: Estimated 13.2 million, growing by 375,000 annually. Unemployment rate in 1973 estimated to be 8.5%.

B. Imports/Exports

1973:	Exports:	$1.8 billion	1974:	Exports:	$2.7 billion
	Imports:	$1.6 billion		Imports:	$3.1 billion
	Balance:	+$0.2 billion		Balance:	-$0.4 billion

Major Trade Partners (1974)

Exports: United States, 42.3%; Japan, 34.8%; Netherlands, 5.9%.
Imports: United States, 23.3%; Japan, 27.5%; Saudi Arabia, 11.0%; Kuwait, 4.7%; Australia, 4.3%.

Major Exports (1974)

Commodity	Percent of Total Exports
Sugar and sugar preparations	28.2
Metalliferous ores and metal scrap	16.3
Animal & vegetable oils, fats, greases	14.2
Wood, lumber and cork	9.2
	67.9

Major Imports (1974)

Commodity	Percent of Total Imports
Mineral fuels and lubricants	20.8
Machinery, other than electric	13.5
Base metals	9.4
Transport equipment	8.4
Chemical elements and compounds	6.9
	59.0

PHILIPPINES (Continued)

Major Imports from the United States, 1974

Commodity	Percent of Total Imports from U.S.
Machinery and transport equipment	35.1
Chemicals	16.0
Food and live animals	15.6
Manufactured goods	14.9
	81.6

Imports Most Susceptible to Substitution

Paper and Paper Products. Although the Philippines have a sizeable pulp and paper industry whose beginning dates back to 1941, the supply/demand gap is expected to rise to 380,000 metric tons by 1985. The industry relies on supplies of bagasse, abaca fibers and pulpwood for its raw materials. In 1974, the Philippines imported the following paper and paper related products:

Paper, paperboard and manufactures thereof	$ 55,999.160
Pulp and waste paper	23,891,958
	$ 79,891,118

In 1974, imports from the United States included:

Paper waste and old paper	$ 2,579,932
Woodpulp, sulphate	2,058,624
Woodpulp, sulphite	850,474
Paper and paperboard	13,849,757
Paper, paper pulp & paperboard articles	1,886,959
	$ 21,225,746

Fertilizers

In 1973, produced the following fertilizer materials:

	Metric Tons
Crude Phosphatic	
Guano	10
Phosphate rock	12,228
Manufactured	
Nitrogenous	60,000
Mixed and unspecified	56,896
	129,134

PHILIPPINES (Continued)

In 1974, the Philippines imported fertilizer materials valued at $96,572,899, as follows:

Manufactured	$ 83,674,117
Crude	12,898,782
	$ 96,572,899

In 1974, imports of fertilizer materials from the United States only were valued at $23,467,557 as follows:

Natural phosphates	$ 3,322,347
Nitrogenous	6,115,366
Phosphatic	4,367,028
Potassic	4,031,207
Fertilizers, n.e.c.	5,631,609
	$ 23,467,557

Iron and Steel. In 1972, the Philippines produced 2,205,000 metric tons of iron ore and concentrate and 256,000 tons of pyrite, while exporting 2,306,180 metric tons of iron ore and concentrate including roasted pyrite, principally to Japan.

In 1974, iron and steel imports from the United States were as follows:

Iron and steel scrap	$ 2,167,446
Pig iron and ferroalloys	63,681
Primary forms	7,145,908
Bars, rods, angles, etc.	1,081,012
Plates and sheets	1,109,387
Hoop and strip	451,061
Rails and railway track materials	91,181
Wire	181,186
Tubes, pipes and fittings	3,251,997
Castings and forgings, rough	3,264,172
	$ 18,807,031

PHILIPPINES (Continued)

C. Resources

Industry. In 1973, industry (mining, manufacturing, construction) contributed 26% to the GNP and employed 15% of the labor force. In the manufacturing sector, food and beverages were the largest groups, followed by chemicals and petrochemicals and textiles. Over 65% of the manufacturing enterprises are concentrated in the Greater Manila and Southern Luzon area. Industrial production in the past has been geared primarily toward meeting the needs of the domestic consumer market. Reliance on the industrial sector as a major vehicle for enhancing export earnings is a relatively recent development.

Industrial growth is inevitable if only because of the country's vast natural resources. Mining is thought to have barely scratched the surface of the mineral wealth available. Copper and gold are the most active minerals, while production of nickel, chromium, platinum, palladium, pyrite and manganese, and such nonmetallics as asphalt, marble, coal and limestone are increasing.

Farming. Arable farm lands comprise an estimated 28.2 million acres, about 38% of the total land area. Philippine farming consists of production of food crops for domestic consumption and cash crops for export. Although food crop production (mainly rice and corn, but also some important fruits and vegetables) has increased substantially in recent years, total output of rice and corn as of 1973-74 still represented only about 93% of domestic consumption requirements. In an effort to narrow this gap, the government has made self-sufficiency in food crops a major development goal and has been working on programs to enlarge the land area under irrigation, expand rural credit, improve distribution of fertilizers and pesticides, and carry out agrarian reform.

Forests. Hardwood forests cover about 40% of Philippine's land area - an estimated 46,000 square miles. In addition to the lumbering industry and the manufacture of plywood paneling, the forests also supply the raw materials for a sizeable pulp and paper industry. The Philippines are lacking in a long fiber pulpwood resource, but have large short fiber pulpwood and bagasse resources.

PHILIPPINES (Continued)

Fisheries. An important industry in the Philippines. Canned tuna is the principal fish exported. Fish provides an important part of the protein in the Filipino diet. Although the Philippines lie in a fertile fishing belt, the domestic fishing industry has remained underdeveloped. Obsolescent methods, inadequate refrigeration and marketing facilities and lack of investment capital have so handicapped the industry that production cannot meet domestic needs. In an effort to curtail the resulting imports of canned fish, the government is making a determined effort to improve the fishing fleet, modernize methods and establish adequate storage, processing and marketing facilities.

In 1974, imported "fish & fish preparations" valued at	$31,600,000
In 1974, exported "fish & fish preparations" valued at	18,400,000
	$13,200,000

Minerals. In 1973, Philippines mineral production was valued at $528.8 million. Metallic minerals were dominant, comprising four out of the five top valued products. The four (copper, gold, iron ore and chromite) generated $421.6 million, or 80% of the total mineral value in 1973. Portland cement production, the leading nonmetallic, was 4.1 million tons but was extremely sensitive to the energy crisis. To conserve bunker fuel oil, all cement exports were suspended as of December 13, 1973.

Other metallic production included cadmium, lead, manganese, mercury, nickel, palladium, platinum, silver and zinc. In addition to portland cement, nonmetallic production included clays, feldspar, guano, phosphate rock, gypsum, lime, perlite, pyrite, salt, stone, sand/gravel, sulfur and talc.

Energy. In 1974, the Philippines imported $653.4 million in mineral fuels, lubricants, etc. Fuels represented 20.8% of the total imports. There is no domestic production of crude oil. Coal production in 1973 was a mere 39,000 tons. Hydroelectric power in the past has supplied only a small portion of the country's electrical output, with thermal plants, most of which burn imported oil, supplying the major portion. But with completion of the Binga and Ambuklao dam projects on Luzon and the expansion of the Maria Christina project on Mindanao, hydroelectric potential is being put to use. In 1972, the Philippines consumed 10.4 billion Kwh of electricity for an average of 259 Kwh per capita.

PHILIPPINES (Continued)

D. Government Policy

...Government policies are presently geared toward the creation of a climate conducive to industrial growth and the provision of necessary social overhead capital and services for the accelerated growth and development of the industrial sector.

...Reliance on the industrial sector as a major vehicle for enhancing export earnings is a relatively recent development signalled by the introduction of the Export Incentives Act of 1970 and by other policy measures.

...In the past, government policy concentrated on the encouragement of import substitution industries. The focus has shifted since 1970 to a policy of active encouragement of export industries.

TANZANIA

A. Profile

Area: 362,820 square miles (slightly smaller than Texas and New Mexico combined)
Population (1973): 13,606,000
GNP (1973): $1,580,000,000
GNP per capita: $116
Labor Force: Majority of working force engaged in subsistence occupations. Monetary sector employed some 420,000 in 1973, largely in agriculture and industry. Average annual wage was $605.

B. Imports/Exports

1973:			
	Imports	-	$439,500,000
	Exports	-	362,200,000
	Balance	-	-$ 77,300,000

Major Trade Partners (1973)

Exports: United Kingdom, 18.8%; United States, 8.3%; India, 6.7%; Mainland China, 4.4%; Zambia, 3.2%.
Imports: Mainland China, 22.3%; United Kingdom, 16.0%; West Germany, 8.2%; United States, 3.1%.

Note: The principal imports in 1973 included machinery and transport equipment, manufactured goods and construction equipment for the Tanzania-Zambia railroad - primarily from Mainland China.

Imports Most Susceptible to Substitution

Volume (total 1972 import data)

	Metric Tons
...Iron and Steel	
.Ore and concentrate	874
.Pig iron, ferroalloys	1,086
.Steel, primary forms	4,838
.Semi-manufactures	
Rails and accessories	56,652
Other	111,358
	174,808

TANZANIA (Continued)

...Fertilizer Materials	
.Crude	$ 26,800
.Manufactured	
Nitrogenous	30,872
Potassic	5,431
Other, including mixed	7,497
.Ammonia	4,595
	$ 75,195

Value (1974) Imports from U.S. only)

...Iron and Steel	
.Bars, rods, angles, etc.	$ 749
.Hoop and strip	658,174
.Tubes, pipes, fittings	387,016
	$1,045,939

Note: Total imports from the United States in 1974 were valued at $51,388,800. The category "food and live animals" totaled $32,127,747, or 62.5% of total imports from the U.S. The single item of highest value was "corn or maize, unmilled" which accounted for $24,452,012, or 47.6% of total imports from U.S.

C. Resources

Agriculture. In 1973, products of agriculture accounted for 40% of the GNP and 75% of Tanzania's total exports. Land suitable for agriculture represents about 50% of the total land area, or 181,000 square miles. Cotton, coffee and sisal account for 40% of all exports. Cashew nuts, tea, tobacco, pyrethrum and sugar accounted for almost 30% of all marketed crops. Livestock production is expanding.

Industry. Tanzania's small manufacturing/industrial sector produces about 10% of the GNP. The principal industries include agricultural processing, textiles, cement, oil refining (using imported crude), aluminum rolling and consumer items. Tanzania has attracted little foreign investment.

TANZANIA (Continued)

Minerals. Tanzania's rather meager mineral resources include gem stones (diamonds are the leading mineral export and the fourth largest export commodity), a few dwindling gold fields. Recently, large quantities of coal and iron ore have been proved. Coal reserves in the southwest of Tanzania are estimated to be some 304 million tons. It is anticipated that with the development of the transport industry, large quantities of coal, iron ore, phosphate, kaolin and salt will be utilized.

Nonmetallic mineral production includes cement, diamond, gem stones, gypsum, lime, magnesite, mica, salt, vermiculite, glass sand. Cement production in 1972 was 236,956 metric tons while 173,577 metric tons were imported and 9,970 metric tons were exported, resulting in an apparent domestic consumption of 400,563 metric tons.

Forests. There are 37 million acres of forest land with indigenous trees, mostly hardwoods. Softwood production is increasing. Among main timbers being exploited are Podocarpus (a genus of evergreen tree), camphorwood, mahogany and mangrove.

Energy. Tanzania has no known natural gas or crude oil reserves. In 1972, some 6,021,000 barrels of crude or partly refined oil was imported. Apparent domestic consumption in 1972 was imported. Apparent domestic consumption in 1972 was 3,319,000 barrels, calculated as follows:

(in 42-gallon barrels)

	Production	Plus Imports	Minus Exports	equals	Domestic Consumption
Gasoline	1,128,000	1,086,000	1,629,000		585,000
Kerosene	148,000	158,000	178,000		128,000
Jet Fuel	459,000	29,000	297,000		191,000
Distillate Fuel Oil	1,299,000	2,454,000	2,392,000		1,361,000
Residual Fuel Oil	2,501,000	-0-	1,447,000		1,054,000
	5,535,000	3,727,000	5,943,000		3,319,000

In 1973, Tanzania consumed 431 million Kwh of electricity, equivalent to 32 Kwh per capita.

Recently it was announced that coal reserves have been proved at Ruhuhu (284 million tons) and Songwe (20 million tons). The quality and characteristics of the coal reserves are not known.

THAILAND

A. Profile

Area: 200,000 square miles (comparable to the combined area of the states of Nevada and Utah)
Population: 40,000,000 (est. 1974)
GNP (1973): $7,090,000,000
GNP per capita: $180
Labor Force: Total labor force estimated at 17 million and expanding by 500,000 annually. Over 50% of total are unpaid family workers in the agricultural secor.

B. Imports/Exports

1973:

Imports (c.i.f.)	$2,090,000,000
Exports (f.o.b.)	1,602,000,000
	- $ 488,000,000

Major Trade Partners

Imports: Japan, 37%; U.S., 14%
Exports: Southeast Asia, Japan, U.S., Netherlands

Imports Most Susceptible to Substitution

Iron and Steel. In 1973, Thailand produced 36,000 tons of iron ore, while manufacturing 306,000 tons of pig iron, crude steel and steel billets. Imports of iron and steel, valued at $221 million, included:

...Scrap iron	280,654 tons
...Pig and sponge iron	4,544 tons
...Steel ingots	1,952 tons
...Semi-manufactured material	610,217 tons
	897,367 tons

In 1973, only one-fourth of total steel consumption was produced domestically.

THAILAND (Continued)

Imports of iron and steel products from the United States in 1974 included the following:

...Iron and steel scrap	$ 3,310,901
...Pig iron and ferroalloy	275,528
...Primary forms	211,668
...Bars, rods, angles	144,051
...Plates and sheets	1,901,958
...Hoop and strip	113,719
...Rails & railway track mat	3,678
...Wire	45,410
...Tubes, pipes and fittings	637,634
...Castings & forgings, rough	4,462
	$ 6,649,009

Fertilizers. In 1973, Thailand imported fertilizer materials were valued at $40 million and included the following:

Crude and Manufactured:	Metric tons
...Nitrogenous	39,250
...Phosphatic	5,547
...Potassic	4,860
Other, including mixed	338,664
Ammonia, anhydrous	214
	388,535

In 1974, Thailand imported fertilizer materials from the United States valued at $19,911,303, as follows:

...Ammonia, inorganic bases	$ 306,702
...Nitrogenous	366,456
...Fertilizers, n.e.c.	19,238,145
	$19,911,303

Paper and Paper Products. Total imports in 1973 were:

...Paper and cardboard	$40,000,000
...Materials used in paper production	21,000,000
	$61,000,000

THAILAND (Continued)

Imports from the United States in 1974 included:

...Waste paper	$ 1,595,837
...Woodpulp, chemical	265,486
...Woodpulp, sulphate	5,592,952
...Woodpulp, sulphite	1,730,231
...Paper and paperboard	2,340,230
...Paper, paper pulp and paperboard articles	1,170,253
	$12,694,989

C. Resources

Agriculture. In 1973, agricultural production, including crops, livestock, fisheries, forestry, was valued at $1,940,500,000, or 27.4% of the GNP. Agricultural lands include 24%, or 48,000 square miles of the land area. Land available for expanding cultivation is marginal. Future growth is dependent upon intensive use of existing farmland. Major crops include rice, corn, rubber, tapioca products, sugar, fibers (jute and kenaf), pineapple.

Forests. Approximately 50% of land area is forested. Hardwood timber includes teak and yang. Teak is a major export.

Minerals. In 1973, mineral commodities contributed $149.6 million to exports; tin metal accounted for $100.6 million, or 67.2% of total mineral exports. Other minerals exported included tungsten ore and concentrate, cement, fluorspar, barite, salt, gypsum, manganese ore, columbite-tantalite concentrates.

In 1973, Thailand had portland cement plant installed capacity of 4.3 million tons and plans were underway to increase capacity by 2.5 million tons to 6.8 million tons. Most of this increase will be exported.

Cement Production/Exports/Imports (1973)

	Metric Tons
Production	3,745,000
Imports	1,018
	3,746,018
Exports	850,000
Apparent consumption	2,896,018

THAILAND (Continued)

Energy. Thailand's energy requirements are presently derived from petroleum (84%), hydroelectric plants (8%), and other sources (8%), consisting chiefly of lignite and wood.

Thailand depends primarily on imported oil to generate its electricity. The only domestic production of petroleum is from the Fang Field in Northern Thailand. Production there in 1973 was a mere 45,000 barrels. In 1973, Thailand refineries processed about 56 million barrels of oil. Three local refineries have a total capacity of 165,000 barrels per day.

In 1973, products of the domestic refineries included the following:

Product	42-gallon Barrels
Gasoline	9,008,000
Jet fuel	4,283,000
Kerosene	1,515,000
Distillate fuel oil	13,753,000
Residual fuel oil	19,470,000
Naphtha	2,466,000
Liquefied petroleum gas	2,539,000
Asphalt	7,742,000
Other	5,727,000
	66,503,000

Eight hydroelectric dams have been scheduled for construction by 1982, thereby increasing Thailand's installed electric capacity from 1,400 to 4,500 megawatts.

Lignite production exists at three and sometimes four mines in the Mae Moh Valley of Northern Thailand. In 1973, production was 361,000 tons, most of which was used as fuel at the Mae Moh steam electric powerplant.

THAILAND (Continued)

Total gross production of electric energy in Thailand for the years 1970-1973 was as follows:

Year	Million Kwh	Annual Increase
1970	4,545	--
1971	5,225	+15%
1972	6,209	+18%
1973 (est.)	7,450	+20%

In 1973, therefore, per capita requirements were 186 Kwh/year.

D. Government Policy

With the aid of substantial tariff protection, many consumer goods imports have been replaced by domestic production. The easier import, substitution opportunities have been virtually exhausted, however, the future growth of the manufacturing sector will depend increasingly on exports.

Activities eligible for industrial incentives by the Thai Board of Investment indicate interest and concern for the agricultural sector and include the following objectives:

...Large scale cultivation of bananas, oil palm, coconuts, cotton, peanuts and pineapples for export
...Production of energy from agricultural wastes
...Oil production from agricultural products
...Fishing and seafood products
...Gelatin products
...Animal husbandry

B. Potential Candidates for Import Substitution in LDCs

Review of information on materials imports of the six (6) LDCs and analysis thereof in the light of available indigenous raw materials and modern materials technology identified a number of substitution possibilities that could contribute to lower foreign exchange outlays, better and more complete utilization of resources, and strengthening of national economies. All of the countries are producers of cement and use large amounts of it in concrete construction. The substitution of acceptable pozzolanic materials or slags for a portion of the cement used is therefore a possibility in all of the countries, not only as a means of reducing fuel consumption but also of increasing production capacity without high capital outlays. Other potential candidates for substitution in individual countries are discussed below; influences of economic, political, social and market factors have not been appraised.

Bolivia

..A portion of the potential for import substitution in Bolivia lies in its petroleum and natural gas resources, production of which is largely exported. Imported materials such as ammonia, organic chemicals, several types of explosives, nitrogenous fertilizers, polymers and copolymers, synthetic resins and plastic materials are commonly manufactured from petroleum and natural gas feedstocks. Fertilizer production possibilities are of special interest, for if this could be done, the resulting products might be used to increase yields of wheat to replace a significant percentage of that (and associated products) which accounts for a sizeable outflow of foreign exchange (over $22 million from the U.S. alone in 1974).

..The 14 kinds of palm trees in Bolivia, many of which are indicated to have fruits suited to the extraction of oils, are possible sources of substitutes for the oilseeds, oil nuts, oil kernals, etc. and vegetable oils (including soybean oil) imported in substantial amounts, according to 1974 data.

..Paper and paperboard imports may possibly be replaced to perhaps a significant degree by products that can be made from bagasse (and other fibrous plant materials) through the application of existing technology and the use of bagasse pulp mill and associated paper-making facilities. At present, bagasse pulp is produced in 22 countries, with daily capacities of mills ranging from 10 to 250 metric tons. As a producer of sugar from cane and an importer of paper and paperboard, Bolivia appears to satisfy two of the basic requisites for substitution as described above. Additionally, if bagasse is used as fuel in Bolivian sugar production, its substitutive use for paper and paperboard production may not pose a problem since natural gas or petroleum are available.

..A process for converting bagasse into an edible flour containing 30 to 40% protein is expected to be tested on a pilot plant scale in the U.S. in the near future. The process is said to employ simple grinding and classification equipment to convert bagasse into 70% flour and 30% waste material that is suitable for making wallboard useful as a building material. The pilot plant reportedly will make flour for animal feed, at an estimated production cost of $20 per ton. This process may be usable with Bolivian bagasse.

..Gypsum is usable for making low energy intensive building products such as blocks, roof planks, etc. and can substitute for concrete in select cases, thus replacing cement which is a highly energy intensive material.

..Although Bolivia's imports of tinplate and tin coated sheet are not substantial ($191,320 from the U.S. alone in 1974), its production of metallic tin (including electrolytic) from indigenous resources affords an opportunity to make and substitute its own materials for the imports. The country imports steel plate and sheet which comprise the other principal materials needed to produce tinplate and tin coated sheet.

..Bolivia's iron ore and fuel resources may be used to produce iron and steel. Reduction of iron ore by employing reformed natural gas is a well-developed technology; it might be employed with Bolivian resources. With development of the country's hydroelectric power potential, steel manufacture in electric furnaces might be possible.

Ghana

..The existing ample supply of hydroelectric power and the potential for its further development provide an important base for the production of import substitutes. Resources of iron ore and limestone provide a partial basis for primary iron and steel making which could figure in reducing Ghana's significant foreign exchange outlays for iron and steel products, both semi-finished and finished.

..Electric power can also be used to provide heat for the manufacture of substitutes for glass and ceramic products, the former using the high-quality silica sand already being utilized in a small glass industry and the latter from clays and aluminum oxide.

..The above mentioned silica sand in combination with lime (from limestone) is a prospective base for sand-lime brick manufacture, using autoclave curing with steam supplied by electrically heated boilers.

..There very likely are other candidates for substitution in Ghana, but information available on imports and resources was too limited and not recent enough to reflect current conditions. For example, plans were announced in late 1975 for a cement plant to be jointly owned with neighboring Togo; this presumably would end in 1976 or 1977 the need to import cement and/or cement clinker. The availability of cement would introduce the possibility of using it with silica sand to produce cellular concrete for building construction, perhaps utilizing waste heat from the cement plant to make steam for autoclave curing.

Guatemala

..The recovery of edible, high protein flour from bagasse to substitute for some of the imported animal feed is a possibility, using the process described for use with bagasse in Bolivia.

..Volanic ash in Guatemala may have sufficient pozzolanic activity to be used in making blended cements. This could substitute for a part of the portland cement produced, thereby reducing the energy requirements for cement manufacture; in effect the ash could therefore substitute for a portion of imported fuels. Also, gypsum can be used as a low energy intensive building material.

..Reported coal deposits may be producible to provide a substitute for imported fuels. In effect, the development of hydraulic power resources to produce hydroelectricity could serve the same purpose.

..Coal could be used for producing ammonia to replace imported nitrogenous fertilizer.

..The availability of hydroelectric power could make it possible to produce substitutes for imported glass and clay products.

..The production of iron and steel is a possibility, using coal, iron ore, and limestone (inferred from cement manufacture). Perhaps, hydroelectricity could be used for electric furnace operations, if and when existing hydraulic power resources are developed.

..As a producer of bagasse and with coniferous forests on its highland plains, Guatemala has basic resources that are usable for the production of paper and paperboard which are imported in substantial quantities.

..With a variety of trees and both agricultural and forest residues available in Guatemala, it would appear possible to produce the exterior structural, multifunctional plywood product and the corrugated, phenolic bonded oriented fiber product, discussed later, as building materials. The corrugated fiber product would substitute for corrugated galvanized iron sheets made from imported steel sheet, an energy intensive product.

The Philippines

..The utilization of bagasse in the same substitution applications as noted for Bolivia and Guatemala would appear appropriate for The Philippines.

..Philippine coal may be usable for production of ammonia to substitute for imported nitrogenous fertilizers.

..Cement can be used to make concrete to substitute for imported steel in many types of construction; Philippine cement production is substantial.

..The substitution of Philippine coal for fuel oil (from imported petroleum) in firing cement kilns would appear to have potential worthy of examination.

..The presence of many volcanoes and much volcanic material suggests the possible presence of volcanic ash that may be sufficiently pozzolanic for use in making blended cements which would be less energy intensive than pure portland cement. In such an application the volcanic ash would substitute for fuel.

..Cement and/or lime (from coral, marble or limestone) with either volcanic ash or silica sand can be used for producing cellular concrete and calcium silicate building products. In appropriate designs cellular concrete can substitute for more energy intensive steel (based on imported scrap) by virtue of its low density that allows reduction in the amount of steel used. Calcium silicate building products can substitute for more energy intensive clay brick and tile, thereby lowering usage of imported fuel required for producing the clay products.

..Sulfur-coated, surface-prepared bamboo may be used as reinforcement in concrete to replace steel reinforcement. This new material is a candidate substitute for steel bars made from imported steel scrap, is very low-energy intensive, and is producible from indigenous bamboo. Its use in concrete for applications with critical service and structural requirements must carefully be examined.

..Although highly price-sensitive, the use of vegetable oils in fuel applications is a prospective incremental substitution candidate for a portion of high-cost imported petroleum, prices of which are likely to increase in the future. History records the use of palm oil to fuel Diesel-type engines in the first half of the 20th century. Combustion technology has advanced markedly since then and present day internal combustion and reciprocating engines have been considerably improved; a new breed of direct-injected stratified-charge engines will operate on a wide variety of liquid fuels. Considering the large quantities of vegetable oils, oil seeds, oil nuts and oil kernels produced in The Philippines, it would seem worthwhile to examine the feasibility of using a portion of production as a replacement for a part of petroleum-based fuel or diesel oil. There is also the possibility of blending petroleum based fuels with the vegetable oils. If such usage is feasible and vegetable oils can be produced at costs that are competitive with petroleum prices, then perhaps production could be increased to supply a portion of the fuel demand.

..The production of methanol for use as an automotive fuel is practicable and technically sound. At present-day prices of petroleum based fuels, methanol is indicated to be competitive, particularly when blended with gasoline. Producible from coal, wood and cellulosic agricultural residues, methanol would be a substitute for part of the gasoline used in The Philippines.

..Gypsum is available for use in making plasters from which a variety of low energy intensive building products can be made to substitute for sheet steel, concrete block, etc.

Tanzania

..Proven resources of coal and iron plus limestone provide a prospective base for the production of iron and steel in Tanzania from which to make a variety of items now imported, including pig iron, primary forms of steel, rails and accessories, steel hoop and strip, steel tubes and pipe, etc.

..Coal is a candidate feed material for the production of ammonia and possibly nitrogenous fertilizer materials that are now imported, plus a number of organic chemicals, pitch and perhaps coke. The production of nitrogenous materials from coal could result in lower cost fertilizers that might permit higher grain yields to offset imports, especially corn or maize.

..Gypsum is available for calcination to provide the semi-hydrate that is the basis of construction and prefabrication plasters used in building. Plasters can, in some applications, be a low energy intensive substitute for cement.

..Bagasse from sugar cane is a candidate raw material for use in making bagasse pulp that can be used in the production of paper and paperboard, now imported in significant amounts. The bagasse pulp can be blended with pulp from softwoods, production of which is indicated to be increasing in Tanzania.

..The possible presence of pozzolanic materials is suggested by volcanic features in Tanzania. These would be candidate substitutes for portland cement in the production of blended cements which, overall, are less energy intensive than pure portland cement. A substitution of pozzolans for part of the fuel used in cement production is thus possible.

..The occurrence of rock phosphate may make it possible to produce phosphatic fertilizer materials, perhaps in conjunction with coal processing that could yield sulfur compounds which could be used for making sulfuric acid. This acid could be used in treating the rock phosphate to make triple or superphosphate for application to croplands.

..Cement now being produced can be used in making concrete to replace steel in structures and possibly to make low-energy intensive concrete block or cement-bonded brick.

..Tanzania's wide variety of soils may provide the basis for cultivation of agricultural crops (soybeans and/or palm nuts) that will yield vegetable oils to substitute for imports. Water for irrigation would appear to be available from Lake Victoria and Lake Tanganyika as well as various lakes formed behind dams for producing hydroelectric power.

..The utilization of silica sand with lime to produce sand-lime brick would permit substitution of a lower energy intensive building material for clay brick and tile. Both silica sand and lime are presently produced.

Thailand

..The iron ore deposits of Thailand, worked in past years to produce material for export, are a resource that could be the basis for increased iron and steel production to reduce imports. The former Japanese market for the ore has dwindled. Thailand's imports of steel scrap and semimanufactures are considerable.

..As a producer of both lead and antimony, Thailand has two of the primary materials needed for the production of lead-acid (automobile) batteries.

..Commercial deposits of gypsum provide an indigenous raw material usable for the production of plasters that can be used in building construction. Substitutable for highly energy intensive cement in a number of applications, technological advances make it possible to make spraying plasters, rendering (cladding) plasters, very high-strength plasters, etc., all relatively low energy intensive products (three to four times less fuel per ton than cement).

..Resources of silica sand, limestone and marble can be used in the production of calcium silicate building products. The limestone would have to be calcined to make quicklime for use with the silica. Both sand-lime brick and cellular concrete shapes can be made with these materials. Cellular concrete can also be made with cement instead of lime, though the usual practice is to use both. Calcium silicate and cellular concrete products are less energy intensive than clay brick and tile. Both can substitute for steel in some types of structures.

..Bagasse and other nonwood plant fibers such as rice straw and bamboo are available in Thailand for use in making pulps for paper production. The country imports significant amounts of paper and paperboard.

..Cellulosic agricultural residues are produced in large amounts and could be used as feedstock for the production of methanol which can be blended with gasoline for automotive fuel.

..Agricultural and forest residues can be used to make low-cost building materials for housing, schools and industrial buildings. Possible products include exterior structural multifunctional plywood that can be made from small logs of secondary tree species and phenolic bonded fiber mats, the latter being usable as facings on the plywood, or as a corrugated substitute for corrugated galvanized iron sheets.

Recap of Import Substitution Possibilities for the LDCs

The candidates for import substitution in the six (6) LDCs reviewed include energy materials, paper and paperboard, concrete, iron and steel, fertilizer materials, gypsum-based materials, ceramics (glass and clay products), animal feed materials, and others. All of these are producible through the application of established technologies, using resources indigenous to the countries. However, there are many unanswered questions that bear on technical, economic, societal and other factors. Thus, the initial identification of candidates for substitution is but a short first step. In all cases there is the matter of whether a given substitution would be attuned to the needs of a particular country. Then there is the question of the cost to achieve the substitution and whether it might outweigh the benefits. These and other questions need to be included in a plan for identifying benefits and barriers to undertaking a given import substitution. This will provide a system or procedure for jointly assessing the substitution's good and undesirable features with appropriate groups, institutions, leaders and decision makers.

C. Resources of LDCs in Perspective

Earlier summaries of the six (6) LDCs contain information on their resources of various types. Almost without exception, the national economies are based on the production of basic agricultural, mineral, forest and other raw materials; this implies a diversity of resources. Some are well-endowed with fossil fuel resources and most have hydraulic power generation. There are, however, undeveloped energy resources in all of the countries. Forest resources are modest to extensive and have been exploited heavily in some cases and relatively little in others. Arable lands cover considerable areas in each of the countries and water for irrigation is available in most.

Mineral resources cover a broad spectrum, both as to the types of metallics and nonmetallics that occur and those that are produced. All of the countries have materials needed for cement-making and sources of aggregates for concrete, though in recent years some were importers of all of these. Gypsum occurs and is produced in most of the LDCs, but within the last five years several of them imported the material in amounts ranging from less than 1000 tons to more than 20,000 tons. All have resources of clays, sand, gravel, stone, etc. and in some cases high-grade materials such as kaolin, high-purity silica sand, quartz, and calcite (essentially calcium carbonate). However, crude clays of various types are imported by several of the countries, as are clay products. Sulfur is indicated to be produced in substantial amounts in only one case. All of the countries appear to be importers of modest to large tonnages of fertilizer materials, though at least two are reported to have phosphate rock resources.

Overall, the resources of the LDCs cover a very broad spectrum; as might be expected, some of the countries are rich in mineral resources while others are endowed to lesser degrees. Knowledge of the resources has been developed to degrees that vary in depth from country to country; in all cases much remains to be learned of the identities, qualities, and quantities of resources. In developing countries such as Bolivia and Guatemala, information on resources must be considered as being very limited.

Data on production of mineral commodities in the six (6) LDCs are contained in tables in Appendix III. These provide general pictures of mineral resources but are incomplete because information has been inadequate to make reliable estimates of output levels. Almost completely lacking is information on the properties, grades and manner in which most of the mineral resources occur; such information is essential in making appraisals of their exploitability and commercial potential. Undoubtedly there are sources both in and outside of LDCs that can fill many of the information gaps; these would have to be identified and utilized in any efforts dealing with examination and appraisal of import substitution possibilities based on production and utilization of indigenous materials.

D. State-of-the-Art and Technology of Materials Substitution

The use of one material, implement, or product in place of another to serve a particular purpose has been practiced either unwittingly or intentionally by man throughout his existence. Thus, the art of replacing or substituting materials has had a long time in which to reach its present state of development.

The history of the use of substances as industrial materials is replete with substitutes among substances, either of the same or different classes. In the same class (metals), aluminum substitutes for copper as a conductor of electricity and heat, and (in foods) vegetable oils substitute for animal-and fish-derived oils; in different classes, steel substitutes for wood in structural applications and plastics substitute for metals and ceramics in numerous applications. Obviously, under appropriate conditions of availability and cost, each of these substitutions can work in the opposite direction. Actually, there are very few industrial materials for which another material is not technically substitutable. Furthermore, there are few industrial materials for which there is only one substitution option.

Substitution among materials can be either evolutionary or radical. Evolutionary substitution generally follows a pattern of gradual improvements in materials and products, leading in time to substitutes having better service capabilities. Radical substitution can involve a change to an entirely different class of material that performs a function much more effectively, or a basic change to a material or product that performs a function by a completely different approach, e.g., the use of adhesives instead of nuts and bolts for joining. Radical substitution often follows a significant materials development that is a technological advancement and which allows replacements of major importance, as in the case of the transistor which replaces vacuum tubes. Radical substitution can take place abruptly, as when a conventionally used material becomes

higher priced, scarce or unavailable rather suddenly, or a government regulation either bans or limits its use. For example, a switch from natural gas to coal and petroleum coke by numerous U.S. cement manufacturers followed quickly after price rises occurred and gas supply shortages developed.

It should be noted that the choice of using a given alternate material or product is often made possible by technologies, processes, and techniques that are substitutive for those used to make a replaced material. For example, calcium silicate building products manufactured by the use of relatively low temperature hydrothermal processing from silica and/or silicate materials plus lime are widely used in place of structural clay products (brick and hollow tile) made by high temperature treatment of items shaped from clay or shale. Although the two classes of products are made in the same shapes and sizes for use in the same types of construction, they are made from entirely different materials, according to different technologies, and by dissimilar processes. Another major difference of much significance in these times of world-wide energy consciousness is that, though the products are both processed by thermal methods, the heat energy required in manufacturing the calcium silicate materials is typically less than half of that required in firing clay products. The above comparison points up technology and energy as two of the important underlying elements in materials substitution; other elements are material resources and the capital necessary for investment.

From a technical standpoint, materials substitution very often involves knowledge, technology and activities that lie in the multidisciplinary field of

materials science and engineering. Figure 1 is a diagram showing the disciplinary mix in materials science and engineering; subjects within the shaded sector on the right are considered to be in the field. Practitioners in this field develop and work with materials that are used to make things--products like machines, devices, and structures. The technology employed varies widely in its relative sophistication and frequently is referred to as high-level or low-level, depending on its complexity or simplicity. In a similar vein, the materials used and the products made from them are exceptionally diverse in class or type. The scope of materials science and engineering spans metals, ceramics, semiconductors, dielectronics, glasses, polymers, and material substances like wood, fibers, clay, sand, and stone. Substitutability within and between these has a great many possibilities when viewed in the light of existing knowledge; the indication is that there is no technologic limit to substitution. A much broader materials spectrum within which substitutions can be made includes foods, drugs and fossil fuels; these are substances that are sometimes considered to be outside of the scope of materials science and engineering. However, while the technologies, materials and products associated with these may be partly or wholly outside of the shaded sector in Figure 1, they and the disciplines that work with them are involved in the field to varying degrees. Together with these disciplines, the field of materials science and engineering encompasses both multidisciplinary and interdisciplinary work.

Materials previously listed as being within the scope of materials science and engineering have come increasingly to be classified by their function as well

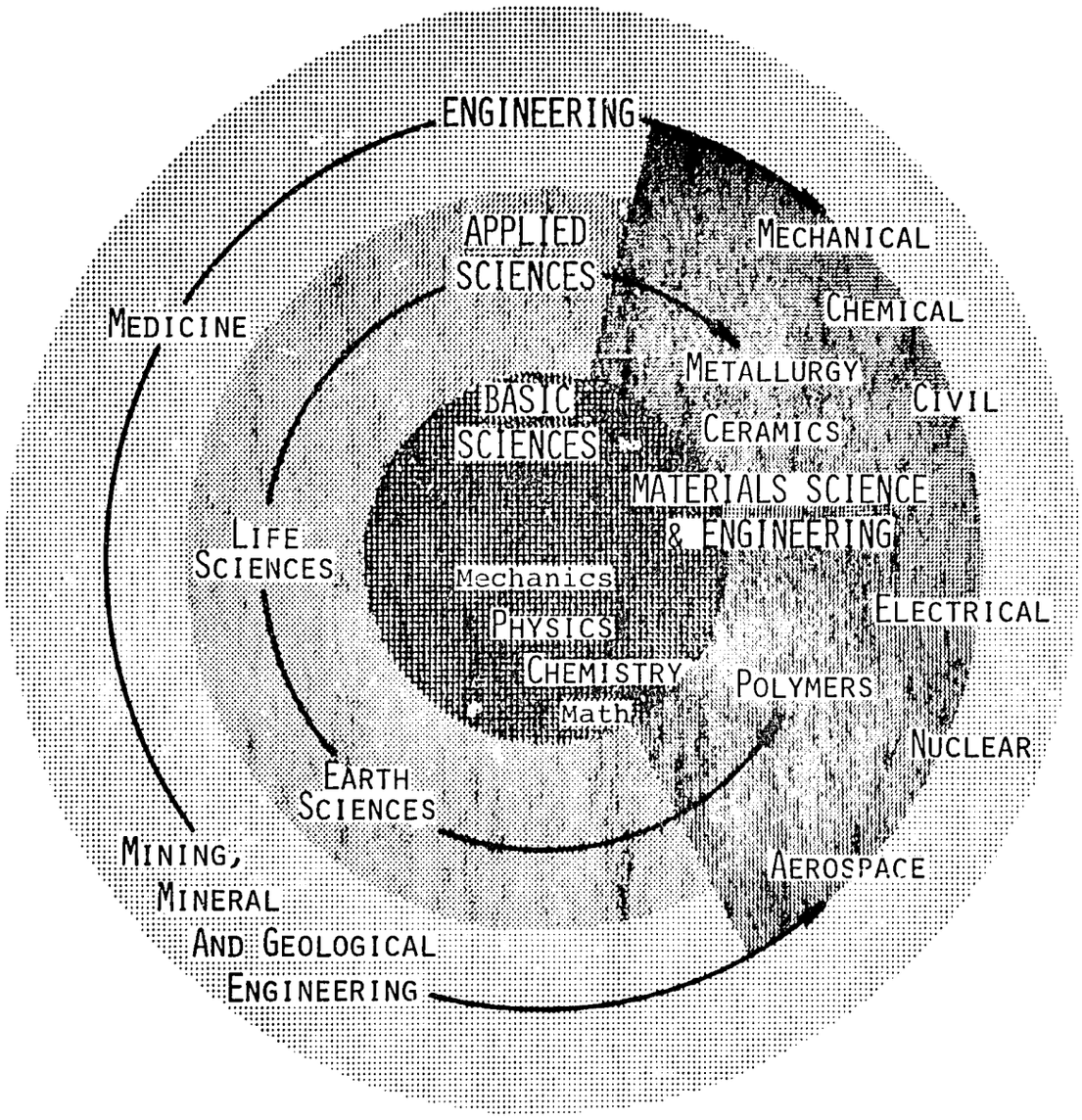

Figure 1. Schematic relationship of the subject matter of materials science and engineering to "basic sciences" (physics, chemistry, and mathematics) that form the necessary core of any technology. The series of concentric circles around the basic sciences core include the applied sciences (earth, life, and materials) immediately surrounding the core, and an outer ring of engineering fields (medicine, the geological engineering fields, mechanics, electrical engineering, etc.). The import features of the location of the materials science and engineering sector are the chemical bias, the extensiveness of the field across the basic-science-engineering boundaries, and the interdisciplinary nature, which is not well illustrated in this diagram.

as by their nature; hence, structural materials, biomedical materials, electronic materials, etc. The properties of specific materials often determine whether products made from them will serve satisfactorily in particular applications. Possibilities of substituting one material for another may be appraised by comparing their respective properties in the light of requirements relative to service, fabrication or processing, and economics. In a highly scientific sense, this involves relating fundamental understandings of the behavior of electrons, atoms, and molecules to the performance of devices, machines, and structures, thereby linking knowledge to the solution of practical problems. At the same time empirical (experience-based) knowledge is highly important and often adequate in a great many instances that involve materials selection and design. In practice, the total knowledge is applicable to the original development and making of a product as well as to any subsequent effort to provide a substitute for it.

The use of a substitute material is frequently a relatively simple undertaking based on availability, cost factors, and the known or readily provable adequacy of the substitute. A common example is the use of alternate types of rock for making road building aggregates--so long as a given rock material meets specified physical requirements and is available at competitive cost, it is usually acceptable. The element of cost is important in virtually all cases of materials usage and it is, as well, a limiting factor in substitution. Import substitutes are also subject to economic qualification; if they cannot supply domestic markets which had been supplied by imported materials, and with attendant decreases in foreign exchange expenditures, they fail to satisfy the basic economic premise of import substitution.

1. The Total Materials Cycle

Since there are many instances where direct use is made of materials more or less readily available from nature, substitution first becomes possible with the basic substances that, collectively, comprise the source from which all things start. From their sources, all materials move in a "total materials cycle," as shown in Figure 2; this is often referred to simply as the materials cycle. Beginning in the lower left corner of the flow diagram or cycle, it is shown that the earth and its atmosphere are the sources of ores, hydrocarbons, wood, oxygen and other substances in crude form that are extracted, refined, purified and converted into simple metals, chemicals, and other basic raw materials. These raw materials are modified to alloys, ceramics, electronic materials, polymers, composites and other compositions to meet functional and performance requirements; from the modified materials are made shapes or parts for assembly into products. Some substances are used directly to satisfy a want with little or no refining, purification, or conversion; examples are coal, wood and water, which have only to be removed from their natural settings and utilized virtually as-obtained to provide heat, shelter and drink. Even at this point substitution is possible, for coal or wood can serve as a source of heat. Alternatives and opportunities to substitute are found throughout the full spectrum of activities involved in the materials system; that is, the resources from which materials are derived, their processing and utilization, and the discharges and wastes to which such activities give rise. Figure 2 shows the interrelationships of materials and the other natural resources in terms of the

THE TOTAL MATERIALS CYCLE

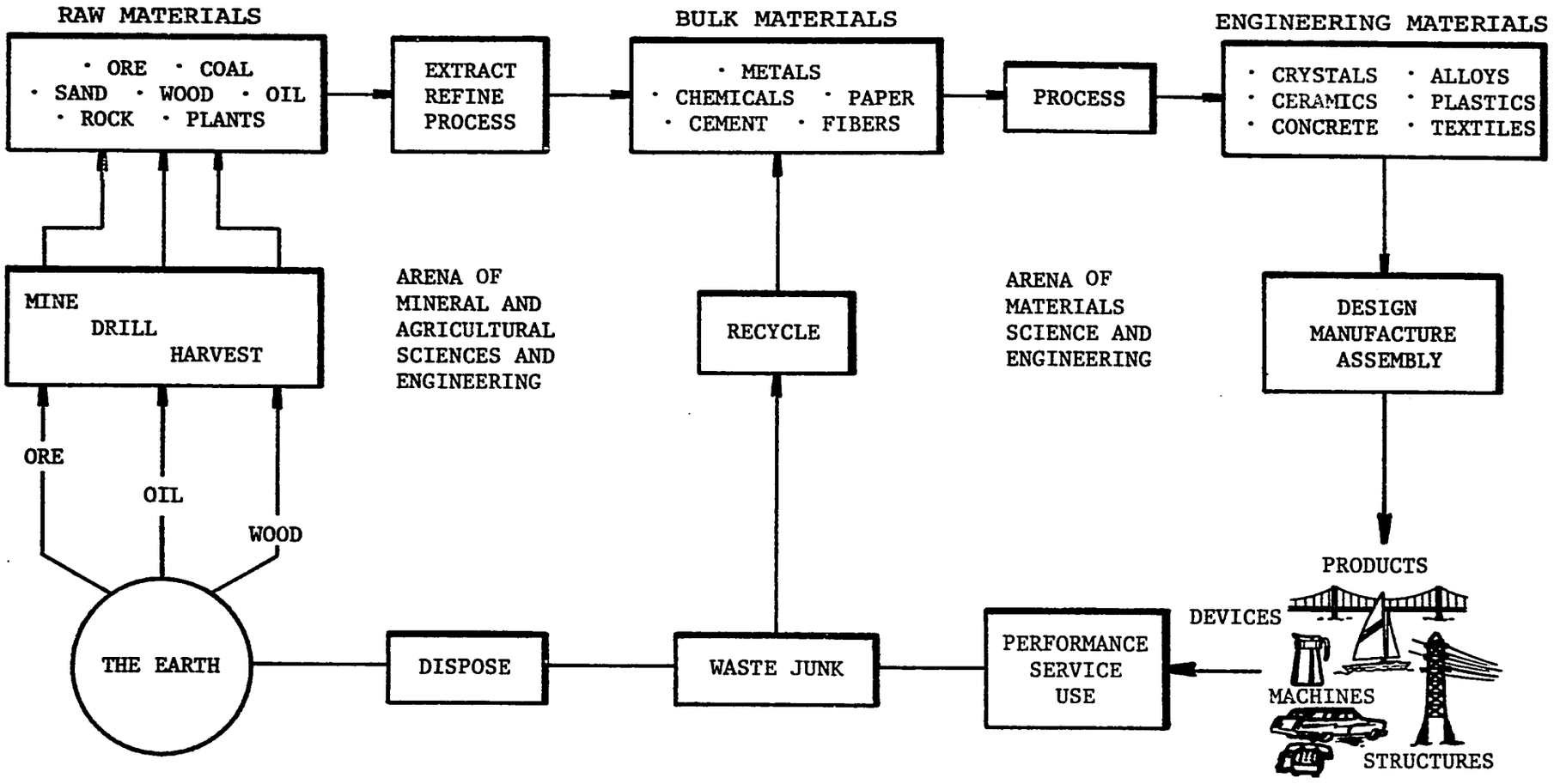

Figure 2. The "total materials cycle" within which materials are obtained, converted to useful forms, utilized, and at the end of their useful life, either returned to the earth or the atmosphere or dismantled to recover basic materials that reenter the cycle. Generally, substitution possibilities exist at any point beginning with and beyond the "raw materials" stage.

flow of resources, as means to attain given ends, through the successive production stages of "raw materials" and "processed materials" (both of which figure prominently in world trade as the "primary commodities") into industrial use and consumer use.

The purposes for which a single material or commodity can be used provide a relative gage as to its importance in commerce and industry. There are many, many materials that are multifunctional, being useful in numerous applications. Coal, for example, is a primary fuel material, but it is also useful as a basic feedstock for making many organic chemicals. This at once points up the substitutability of coal for petroleum for such usage. Some raw materials have more than a hundred established uses and may be the most preferred for a number of those. This points to possibilities for substitution particularly in the use of materials that occur in more than one form. Silica, for example, is much preferred in the form of high-purity sand for glass-making, but must be in the form of ultra-pure, perfect crystals for usage in electronic applications. Aluminum has its preferred source in bauxite, but some clays and other materials can also be used; the same clays can be utilized in other applications, such as perhaps in making refractories or other ceramic products. The spectrum of uses for a number of industrial mineral raw materials is of interest from the standpoint of their possible utilization in import substitution. Examples of these are gypsum, salt and lime; partial listings of industrial uses for these are as follows.

Gypsum - Hydrous calcium sulfate, ($Ca\ SO_4.2\ H_2O$)

(a) Uncalcined:
- Portland-cement retarder
- Agricultural gypsum (fertilizers)
- Filler and rock dust
- Brewer's fixe
- Color manufacture
- Glaze in paper manufacturing
- Source of sulfur

(b) Calcined:
- Industrial
  - Plate glass and terra cotta plasters
  - Pottery plasters
  - Orthopedic and dental plasters
  - Plaster bandages and casts in surgery
  - Statuary
  - Industrial casting and molding plasters
  - Dead-burned filler
- Building
  - Cementitious
  - Plasters
    - Base coat
    - Sanded
    - Mixing plants
    - Gauging and molding
    - Prepared finishes
    - Insulating and roof decking
    - Joint filler, patching and painter's plaster
  - Keene's cement
- Prefabricated
  - Lath
  - Wallboard
  - Sheathing board
  - Laminated board
  - Tile, including roof, floor, soffit, shoe and other types of gypsum products
  - Tiling and planks

Lime (including hydrated lime), Calcium Oxide (CaO), derived by burning limestone ($CaCO_3$) or dolomite ($CaCO_3.MgCO_3$)

(a) Agricultural

(b) Building:
- Finishing lime
- Mason's lime
- Prepared masonry mortars

(c) Chemical and industrial:
- Acid neutralization
- Alkalies, (ammonium, potassium and sodium compounds)
- Asphalts and other bitumens
- Bleach, liquid and powder
- Brick, sand-lime and slag
- Brick, refractory silica
- Calcium carbide
- Cyanamide
- Chromates and bichromates
- Coke and gas (gas purification and plant by-products)
- Explosives
- Food products:
  - Creameries and dairies
  - Gelatin
  - Stock feed
  - Deodorant for vegetable oils
- Glass manufacturing
- Glue
- Grease, lubricating
- Insecticides, fungicides and disinfectants
- Magnesia (85%)
- Medicines and drugs

(d) Metallurgy:
- Nonferrous smelter flux
- Steel (open hearth and electric furnace flux)
- Ore concentration:
  - Flotation processes
  - Cyanidation
  - Bauxite purification
  - Magnesium manufacture
- Wire drawing
- Mold coating

Paints
Paper mills, including bleach
Petroleum refining
Rubber manufacture
Salt refining
Sewage and trade wastes treatment
Soap and fats
Sugar refining
Tanneries
Textiles
Varnishes
Water purification
Wood distillation
Alcohol
Bromine
Precipitated calcium carbonate
Cement manufacture
Dicalcium phosphate
Photographic supplies
Polishing compounds
Retarder
Rock wool
Sulfur
Tobacco
Wood pullers

(e) Refractory lime (dead-burned dolomite)

Salt (Rock) - Sodium Chloride (NaCl)
Mineral is "Halite" (NaCl)

Chlorine and bleaches
Soda ash
Dyes and organic chemicals
Soap precipitant
Textile processing
Hides and leather
Meat packing
Fish curing
Butter, cheese and other dairy products
Canning, preserving and other food processing
Refrigeration
Livestock
Highways, railroads, dust and ice control

Table and household uses
Water treatment
Agricultural uses
Metallurgical uses (Sodium Cyanide)
Manufactured sodium compounds, such as:
- Sodium Acetates ($Na\ C_2H_3O_2 \cdot 3\ H_2O$)
  - Photography
  - Reagent
  - Mordant in dyeing
  - Foot warmers
  - Thermos bottles
- Sodium Aluminate ($Na\ Al\ O_2$)
  - Fabric printing
  - Lake colors
  - Paper sizing
  - Manufacture of milk glass
  - Manufacture of soap
  - Hardener for building stones
  - Water softener
- Sodium Bicarbonate ($Na\ H\ CO_3$)
  - Manufacture of various sodium salts
  - Manufacture of CO_2
  - Fire extinguishers
  - Baking powder
  - Effervescent salts
  - Cleaning compounds
- Sodium Bisulfite ($Na\ HSO_3$)
  - Bleach and disinfectant
  - Dyeing
  - Paper manufacturing
  - Reducer (stripper) in laundering
  - Coagulent for rubber latex
  - Fermentation industries for an antiseptic
- Sodium Borate ($Na_2B_4O_7 \cdot 10\ H_2O$)
  - Soldering metals
  - Glazes and enamels
  - Tanning
  - Cleaning compounds
  - Preservatives
  - Fireproofing
- Sodium Bromate ($NaBrO_3$)
  - Used in gold solvent with sodium bromide

Sodium Bromide (NaBr)
- Photography

Sodium Carbonate (Na_2CO_3)
- Manufacture of sodium salts
- Manufacture of glass
- Manufacture of soap
- Wool washing
- Bleaching linen and cotton
- Water softener
- Photography
- Reagent

Sodium Chlorate ($NaClO_3$)
- Oxidizer in dye manufacturing
- Explosives
- Matches
- Dyeing and printing fabrics
- Leather tanning and finishing
- Weed killer

Sodium Chromate ($Na_2CO_4 . 4 H_2O$)
- Corrosion and rust preventative for iron

Sodium Cyanide (NaCN)
- Metallurgy of gold and silver
- Electroplating baths
- Fumigant for trees, ships, railway cars, buildings
- Case hardening steel
- Manufacture of hydrocyanic acid

Sodium Fluoride (NaF)
- Insecticide
- Disinfectant
- Preserving wood, pastes and mucilages

Sodium Nitrate ($Na NO_3$)
- Manufacture of nitric acid
- Catalyst in sulfuric acid manufacturing
- Manufacture of:
  - Sodium nitrate
  - Glass
  - Pottery enamels
  - Matches
  - Smoking tobacco
- Meat pickling

Sodium Sulfate (Na_2SO_4)
- Standardizing dyes
- In freezing mixtures
- Textile dyeing and printing

Sodium Sulfide ($Na_2S . 9 H_2O$)
- Manufacturing artificial silk
- Dyeing
- Hide dehairing
- Sulfur dyes

Rubber manufacturing
Engraving and lithography
Sodium Sulfite (Na_2SO_3)
Photographic developer and fixative
Bleaching wool, straw and silk
Generating sulfur dioxide gas
Dyes
Silvering glass
Paper manufacturing
Food preservative

Various other sodium compounds are used in medicinals and pharmaceuticals. Some are consumed industrially for uses paralleling many of those outlined above.

2. Materials Substitution Practice

It is at once apparent that the process of substituting one material for another may be relatively simple in some cases while in others it may be complex. Therefore, an early appraisal of the ease or difficulty of a proposed substitution is necessary to determine whether the project appears sound and achievable with available means, according to Lovelace.[2] This should include consideration of the substitutive materials, their suitability as indicated by known properties, their availability, the sufficiency of reserves, and any potential problems in supply. Appraisal of these aspects should be as complete as available information allows, and needs for additional information should be identified and defined and preferred methods indicated for obtaining it. Similar appraisal is necessary for the technologies to be employed in the substitution. Lovelace urged that substitution not be viewed as a casual or easy process, pointing out that even with seemingly simple substitutes there can be unwelcome surprises as a result of inadequate attention to some aspect of a proposed substitute.

(2)Alan M. Lovelace, Associate Administrator for Aeronautics and Space Technology, NASA, Washington, D.C., at the Conference on Materials and the Development of Nations: The Role of Technology; Concurrent Workshop on the State of Relevant Technologies - Substitution; National Academy of Engineering/ National Academy of Sciences, Washington, D.C., April 28-29, 1976.

Hambraeus[3] considers substitution preparedness as being very important to the process of replacing one material or article with another. He described preparedness as action or planning in order to alleviate or shorten difficulties and adverse consequences that attend or follow substitution. Among the first steps that he recommends is the forecasting of resource reserves, both for a given material and one that is to replace it. Information areas concerning resources or primary materials to be used in making substitutes are 1) production methods and rates, 2) consumption (allowing for waste or residues), 3) analysis of prices for proposed primary materials, especially from alternate sources, 4) political aspects, 5) energy needs, sources and costs, and 6) effects of other markets on primary materials supply and demand. With regard to the substitute itself, Hambraeus lists as being important the need for information on consumption patterns, fundamental qualities required in view of functional and performance requirements, and data on properties of the possible substitute. He pointed to the need to identify critical performance areas by model studies, and to research and development to provide information not available for any of the sectors mentioned above. Where necessary, appropriate tests should be made and pilot studies conducted. He indicated that substitutes may be obtained by restructuring of products or "off key design."

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(3)Gunnar Hambraeus, President, Royal Swedish Academy of Engineering Sciences, Stockholm, Sweden, at the Conference on Materials and the Development of Nations: The Role of Technology, Washington, D.C., April 28-29, 1976.

Arrol[4], with 23 years of background in work involving the substitution of materials, identified several new driving forces that must now be considered in thinking of substitutes, whether in materials, or technology, or processes; these are energy, the environment, and public health. The two elements found by him to be of highest importance in developing substitutes are performance and properties; this has been especially so in finding substitute materials in England's automobile and aircraft industries. Rules emerging from many cases of materials substitution were said by Arrol to be:

1. There is usually always a necessity for final development of a substituent material; this is because the basic material is rarely in the final form that is needed.
2. Redesign of a product is frequently required, and this may involve modification of the substitute material.
3. A new manufacturing process(es) may be employed.
4. Realistic proving of the substitute material or product is necessary.

(4)W. J. Arrol, Director of Research, Group Research Centre, Joseph Lucas Limited, Lucas Industries, Shirley Solihull, West Midlands, England, at the Conference on Materials and the Development of Nations: The Role of Technology; Concurrent Workshop on the State of Relevant Technologies-Substitution; NAE/NAS, Washington, D.C., April 28-29, 1976.

Arrol cited a number of examples of substitute materials, including fiber reinforced resins to replace wood and metal in boat manufacture, carbon fiber in brake units to replace asbestos and metal fibers, changes in materials and redesign in a fuel piston pump having many rubbing services, and a glass fiber reinforced polyester headlamp reflector housing to replace one made of steel.

Hibbard[5], in speaking as Chairman of the Workshop on Substitution at the Conference on Materials and the Development of Nations: The Role of Technology in Washington, D.C., April 28-29, 1976, cited a number of materials substitutions that have been developed to solve or alleviate problems, or to provide materials with improved properties and performance capabilities. Among these are 1) the increasing use of concrete as a product of lower energy intensity to replace steel in structures of many types, 2) the use of misch metal to replace manganese in steels, 3) the growing use of plastics to replace various metals in industrial transportation, household, and many miscellaneous products, 4) the use of fiber reinforced plastics, and 5) impregnated concrete having higher strength and much lower permeability than conventional concrete. Pointing out that new developments are on the horizon, Hibbard referred to substitutability as one of the key factors in maintaining equality in life.

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(5)Walter R. Hibbard, Jr., University Distinguished Professor, College of Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

3. Incremental Substitution

Substitution does not necessarily involve a total replacement; there can be partial or incremental substitution so long as performance requirements are met and/or functional needs of the final composite material or article are satisfied. A substitution of this sort often is found or required in a system and it may be of either major or minor proportions. The stimulus for using partial replacements may be associated with cost, materials availability, service conditions, appearance, regulations, preference, and other factors. The automobile and the airplane are examples of systems in which many components are now produced from materials that, while of the same class, differ from the original ones used (metals), and from materials that are of different classes than were originally used, such as plastic for steel and composite structures for aluminum. Also, many building structures can be and are designed and built compositely of wood, metal, plastics, ceramics and concrete, with the proportions of each varying according to circumstances. It is, in fact, in the area of construction materials that a large number of the opportunities for incremental substitution are to be found. Large, multistory buildings often are built principally of concrete, with steel being used only in the form of reinforcing bars. This has led in many instances to savings in costs of both materials and construction as compared to similar structures built mainly of steel. Conversely, the same buildings could be constructed almost entirely of steel, with little concrete being used. The options are numerous with regard to structural elements, interior finishing materials, and other parts of buildings.

Incremental substitution is possible also with basic building materials. For example, there are a number of substitutes for pure portland cement, including blended hydraulic cements such as 1) portland-pozzolan cements in which as much as 40% of the portland cement may be replaced by a suitable pozzolanic material such as volcanic ash or by an acceptable fly ash, 2) portland blast-furnace slag cement in which up to 65% of the portland cement may be replaced by acceptable blast-furnace slags, and 3) others. Incremental substitutions of the above types in cement making are gaining favor around the world because they can reduce the fuel requirements per unit of finished cement output. The basis for this is that the pozzolans and slags used do not have to be thermally processed; they are added to ground portland cement or are blended by intergrinding with clinker.

An example of incremental substitution not associated with building materials is in the manufacture of paper from pulp from bagasse and imported long-fibered pulp. This is particularly appropriate for countries that are cane sugar producers but have little or no resources of soft woods for making pulp, as is the case for many LDCs. The properties of bamboo kraft pulp-relatively high tear but low tensile strength--make it particularly suitable in blends with pulps of lower tear but higher tensile strength, such as those from hardwood and bagasse. Such blends provide a useful balance of strength and other properties for many grades of paper. Thus, in many Torrid Zone countries where bamboo thrives and sugar cane is a major crop, there is potential for incremental substitution in which the fibers of these materials can be used in paper-making.

This can eliminate or substantially reduce the need for long-fiber pulp produced from soft woods and usually imported by countries not having soft wood forest resources. The technology and state-of-the-art for producing and using bamboo pulp are well-developed in India where the world's modern bamboo pulp and paper industry is centered, and where about 70 percent of the total pulp produced is made from bamboo in about 20 mills.

4. Substitution In Manufacturing and Construction

Materials substitution technology as practiced in manufacturing and construction deals largely with solving problems that grow out of diminishing supplies of basic materials, expected scarcities, advancing costs of materials and labor, and the high cost of energy. In recent years, the use of substitute materials and also substitute technologies has tended to become more the rule than the exception, with increasing emphasis being placed on the substitution of plentiful for less plentiful resources. There has been a growing awareness of substitution possibilities in all sectors of industry.

a. Manufacturing

In manufacturing, and, indeed, in virtually any activity that employs materials, the search for alternate and/or new materials results from the pressures to satisfy extremely important functions for which existing materials are only marginally successful. For example, the aerospace accomplishments of recent years in the United States depended on the development of new materials and structures with high strength and stiffness-to-weight ratios. This effort stimulated work on low-density, high-performance composites reinforced with boron

and carbon fibers. More recently, the changing fuel supply situation has caused new emphasis to be placed on metals and ceramics having higher temperature capabilities for use in heat engines. Such materials are needed to achieve greater Carnot efficiency and to withstand the increasingly hostile chemical environments due to the expected deterioration in the quality of economically affordable fuels.

The above are examples of the pursuits of particular individuals or organizations concerned with materials effectiveness. On a broader scale, increasing emphasis is being placed on the search for materials that meet specific "hardware" requirements. Economics and good design dictate that materials be used as efficiently as possible. Thus, materials are being worked harder to increasing degrees. This hard working of materials can be done when the use conditions are carefully defined and controlled. However, it can also lead to problems when the same article or apparatus is operated under a new set of conditions. Manufacturers are becoming increasingly skilled in learning to use scarce and expensive materials locally only where needed. The substitution of one class of materials for another and the reexamination of designs in terms of their functional requirements place a continuing challenge on the materials and design communities to establish better mutual realistic awareness of their respective capabilities and limitations.

The heavy manufacturing industries of developed nations in particular are today faced with tremendous technological challenges brought about by actual and potential shortages of critical materials and by demands to reduce the weight of their products and to decrease component energy content. On top

of these and other challenges is the traditional engineering goal of reducing a part's total cost. Material substitution can often be the most direct route to realizing these ends.

In few industries is competition among materials as fierce as in automobile manufacture, which converts some $5 billion in materials annually into about 10 million vehicles and will struggle to lop pennies from the manufacturing cost per car. A weight increase of one (1) pound per vehicle adds 5000 tons annually to the industry's consumption of materials. The automotive industry in the United States is committed to reducing the weight of its standard size vehicles by up to 1000 lb (455 kg) as part of a program to slash fuel consumption by as much as 40%. Redesigning existing parts rather than building new ones from the ground up is viewed as the cost-conscious solution. This can involve decreases in iron or steel thickness and using some substitutive aluminum in parts where structural and performance integrity will not be penalized as a result. The substitution of formable high-strength, low-alloy steels for lower strength steels that require heavier sections in many parts is now widely practiced. The use of powder metal parts for castings and wrought products involves, first, a process substitution and, second, a materials substitution. Additionally, the production of components by powder metallurgy permits the reduction and often the elimination of scrap. Most of the major plastic applications in automobiles and trucks are at the expense of zinc die castings. For example, a sixfold reduction in weight accompanied a switch from a plated zinc wheel cover

insert to a plated plastic insert. Also, a side marker light fixture, formerly four (4) zinc die castings assembled with screws, was replaced by a one-piece chromium plated plastic part with an ultrasonically sealed acrylic lens. A case in England where a plastic substitute replaced a drawn sheet steel item involved the use of a glass fiber reinforced, injection molded polyester head lamp reflector housing for automobiles.

In the manufacture of industrial equipment, gray iron castings are being replaced by aluminum die castings for savings in materials, machining, and shipping costs. Titanium is making inroads in the large compressor industry as speed requirements and operating temperatures increase. The substitution of forged titanium alloy for steel, for example, achieved a 40% weight reduction on one giant rotor and resulted in a cost saving.

It is realistic to say that no manufacturing industry is without options as to the use of substitute materials of the same or different classes at some stage of processing and production. Alternatives exist as to the nature of raw substances or materials to be extracted, refined, purified or converted as well as to the forms of energy employed. For example, quicklimes are produced from limestone, coral or oyster shells, using either rotary kilns or shaft kilns fired with oil, gas, coke, wood or coal. Paper and paperboard are manufactured from pulps produced from softwood and hardwood trees in the United States and principally from softwood in Canada, but sugar cane bagasse, bamboo, kenaf, rice straw, cereal (wheat and rye) straw, cotton linters, various grasses and other nonwood plant fibers as well as hardwoods are used in countries of the Far

East, Asia, Latin America, Africa, the Near East and the Middle East. Ammonia production for fertilizer usage is based on natural gas as a hydrogen source in the United States, but a number of countries use coal from which synthesis gas is made and used in lieu of natural gas. An unusual example of utilizing available materials (for the direct synthesis of ammonia, using steam decomposition over hot carbon to make water gas which is a source of hydrogen) when other hydrogen-source materials are not available or would be uneconomical, is a plant in India that produces hydrogen using the steam-iron process; crude hydrogen gas used for reducing the iron is obtained from partial oxidation of wood, gathered from the extensive forests there. Containers for foods, pharmaceuticals, beverages, and other substances are made from materials in several different classes--glass, metals (steel and aluminum), plastic, and ceramic. These are manufactured from different types or classes of materials and by the use of distinctly different technologies (except for plastic and glass containers which are made by somewhat similar blow-molding techniques).

Many manufactures are based on fabrication from materials produced in basic industries that provide steel, wood, cement, chemicals, plastics, base metals, textiles, etc. in various standard forms such as ingots, sheet, wire, plate, structural shapes, bars, etc. of steel; logs, timbers, planks, plywood, etc. of wood; liquids, granules, powders, and lump chemicals; liquid, granules, powders, sheet and other forms of plastics; bars, sheet, plate, extruded shapes, wire, etc. of base metals; and fabrics, cloths, carpeting, meshing, etc. of textile products. Among the various materials listed there are dozens of

substitution possibilities as to the finished products that may be made from them--plastic or galvanized buckets, wooden or steel or concrete structural members, steel or aluminum beverage cans, aluminum or steel or plastic or wood boats, steel or wood or plastic or concrete pipes, steel or wood or plastic furniture, and so on. Such a wide variety of materials from which to fabricate and manufacture is, of course, found principally in developed and relatively developed countries. Interestingly, the basic resources from which a very large percentage of the manufactures originate have their sources in lesser developed countries. It would appear, then, that substitution possibilities and opportunities in manufacturing in those countries are dependent on more complete development and utilization of indigenous resources.

b. Construction

Perhaps in no other area of materials usage are there more options for the use of alternates or substitutes than in construction. Considering the broad spectrum of materials that can be utilized in construction, this is not surprising. A factor likely to bring about changes in materials usage and structural designs is the radically changed picture of fuel supplies and costs. The National Bureau of Standards has estimated that energy consumed in residential heating and air conditioning, for example, could be reduced nationwide in the United States, by as much as 50 percent from current levels by better insulation and construction. The technology is available and insulation is being upgraded.

The spectrum of materials finding use in building and construction includes inorganics and organics, or metals and nonmetallics. Insofar

as substitutability is concerned, important considerations are functional properties, availability, and cost. In appraising alternate materials in a given construction application, performance criteria are indicated to be preferrable to building codes. For example, the estimated 4,000-6,000 building codes in the United States impede progress partly because they are out of date and more importantly because they differ among themselves. The resulting effects are to limit both the range of usable materials and the size of their markets; both factors restrict the effort likely to be expended on new or substitute materials. The matter of performance criteria vs building codes is worthy of note because of the need to have guidelines and/or regulatory means for specifying degrees of safety, durability, livability and the like for the products of construction. Experience of the United Nations in a number of lesser developed countries has indicated a need for realistic building standards, a situation which reflects on materials selection, suitability, and utilization.

Construction projects invariably involve design and materials selection whether for dwellings, public buildings, dams, industrial plants, roads and highways, bridges, offshore drilling platforms, or other structures. Some of these--dwellings and roads, for example--can be built entirely of native materials that are locally available, as is frequently the case in many areas of lesser developed countries. There, the need often is for livable dwellings, without frills, that can be provided at low cost and without using a wide variety of materials. However, there may not be many substitution options because of limitations of local materials. Low-cost housing projects frequently being

undertaken in both developed and lesser developed countries often create demands for sizeable quantities of materials that may, in part, be departures from materials normally used. In such instances, economies of scale may come into play; at the same time, low-cost housing projects afford realistic proving grounds for new and substitute materials and systems based on them. However, experience has shown that the cost/benefit ratio (where benefit is understood in the broadest sense, and cost means total cost) of well-known materials is difficult to beat with new materials; indeed it happens quite rarely. Some of the newer materials that are being substituted for traditional materials are discussed in the following sections.

Plastics

One of the materials to be used in construction is that of plastics or resins. Fabricated into a broad spectrum of articles, these are widely substituted for metals, ceramics, wood and paper. Costs of plastics are situated between the cheap materials (brick, cement...), and the "fine" materials (copper...); they are situated in the range of common metals (steel, aluminum...). Despite the savings in costs that are obtained when production attains a higher threshold, it is unlikely that costs will change much in the future; indeed, they have not changed very much as a result of the relatively recent cost modifications stemming from the oil price increases. Depending on the cost of the traditional materials for which plastics are substituted, plastics will seem to be expensive or cheap. Often, the costs of the materials suggest their use as a bonding agent for aggregates which occupy 80% to 90% of the final

volume. This approach also improves the rheological properties, aging characteristics and fire behavior. Most often, plastics tend to be used as direct substitutes for traditional materials, in which case the cost aspect of the cost/benefit ratio alone enters into consideration (where benefit still includes durability). In this way plastic pipes compete with copper, plastic foams substitute for mineral wools, and polyvinyl chloride (PVC) floorings for wood parquets. Also, plastics substitute for steel, iron and ceramic plumbing hardware (pipe, shower stalls, sinks and bathtubs, table and bench-top tile, etc.); in many items the plastic is reinforced with glass fiber or filler with mineral grains or powders. However, plastics are not competitive with, for example, asbestos cement or concrete for external claddings. Sometimes, however, certain plastics have properties that traditional materials do not possess, as in the case of elastomers. Then price ceases to be a factor.

Sandwich panels with skins of asbestos--cement, galvanized sheet steel, enamelled steel or aluminum, enamelled glass, thin stone slabs, etc. and filled with expanded polystyrene, stiff-foamed PVC, expanding polyurethane or isocianurate-type resins have come into widespread use as substitutes for brick, wood, concrete, and metal in commercial and industrial buildings for facades, curtain walls and other building elements. In the same family are cladding panels which are usually of larger size than sandwich panels and typically are clad with steel or aluminum.

Gypsum Plaster Materials

Building and construction materials made from calcined gypsum ("stucco" or plasters) have been used for an increasingly larger part of buildings constructed in many parts of the world, thus substituting for wood lath, lime plaster, and other materials that have traditionally been utilized in roofing and wall systems. Prefabrication and spraying are established application techniques. Plaster components, or plaster-based components, can be used for partitions or as linings associated with insulation, as wall and ceiling cladding or as permanent formwork. The mechanical properties that are particular to plaster suggest an increasing spectrum of usage; it is said that compressive strength of 3500 psi is readily obtainable (somewhat above the compressive strength of standard concrete--2500 to 3000 psi) and that it is possible to reach 7-8000 psi. Dynamic modulus of elasticity is much lower than for concrete; bending strength is low but sufficient at 700 to 1400 psi. Water solubility (0.3 oz/gal) and loss of strength under damp conditions were formerly a problem but this has been overcome. Large-size plaster panels are a recent West German development. Blocks, planks and a variety of other products are substitutable for their counter parts made of concrete, brick and other more energy intensive materials. In Germany, large blocks made from lime and plaster have been marketed for the construction of single-family housing. Sprayed plasters that are weather-resistant appear to be fully developed and are becoming available on the market place. Not all of the qualities of plaster have been fully exploited and research into possible energy savings promise

a good future for plaster, since it is economical to make (requiring three or four times less fuel per ton than cement) and has remarkable characteristics (particularly for insulation).

New Uses for Fired Clay

French studies are examining the production and use of cellular or foamed, fired clay products for use in construction. By one method, cellular structures are obtained from a slurry of clay and water, to which a foaming agent is added; the slurry is vigorously stirred, poured into a mold, dried and fired. By the second method, (thermo-foaming) dried and ground clay is placed in a refractory mold and fired; the firing cycle includes a phase of rapid temperature rise. At the temperature at which the clay becomes plastic, a phenomenon of expansion (bloating) takes place within the mass. After cooling slabs are obtained which can be cut to dimensions. The applications of clay foams and thermo-foams partially overlap; they include:

..story-height monolithic panels
..thermal insulating exterior cladding panels
..insulation for roof-decks
..fire protection
..etc.

Other fired clay products include 1) large-size drawn bricks, which are story-high in length, of modular widths, which are laid with the hollows vertically, 2) roof slabs made by extrusion, with ribbed shape, which are to be laid on a roof like gigantic roofing tiles, 3) heavy aggregates made from fired clay for use in very high resistance concretes, with one design (for skid resistant road surfaces) made of fired clay aggregates of tetrahedral shape, and

4) impregnated fired clays (filled with resins) that have shown a considerable increase in mechanical strength, exceeding 9600 psi in bending and above 50,000 psi in compression. All of these products can substitute for traditional building elements of concrete, steel and brick. However, they are quite energy intensive and are not likely to be cost competitive under usual circumstances.

Plastic Foams

Foams (rigid) can be made from almost any plastic material; however, polystyrene and polyurethane are readily available and not too costly. Foams have low modulus of elasticity and a high degree of creep. Provided suitable configurations are designed, the foams can be used in a primary or secondary structural role, or as formers for other materials. For primary structures, it is best to use doubly-curved shapes (to limit strain) so that the amount of materials can be reduced; extremely economical structures have been made from polystyrene and polyurethane foams. As a secondary structural material, a single curvature or folded structures can be made; production processes can be devised to meet the requirements as to the properties of the material. Plastic foams used as primary or secondary structural materials can be substituted for wood, steel or aluminum, concrete, and brick, but they require protection from physical damage and ultra-violet ray degradation and their flammability must be given due consideration. Also, designs of construction elements and structures must take into account the properties and limitations of the plastic foams.

Other Materials

A group of materials which are being used increasingly in the construction industry are composites in which a weak matrix is reinforced with high strength, high modulus fibers. Within this group are 1) glass fiber reinforced plastics, 2) glass fiber reinforced mortars, and 3) chipboard paper or paperboard. Relatively new to the construction industry, these materials generally have acceptable ultimate tensile and compressive strengths but low elastic moduli. To enhance the potential of these materials it is necessary to derive extra stiffness by a) incorporating them in a frame structure, constructed from materials such as wood timber or metal, which supports the low modulus component, and b) forming these low modulus materials into folded plate structures.

Industrialized building systems using fiber reinforced matrix materials may be divided into two groups.

a) Those systems which are manufactured wholly from the fiber matrix material which replaced or substitutes for traditional materials such as wood, concrete, metal and brick or tile; and

b) Those which are in the form of a composite construction with a structural frame made of a conventional metal and the cladding made of a fiber matrix material.

Of the three materials, glass fiber reinforced plastics appear to be used most. Glass fiber reinforced cements represent a relatively new technology and the techniques for manufacturing and testing components are still being developed;

only prototype structures using this material have been produced so far. Paperboard or chipboard paper, as compared with conventional engineering materials and with the above fiber reinforced materials, has very low modulus of elasticity in direct tension and bending and very low tensile strength. Its structural properties also vary with temperature and humidity. It has substitutive use in emergency housing, replacing wood, fabrics (tents), and other materials used in temporary situations.

Polymer concrete building panels, either solid or cavity-type, are composed of another relatively new construction material that is finding substitutive use for masonry, cast-in-place and prefabricated concrete, and metals. The panels are used in facades and interior partitions and facings.

Steel fiber reinforced concrete is a newly developed material that is used in place of conventional reinforced concrete in severe service pavements.

Traditional Materials

As indicated earlier, new materials for use in construction may broaden the variety but they are not likely to bring about major changes in the overall materials utilization picture for the field of construction because it is difficult to beat the cost/benefit ratio for traditional materials, such as concrete, metals, ceramics and wood. These are substituted for one another more or less at will, as, for example, concrete for steel and wood in commercial, industrial and institutional buildings and in bridges, docks and other structures. Brick and texturized or special effects concrete are frequently used in lieu of each

other and wood may be substituted for both. Concrete will always be a front-running construction material because it can be cast-in-place or precast to make large and small units or members. Further, it is one of the lowest cost materials available in most areas of the world. Wood can be lower in cost, but as is the case with any material, the more it is worked (prepared) the less is the cost advantage. Clay brick is often replaced by sand-lime brick, structural clay hollow tile,cement-bonded stone brick, block made of cement-bonded aggregate, and cellular concrete block; all of these are used in wall systems and partitions or dividers. Plain or stabilized adobe or compacted earth blocks are brick substitutes in many developing countries.

Roofing systems offer as many options for materials substitution as any area of construction. There are asphalt shingles, felt and gravel or crushed stone (built-up roofs), sheet copper and aluminum and steel, ceramic and asbestos-cement roofing tile, gypsum plaster roof plank, cellular concrete roof plank, straw thatch (even in some developed countries), slate, cedar shakes and shingles, steel and wood trusses, perlite and vermiculite/cement mortars, asphalt, polyurethane sandwich panels, plywood, and others. Factors affecting the use of these materials are numerous and include,but are not limited to cost, appearance, climate, availability, custom and preference.

The use of construction materials is highly oriented to resources, and methods and techniques for using them from one region to another have evolved over long periods of time. Although substitution is possible, it may not be practiced until and unless alternate materials have been proven through satisfactory performance. This is the present situation with a number of construction

materials made of plastics, glass fiber reinforced concrete, industrial wastes and residues, polymer and sulfur impregnated concrete, and others.

5. Materials Substitution Research

Considerable research pertaining to materials substitution in manufacturing and construction is in progress at universities, and research institutes in the United States and in numerous institutions and laboratories of governmental agencies in developing countries. Most of the readily available information on the research deals with biomedical materials and with construction materials. Presumably, this is because the programs in these areas often are concerned with common denominator problems and are typically supported with public funds. Research dealing with materials substitution in manufacturing is very often conducted by industry, as is research in new materials, improved materials, and processing; more often than not the research is proprietary. Universities and research institutes also engage in research in these areas, frequently for industrial sponsors and under contracts that provide for sponsors' proprietary rights. Exceptions to this are in areas of substitute materials, new materials, recycling, and materials processing associated with agricultural and industrial wastes or residues. These subjects are in the realm of national interest and are closely aligned with protection of the environment, conservation of materials and the saving of energy.

The research projects and programs involving or related to materials substitution that are listed in the following sections represent samplings of current work at universities, research institutes, and in developing countries.

While indicating a diversity of subjects, the projects do not necessarily provide a cross-section of the total work in progress.

a. Research at U. S. Universities

While a great deal of research is in progress on materials at U. S. Universities, indications from published information and conversations with university and college staff members are that, as a percentage of the total, relatively little of it is concerned with materials substitution. Because of increasing levels of proprietary research and difficulty of obtaining information from different universities pertinent to specific current research identifiable with or directed toward materials substitution, only a partial listing of projects is given. By way of placing the overall picture of university research in materials in perspective, a 1974 summary report of the National Academy of Sciences Committee on the Survey of Materials Science and Engineering (COSMAT) indicated that up to that time the universities had produced relatively little in the way of new materials, per se. It was felt that the reason for this was that the academic community, with some exceptions, traditionally has resisted interdisciplinary and applied research. However, it was indicated also that the materials research centers at universities planned, at that time, to shift their emphasis somewhat toward applied research, with the area mentioned most often being biomaterials. This field, which holds many opportunities for materials substitution, is highly interdisciplinary, though the corresponding body of technology is much smaller than in other areas, such as ceramics, polymers, electronic materials, etc. Less than three (3) years after the COSMAT report,

which was prepared in 1973 but published in 1974, it is apparent that a significant portion of university research is, indeed, in the area of biomaterials for use in making substitutes for parts of the human body. Other areas are construction materials, ceramics, forest products, and energy resources; it is evident that more applied research is underway, though materials substitution, per se, is not a prominent subject. In a few cases, a brief description of the research effort was available while in others only a descriptive project title was obtained.

The University of Texas at Austin

..Dynamic Model for the Efficient Utilization of Exhaustible Energy Resources (categorization of energy resource demands by substitution possibilities and expense).

..Optimized Use of Solar Energy for Steam Fired Boiler Cycles (study directed toward improving each component in solar systems for 500°F, 250 psi steam).

..Alternate Power Sources (alternate power sources for medium sized electric utilities--municipalities), with primary effort presently directed toward usage of sewage and garbage as fuel for firing conversion type boilers).

..Fiberglas Rod Reinforcement for Concrete Beams (strength and behavior of concrete beams reinforced with fiberglass rods for flexure, using latex modified concrete as a measure toward greater durability for concrete in chemically hostile environments).

..Polymer-Impregnated Concrete for Highway Applications (method of impregnating concrete bridge decks; investigation of means for repairing damaged or cracked concrete; use of polymer-impregnated beams and piling).

..Polymer Concrete - Highway Applications (use of polymer-concrete composites in highway applications is being investigated).

Lehigh University

..Mechanisms of Wear of Ceramic Cutting Tools (substitute for metal and carbide tools).

..Sulfur Impregnated Bricks, Blocks and Concrete (susbstitutes for unimpregnated same products, but impregnation greatly improves strength qualities and renders materials impervious).

..New Cementing Material from Rice Husk and Sugar Cane Bagasse Ash (substitute for conventional cements).

..Performance Study of Sulfur-Sand Treated Bamboo Pole (substitute for structural members of other materials).

..Structural Behavior of Sulfur-Bamboo Reinforced Concrete (replacement for steel reinforcing--surface preparation of bamboo followed by treatment in molten sulfur to coat and seal renders the bamboo resistant to dimensional change that occurs with this high-tensile strength material in the untreated state).

..Polymer Impregnated Concrete as a Construction Material (substitute for conventional concrete in aggressive environments).

Texas A & M University

..Clay-Fly Ash Aggregates (synthetic aggregates to replace natural aggregates for construction usage).

..Partial Replacement of Asphalt by Sulfur in Bituminous Pavements (substitution of sulfur for asphalt).

..Fly Ash as a Filler in Asphaltic Concrete (substitutes fly ash for pulverized rock).

University of Virginia

..The Use of Volcanic Ash Compounds for Construction Projects in Iceland (This work, conducted jointly by

Gillette Research Institute and the University of Virginia found that volcanic ash from Iceland in combination with lime and gypsum--all pulverulent--yielded a cementitious material having potential usefulness in the production of building modules such as bricks, blocks and panels. These would substitute for the reinforced concrete and other normally used construction materials, including bricks, wood, steel, aluminum, etc., that must be imported. Use would be made of geothermal heat for curing. Establishment of the pozzolanic qualities of the Iceland volcanic ashes would appear to be a first step since this could lead to the identification of the most reactive volcanic ashes and the ones best suited for use. With information on the ash's pozzolanic qualities, the proposed work could proceed more or less as planned. However, examination should also be made of other options, particularly the possibilities of using the volcanic in combination with cement and/or lime to produce conventional density building modules and/or cellular concrete cured by hydrothermal treatment; this involves autoclaving in a saturated steam environment at about 355-365 °F and 150 psi, with

ultimate cure being obtained in 8 to 12 hours rather than a matter of days as in curing at atmospheric pressure. The quality of the geothermal heat on Iceland may be adequate for this. Cellular concrete has good thermal insulating qualities and can be designed such that structural strength is adequate. The project has considerable merit and may lead to substitute materials for use in construction, based on materials indigenous to Iceland. Similar combinations of materials in other countries could be a basis for import substitution).

University of Washington - Seattle, Washington

..Dental Implant Materials.

..Studies of Diatomite and Its Usage.

..Low-cost Building Materials for Housing, Schools and Industrial Buildings (This work consists of two related programs, one dealing with the use of agricultural and forest residues for making exterior structural, multifunctional plywood products, and the other dealing with the use of bagasse and other fibers which are formed by a simple process into an oriented fiber mat, with phenolic binder. The plywood product has a 3-ply core made of thick, low-grade veneer, or

veneer of secondary species, produced from four-foot logs as small as 6 inches in diameter. Facings are of a phenolic-bonded, compressed fiber mat which can be made from veneer residue or, more easily, from either straw or bagasse fiber. The resulting panel can be supported with lumber framing on four-foot centers and used for flooring, sidewall sheathing, shutters, doors, and, perhaps, roof sheathing in typhoon-proof and earthquake-proof houses. The fiber mat product of the second program is corrugated while being pressed into a corrugated hard board which may later be painted or given an asphalt coating that contains aluminum flakes. This product is primarily designed to be a roofing material, usable as a replacement for commonly used corrugated galvanized iron sheets.

Both programs involve technical and economic studies, and demonstration; minimum-scale production units are to be established in several developing countries).

North Carolina State University

..Development of High Melting Point-High Strength Glass Ceramics.

..Ceramic Matrix-Metal Fiber Composites for Bone Implants.

Pennsylvania State University

..Crystallizable Glasses for Thick Film Microcircuit Applications.

..Porous Biomaterials (hydroxyapatite) Implants.

..Advanced Materials for Highway Applications.

..Low Cost Inorganic Composites for the Construction Industry.

University of Illinois

..Ceramic Products from Rice Hulls.

..Ceramic Materials from Power Plant Bottom Ash.

Virginia Polytechnic Institute and State University

..Use of Fly Ash For Soil Conditioning and Trace Element Source.

..Low-Cost Housing With Wood in Latin America.

..Performance of Wood As a Material of Building Construction.

California State University (Fresno)

..The Manufacture of Asphalt Stabilized Adobe.

Carnegie-Mellon University

..Materials and Systems for Low Cost Housing.

University of West Virginia

..Use of Power Plant Bottom Ash in Road Construction.

..Production of Forty Percent Core Area Fly Ash Brick (uses lignite fly ash, West Virginia fly ash and Kentucky fly ash).

Georgia Institute of Technology, Cornell University, and Massachusetts Institute of Technology

..Industrial Development in Developing Countries (It is understood that these three (3) universities have grant programs for providing guidance and assistance in industrial development programs in many developing countries. Such industries must use materials, either imported or indigenous, or both. Therefore consideration of import substitution possibilities and opportunities is a facet of the programs. Details as to the role of materials substitution in the work were not obtained. The University of Arizona is engaged in a somewhat similar program, but it is concerned principally with activities oriented to arid lands.)

The preceding list of university projects is but a sampling and is intended to show the diversity of research in progress and to provide an indication of the extent to which the research is involved with materials substitution.

b. Research at Leading Research Institutes

Many of the studies underway at leading research institutes are of proprietary nature, but sufficient information is available to indicate that a considerable portion of them deal with materials substitution and the development of new materials, the latter often involving evolutionary substitution. A major percentage of the research institutes are engaged in biomaterials for use in making substitutes for bones, teeth and other parts of the human body; this somewhat parallels or complements similar work in progress at many universities. Descriptive project titles of a number of projects involving or related to materials substitution are given for three (3) leading research institutes.

Battelle Research Institute,
Columbus Laboratories

..Improved Ceramic Proppants for Petroleum Crude Recovery.

..Characterization of Charred Refuse for Use As An Active Carbon.

..Evaluation of Processed Gypsum for Industrial Applications.

..Properties and Applications of Steel Fibrous Concrete.

..Properties and Applications of Stainless Steel Fiber-Reinforced Refractory Castables.

..Development of Polymer-Impregnated Wire-Reinforced Mortar.

..Development of Erosion/Abrasion Resistant Ceramics for Coal Liquefaction Service.

..Development of Procedures for Centrifugally Casting Wire-Reinforced Pipe for Coal Gasification Applications.

..Development of Bioresorbable Ceramic Materials Having Improved Structural, Mechanical Resorption Properties for Repair of Base Defects.

..Development of Improved Designs and Forming Procedures for High Purity Alumina Tooth Root Prosthesis.

Pacific Northwest Laboratories (Battelle)

..Development and Evaluation of Ceramic Dental Anchors.

..Development of Ceramic Filled Plastic for Dental, Medical and Industrial Applications.

IIT Research Institute

..Ceramic Components for Internal Combustion Engines.

..Development of Corrosion Resistant Concrete by Impregnation with Sulfur.

..Development of New Ceramic Materials and Bonding Techniques for Use in Cardiac Pacemakers.

..Fiber Reinforced Concrete Studies.

..Impregnation of Concrete Aggregate with Sulfur.

Southwest Research Institute

..Use of Fly Ash in the Production of Cellular Concrete Building Blocks and Panels.

..Sulfur Impregnated Concrete Pipe for Use in Aggressive Environments.

..Silica Polymer Cements for Structural and Other Applications.

..Permanently Attached Artificial Limbs.

..Use of Fly Ash and Slags As An Energy Conservation Measure in the Production of Blended Cements.

..Use of Sulfur Surface Bonded Block Wall Structures.

..Silica Foam As Material for Fireproof Insulation, Filtering and Other Applications.

..Pozzolan-Lime Building Materials.

..Synthetic Aggregates.

..Use of Power Plant Bottom Ash in Concrete Block.

..Use of Sulfur in Highway Lane Marking and Striping.

..Hydrothermal Cements for Use In Oil, Gas and Geothermal Wells.

..Direct Injection Stratified-Charge Reciprocating Engines with Multi-Fuel Capabilities (engines of various design configurations can be operated on fuels within a wide range of qualities and BTU content).

c. Research at Institutions of Developing Countries

A considerable amount of work related to materials research and development, utilization and substitution is indicated to be in

progress in developing countries, but information and details were found to be generally limited and/or not readily available. Very little information was available from LDC embassies, though some was obtained from such agencies and organizations as the United Nations' Centre for Housing, Building and Planning, U. S. AID's Office of Housing, and the U.S. Peace Corps. A number of research activities were indicated in the current literature and by persons contacted in developing countries. Descriptive titles of a few of the programs are listed below; explanatory statements are given if information obtained on the work was sufficiently detailed.

Ghana

..Development of A Machine for Brick Production-Building and Roads Research Institute (BRRI), Ghana. Large sums of money are appropriated by Ghana for its imported cement. The government hopes to cut that sum by finding a relatively efficient way to make bricks with equipment that can be maintained by Ghanians.

Colombia

..Cultivation and Utilization of Bamboo--Banco de la Republica, Federaction Nacional de Cafeteros, Tondo Colombians de Investigaciones y Prozectos Especiales, Colombia. This is a continuing program concerned with production and applications of bamboo in paper-making, construction, architecture, engineering and art crafts.

..Utilization of Indigenous Materials in The Construction of Houses in Tropical Zones of Latin America, Industrial University of Santander, Bucaramanga, Colombia.

Trinidad, W.I.

..Utilization of Pozzolanic Materials for Wall Construction, The University of the West Indies, St. Augustine, Trinidad, W.I.

Brazil

..Lumber Standards in Industrialized Low-Cost Housing, Institute do Pesquisas Tecnologicas, Sao Paula, SP, Brazil.

Mexico

..New Insulating and Construction Material, Utilizing Bamboo as Reinforcing Elements, Centro de Investigacion de Materiales, UNAM, Mexico, D.F., Mexico.

Venezuela

..The Teaching of Materials Technology in Developing Countries, UNESCO, Caracas, Venezuela.

Iraq

..Research on Building Materials, Designs and Methods, Scientific Research Foundation, Government of Iraq.

6. Energy and Materials Substitution

The production and conversion of materials requires energy in amounts that vary over a very broad range. Since the needs are subject to the conditions of individual situations, each material requires its own analysis development under some broad guidelines. In one methodology, any specific energy-related materials analysis covering a commodity must be broad enough to include the entire industry of any nation. All degrees of technological progress must be represented in the final output figures. In developing countries where it may be desirable for materials production and conversion to be more or less labor intensive, this must be factored into the analysis; this is especially important when labor can substitute for significant amounts of energy and would reduce the requirements for energy intensive materials and equipment.

The energy requirements of all industrial materials must be known for many purposes. The most important are for determining 1) the energy intensiveness of specific materials, 2) the national requirements for specific materials industries, and 3) energy flow diagrams paralleling process flow diagrams. These factors help guide the selection of materials. Further, they aid those seeking to conserve energy in existing and currently used systems and to minimize energy requirements in selecting alternate systems or in developing new technologies.

The dramatic worldwide increases in energy costs since late 1973 have led to studies for the evaluation of the energy required for extracting, refining, purifying and converting materials to useful forms. Available data from the studies pertain to energy in materials under conditions in the United States, but they are generally applicable to other industrialized countries as well since the employed technologies and processing methods are usually the same or similar. The importance of knowing the levels of energy in different types of materials insofar as import substitution is concerned is several fold: 1) a gage is obtainable of the energy expended in producing a material that is imported; 2) a comparison can be made between that energy level and the known or estimated energy level for a substitute for the import; 3) a basis is provided for a decision on the adequacy of indigenous energy resources to sustain production of the import substitute over a period of years; and 4) energy requirements for possible alternate materials can be compared in evaluating advantages and disadvantages of different substitutes for the import, e.g., concrete or wood or clay brick, or sand-lime brick to substitute for imported structural steel elements for use in construction, or plastics for sheet metal products. Table I shows the energy required for selected metallic and nonmetallic commodities and products in the United States in 1973. As a class, nonmetallics are almost an order of magnitude lower in energy intensiveness per ton than

TABLE I

ENERGY REQUIREMENTS FOR SELECTED COMMODITIES AND PRODUCTS
(United States 1973)

Commodity	Product	Energy Required Per Net Ton Product (10^6 Btus)
	Metals	
Iron and steel	Steel slabs	24
	Gray iron castings	34
	Carbon steel castings	42
Aluminum	Ingot	244
Zinc	Ingot	65
Lead	Ingot	27
Copper	Cement copper	87
	Refined copper	112
Chromium	High-carbon ferroalloy	61
	Low-carbon ferroalloy	129
Magnesium	Metal	358
Manganese	Ferromanganese	49.5
	Blast furnace	46
	Electric furnace	52
Titanium	Metal	408
Uranium	Uranium oxide	
	Acid circuit	776
	Alkaline circuit	1123
	Resin-in-pulp	795
	Nonmetallics	
Calcium	Quicklime	8.5
Cement	Portland cement	7.6
Ceramics	Common brick	3.5
Glass	Glass containers	17.4
Refractories	Basic brick	27
	Fireclay brick	4.2
Clays	Kaolin	2.8
	Other clays	0.1-5.3
Gypsum	Calcined gypsum	1.5
Sand and gravel	Sand and gravel	0.056

metallic materials. This could be an important factor in appraising import substitution possibilities where a metallic material or product can be replaced with a nonmetallic one.

As compared to metallic and nonmetallic materials, the gross energy requirements for many wood products are substantially lower, ranging from just under $6x10^6$ Btus per oven-dry ton for softwood lumber and $7.6x10^6$ Btus for softwood sheathing plywood to $10x10^6$ Btus for medium-density fiberboard and $20.4x10^6$ Btus for wet-formed hardboard. Moreover, the degree of energy self-sufficiency of many wood products is striking; the fuel residues generated in the manufacturing process for these are sufficient to supply all of the energy needed for production, plus a substantial amount for other purposes.

Energy requirements for processing to produce plastics are comparable to those for some of the metallics but are above those for wood products, ranging from $45x10^6$ to $70x10^6$ Btu/ton for polystyrene to $135x10^6$ Btu/ton for low-density polyethylene.

In the area of energy materials themselves, a number of substitution possibilities exist. For developing countries, one or another of these may afford opportunities for big pay-off. Many of these countries depend heavily on wood for energy. The use of wood, however, is inefficient. In a populated area, over dependence on wood decimates forests and so causes erosion and desertification of lands. (This happened in the drainage area of the Magdalena River in Colombia and resulted in siltation of the river, reducing its navigability.) To save the land and its populations, the developing countries could do well to look at biogasification.

According to Russel Peterson, Chairman, U.S. Council on Environmental Quality: "If biogasification were widespread in most developing countries, crop residues and animal waste could produce all the fuel needed for cooking, plus enough energy to manufacture nitrogen fertilizers for intensified farming."

Biogasification provides methane for cooking, thereby reducing dependence on firewood. When dried and burned in an open fire, as is currently done, cattle dung provides 1.65 times the Btus available from the methane gas generated by anaerobic fermentation of the dung. However, only 5 percent of the heat released in open fires is usefully consumed, while 50 percent of the energy in methane can be used in burners that can be turned off. Thus biogasification offers six times as much energy.

Moreover, residues from anaerobic fermentation still contain virtually all the nutrient and fertilizer values of the animal waste. Thus, they can be used as a feed supplement for cattle or as crop fertilizer. When fresh animal manure is used for fertilizer, only about half of the nitrogen value is available for the next crop; the other half is so bound up in complex organic molecules that it cannot be utilized by plants until a year after application.

Methanol can replace up to 25% of the gasoline in blends of these two fuels for use in automobiles and other units powered by internal combustion engines. By the use of established technology, methanol can be produced from coal, waste and wood, the last two being renewable resources. Waste includes agricultural residues, which many developing countries produce in large quantities.

It has been estimated that a ton of methanol can be produced from 5 tons of waste, 3 tons of wood, or about 2.4 tons of coal. Cost is a major concern in development of synthetic fuel plants, whether the feed material is coal, waste or wood. High capital cost is usually accompanied by sizeable costs for transporting and preparing the feed. A coal conversion plant depends on economies of scale to bring the costs down. However, waste/methanol production plants favor medium-sized installations. Thus they can be sited near the sources of feed materials.

The use of vegetable oils as fuels is a possible substitute for fossil liquid fuels. For example, palm oil reportedly has been used to fuel Diesel-type engines. An average heat content for the oil is indicated to be about 9500 gm cal/g With fossil fuel resources declining and prices at record highs and virtually certain to increase, partial replacement of them by vegetable oils may prove to be a viable substitution. Although costs for the two materials have not been compared, it would appear that they may or could be competitive. Economies of scale could provide a favorable picture for the vegetable oils which are derived from trees, a renewable resource. This aspect of the possible substitution has considerable appeal because it holds some promise of being the basis for a perpetual supply of fuel for those applications where vegetable oil can be used.

7. Materials Conversion Techniques and Processes

In the total materials cycle referred to earlier and illustrated in Figure 2, raw resources such as ore, coal, sand, wood, oil, rock, and plants are obtained and extracted, refined, and processed to produce bulk materials that include metals, chemicals, paper, cement, fibers, etc. These are utilized

in making alloys, plastics, textiles, ceramics, concrete and other industrial and engineering materials that through design, manufacture and assembly are fabricated into products, devices, machines and structures. All of this is accomplished through the use of an extremely broad spectrum of physical, mechanical, thermal, hydrothermal, and chemical techniques and processes. There are so many of these that volumes have been written in describing them, and the number continues to grow. A few were mentioned previously in discussing particular products. It would seem sufficient to say that a given material or product is made by the application of appropriate technologies and methodologies. However, there are nearly always alternative ways of producing a given material or item, but for the sake of economy, environmental considerations or expedience one or another is usually preferred. For example, it is possible to produce hydrated lime by chemical processing of calcium carbonate (limestone) involving several stages of treatment; whereas,the same material is producible from limestone by calcinination to produce quicklime (an industrial material) which is then hydrated by water addiction. The latter methodology is preferred because there are no residues, plant investment is lower, and production costs are less even with present fuel prices; it is, however, highly energy intensive. The production of unrefined copper metal from ores and concentrates provides another example. This can be accomplished by smelting, using pyrometallurgy, or by hydrometallurgical methods based on acid leaching and electrochemical recovery or other wet methods. The latter is indicated to be more acceptable from the environmental standpoint

and has been economically proven on a commercial scale; it is gaining in preference.

The preceding examples indicate that a given material or product can be made by more than one conversion technique or process. It also indicated that, as technology advancement provides improvements and a wider variety of processes becomes available for materials conversion, there are additions to the spectrum of materials that can be turned to usefulness. This extends the product base and, insofar as import substitution is concerned, makes it possible and even practical to consider the exploitation of an increased variety of indigenous materials as substitutes. For example, alumina for aluminum production cannot be obtained readily from clays and other mineral substances by the same process used to extract it from bauxite. Accordingly, various thermal and chemical processes have been developed that make it possible to use the non-bauxite materials as alumina sources. One of the thermal processes even produces a residue that, having already been heat-combined, is used (in Poland) as an energy saving raw material in cement manufacture. Then there are those situations where the development or recognition of a match between raw materials, processing, and products provides the basis for a series of interrelated manufacturing and products that can yield several substitutes. An example is the use of coal, wood, or agricultural residues to produce methanol which is not only an alternate fuel to gasoline but also a material usable for ammonia synthesis to substitute for imported nitrogenous fertilizers. Further,

methanol can provide the reducing agent for making prereduced iron pellets from iron ore or concentrates therefrom. These prereduced pellets are used for enrichment of blast-furnace feed or for direct charging to oxygen converters or electric-arc furnaces, the latter presently being used in numerous developing countries for producing steel from imported scrap. The growth of the use of direct reduction of iron ore has been rapid and is predicted to continue in the future. Direct reduction is of interest in connection with minimills since through its use it becomes possible to produce steel at a competitive price even in areas or countries with small markets. Thus, from indigenous coal or agricultural residues it is possible to produce methanol as a substitute fuel and/or as a key material in steel-making.

There are many more examples of materials conversion techniques and processes that can be cited in connection with materials substitution. These would further emphasize the rationale and the need for systematically analyzing materials imports in the light of available raw materials and modern materials technology, especially with regard to how materials can be used. The spectrum of substitution possibilities is so broad that, in the case of developing countries attempting to substitute locally produced materials for imports, a systematic approach to identifying the best opportunities in the light of import volumes and costs and locally available raw materials has more to offer than dealing with individual materials and products on a piecemeal basis. It allows for thinking of raw materials in terms of the total number of products that can be produced from them, thereby making it possible to plan for industrial development on a

broader basis. Also, it can permit advantage to be taken of economies of scale, particularly in instances where a single raw material can be used for a number of applications, each of which can yield different products. Finally, the systematic approach opens the door to broader strategies for decreasing the demand for imported materials which will serve to reduce foreign exchange expenditures. For example, one way to decrease demand for materials is to substitute for them in design of products; this allows one material to be substituted for another where their properties are comparable. However, substitution can be broader than this and still accomplish the end goal of using less of an imported material; products may be substituted where they provide the same function (e.g., microwave transmission for telephone cable), or the functions themselves may be substituted (e.g., energy transfer by electrical transmission instead of transporting oil). A systematic approach to substitution can provide a much broader perspective of opportunities when considered in the light of such possibilities.

VIII. RESEARCH DESIGN, METHODOLOGY AND PLANS

The research plan involves a series of progressive activities having objectives of identifying, analyzing and evaluating possibilities and opportunities for materials substitution to replace developing country imports and then studying and determining conditions and requirements for implementation of the most promising substitution opportunities. The major activities will entail studies appropriate to achievement of objectives in sequence. The activities will be interdependent to a large degree, and they will be generally applicable to systematic investigation of materials substitution in any developing country, subject, of course, to modifications necessitated by individual developing country conditions. Areas of priority will be 1) consideration of materials substitution consistent with developing country needs, 2) identification of opportunities having promise for high pay-off, and 3) substitutions that are possible avenues to reduction of energy materials imports.

Following designation of developing countries to be studied, the initial major activity to be undertaken will involve acquisition, summarization and analysis of information on imports and resources. Milestones in this activity will be reached at points where 1) needed information on imports and resources has been obtained, reviewed and summarized, and 2) analysis and evaluation of information to identify the spectrum of substitution possibilities has been completed. The next major activity will undertake determination of the most promising substitution possibilities in the light of developing country needs and where the best contributions can be made, based on import costs and resources availability.

This will involve tasks to screen the spectrum of substitution possibilities and identify those of particular promise and then correlate them with country needs and determine which ones can make the best contributions; this will require developing country participation. Completion of this activity will be another milestone. With the most promising substitutions identified, the next major activity will determine the technical and economic requirements associated with each one; a milestone will be reached when study of the technical details has been completed and another when examination of economic aspects has been concluded. Findings of this activity will be expected to point up deficiencies and areas in need of special study. A major activity will be undertaken to analyze these needs, define study objectives, and determine study methodology. The resolution of deficiencies or identification of means to circumvent them will constitute a milestone. The reaching of that milestone would open the door to consideration of steps to realize materials substitution on a demonstration basis. The next major activity would undertake whatever projects were necessary to demonstrate substitution practicality, perhaps by making specimen materials or products, using developing country facilities (laboratory or pilot plant) and personnel, and employing technology appropriate to developing country circumstances. Production of the first substitute materials or products would constitute another milestone. The final major activity would consist of discussion of full-scale substitution based on local materials and earlier demonstrated methodology adapted to a commercial scale; the reaching

of a developing country decision to enter commercial production and subsequent output of the substitute material which would be the final milestones.

Major objectives and activities or tasks are summarized below; the order or sequence assumes prior selection of developing countries where materials substitution is to be studied.

Objective #1. Development and Analysis of Background Information

Task a. Acquisition and summarization of information and data on developing country imports, resources and other features; completion will constitute a milestone. A visit to the developing country will be made to set up liaison with developing country governmental, institutional and industrial key personnel and to obtain additional information not available from other sources.

Task b. Analysis and evaluation of information and data from (a) to identify the spectrum of substitution possibilities based on imports and resources and starting materials used for making imports; completion will constitute a milestone.

Objective #2. Determination and Evaluation of Materials Substitution Opportunities

Task a. Determination of the most promising substitution opportunities in view of developing country needs and where the best contributions can be made, including priorities based on levels of foreign exchange expenditures for imports and indicated resources availability; this activity will require participation by upper level decision makers in the developing country. Completion will constitute a milestone.

Task b. From among the most promising opportunities determined in (a), those that could have high pay-off will be identified and described in terms of what imports and resources will be involved, what processing will be involved, and why the opportunity is outstanding. Designation of high pay-off opportunities will constitute a milestone.

Objective #3. Appraisal of Technical and Economic Requirements and Judgment of Feasibility

Task a. Determination of technical and economic requirements for exploiting each of the most promising substitution opportunities, to include material conversion techniques and processes, equipment types, raw material types and properties and production methods, minimum economic production capacity, energy needs, residues and wastes, technical manpower needs, etc.; completion of study of technical area requirements will constitute one milestone and study of economic area requirements another.

Task b. Survey of developing country mining, manufacturing and industrial facilities, raw materials and activities to determine possibilities for linkages with materials substitution opportunities; completion will constitute a milestone.

Task c. Determination of areas in need of special study, analysis of study needs, definition of study objectives, and determination of appropriate methods for undertaking studies; completion will constitute a milestone.

Objective #4. Demonstration of Substitution Feasibility and Implementation

Task a. Demonstration of the feasibility of substituting a given material for an import, using local raw materials, technology and methodology appropriate to developing country conditions; this will set the stage for full-scale implementation and also point up any previously unidentified matters in need of resolution. Completion of demonstration will constitute a milestone.

Task b. Implementation of substitutions demonstrated will involve planning and design of full-scale operations for commercial production, taking into account considerations of technology to be employed, degree of labor intensiveness, location of operation, personnel training, residue or waste disposal, and so on. The start-up of production of a substitute will be a milestone.

The activities that will be involved in accomplishing the objectives of the research program are discussed below.

Objective #1

For reaching Objective #1, a primary task will involve 1) preparation of a topical list of kinds of information that will be needed to determine to provide the most complete account obtainable of developing country imports by type, volume and cost, and of indigenous resources of all types, both exploited and unexploited, 2) determination of sources where the information may be obtained, and 3) acquisition and summarization of the information. Much of the information needed will be obtained from published materials of the United Nations, World Bank, developing country institutions and agencies, and numerous U. S. governmental departments and agencies such as AID, Department of Commerce,

Geological Survey, Bureau of Mines and other recognized sources, including a wide variety of other publications. However, experience has shown that much of the detailed information needed to provide a reasonably complete picture of imports and resources is not available from those sources, and may, in fact, be recorded but unpublished. For example, very little information on types, volumes and costs of developing country imports from all countries exporting to them was found to be readily available in the present study. Therefore, consideration will be given to seeking such information from the developing countries themselves. It is considered desirable to have information that accounts for at least 75% of the total imports--and preferably a higher percentage--in order to obtain a reasonable cross-section view of their types, volumes and costs. Information from published sources on developing country resources is also incomplete and, in many cases, not up to date. Yet it is known that resource studies have been underway in many of the countries during recent years. A visit to the developing country during this task would therefore appear to be warranted to obtain up-to-date information and data on resources and imports to supplement that available from published sources. The visit could also serve the purpose of establishing liaison early in the program and apprising decision makers there of the program's nature and objectives.

With the information previously obtained, a follow-on task directed toward reaching Objective #1 will undertake analysis and evaluation to identify the entire spectrum of substitution possibilities perceivable in the light of types of imports, the likely basic raw materials from which they were made, and developing

country resources. This task will correlate imported materials and products and their underlying raw materials with developing country resources. The work will make use of experience and knowledge in the area of materials science and engineering, especially with regard to the uses for various raw materials and the products that can be made from them. Analysis and evaluation of information from the first task will, in effect, view the materials in the light of the total materials cycle, previously shown schematically in Figure 2 of this report. Some of the imports will be bulk materials to be processed into engineering materials which are, in turn, transformed by manufacture and/or assembly into products, devices, etc. Other imports are in the form of engineering materials and still others are products, devices, machines, etc. The task will, therefore, relate developing country resources to these various types of imports. The product of the work will be essentially a listing of raw material resources and the products to which they can be converted. These will be grouped according to types of manufacturing or perhaps by a standard industrial classification, e.g., textile mill products, lumber and wood products, paper and allied products, primary metal industries, and so on.

Objective #2

For reaching Objective #2, two major tasks or activities are visualized in which the most promising substitution opportunities for a developing country will be determined from the spectrum of substitution possibilities found as Objective #1. Selection of the opportunities will be based on developing country needs and where the best contributions can be made, plus the levels of foreign

exchange expenditures for imports; these factors will be related to raw materials or other resources indicated to be available in the country. Needs of the country and the matter of where the best contributions can be made will be ascertained primarily from discussions with leaders and decision makers in the developing country. The first task will, therefore, be to fit substitution possibilities with country needs to identify those combinations that present opportunities and appear promising, particularly after factoring in foreign exchange expenditures and available resources. In a second task, priority ratings will be given those opportunities that offer promise of high pay-off. The product of this activity will be one or more substitution concepts worthy of in-depth study and examination.

Objective #3

Objective #3 will be reached through several tasks to 1) relate particular substitution materials and products to basic raw materials and techniques and processes for converting them to useful forms equivalent to or exceeding those of imports, 2) review developing country operations in mining and manufacturing to seek possible association with import substitution opportunities, and 3) identify areas in need of special study. From overall findings of the three tasks, information would be provided for assessing feasibility of individual substitutions. The first task will draw on knowledge in areas of processing technology to identify appropriate methodologies for production under conditions in the developing countries, including residues and wastes to be generated and their disposal. Important considerations will be whether preferred levels of human

labor intensity in substitute production are to be high, intermediate, or low and the need to utilize processing methods of the lowest possible energy intensiveness. Both of these will influence process and equipment selection. Raw material requirements with regard to grade or purity, impurity tolerances, physical qualities, proximity of source to point of use, and other qualifying factors will be determined in the light of intended usage. Economic aspects and requirements will be determined relative to quantities of raw material input and product output, estimated water and energy consumption, production capacity as indicated by size of market (to be based in part on volume of imports), indicated manpower needs, estimated capital investment, and other items. Several visits will be made to the developing country under study to discuss or ascertain raw materials properties and availability, preferences as to labor intensiveness of production, and other pertinent aspects of making substitute materials with key government, institutional and industrial personnel. Products of studies of technical and economic requirements associated with exploitation of promising opportunities for substitution will be descriptions of processes and, where appropriate, preliminary flowsheets showing the course of materials from raw state to final products to replace imports.

After the import substitutes have been identified with particular raw materials and conversion processes, developing country operations in mining, manufacturing and other relevant activities will be reviewed in a task which will attempt to associate them with opportunities to produce import substitutes, or to point up situations where experience and/or facilities should be adaptable to the making of specific substitutes.

During and after studies of technical and economic requirements for production of substitutes, it is likely that areas will be apparent which need special study to resolve questions of, perhaps, raw material suitability, need for beneficiation, efficacy of the use of new or different processing, acceptability of alternate treatments, or other matters. These will be examined and determination made of the nature of the problems, what needs to be resolved, and appropriate means to be employed in seeking solutions. This plan does not provide for the actual undertaking of any special studies that may be needed since their nature and magnitude cannot be foreseen. Irrespective of that, such studies should be carried out as fully as possible within the developing countries by institutions or research groups having the capabilities and facilities, or provisions should be made to establish facilities and train personnel locally for such work.

As a concluding activity under Objective #3, judgment will be made of the success potential and feasibility of exploiting individual substitution opportunities. This will involve the assignment of pro and con ratings to technical, economic, and other factors of each case, such as raw material suitability, degree of need for the substitution, satisfaction of country's needs, size of market as related to least capacity for economic production, overall estimated unit production cost as compared to cost of import, energy needs, etc.

Objective #4

Specific activities necessary for reaching Objective #4 cannot be determined until the nature of substitute materials and products to be made becomes

known. However, it is possible to make demonstration specimens of an extremely wide variety of products by the use of appropriate techniques on a laboratory scale in the developing country or with specially provided facilities. Other means include the shipment of raw materials to laboratories that specialize in the particular kinds of work needed, or to equipment manufacturers having laboratory and/or pilot plant facilities for treating and processing in areas of their specialty. No matter what means are employed, the specimen material or product will need to be examined, evaluated and compared to the import that it is intended to replace. This may not be necessary if raw materials are sufficiently well characterized and processes and equipment to be employed in treating them are so conventional as to leave little doubt of feasibility. In the end, demonstration of feasibility will be by means appropriate to the situation and, depending on the simplicity or complexity of product, can entail either a small or a large project. The important aspect is that the demonstrated item be acceptable and reproducible on a commercial scale, using methodology appropriate to particular developing country conditions.

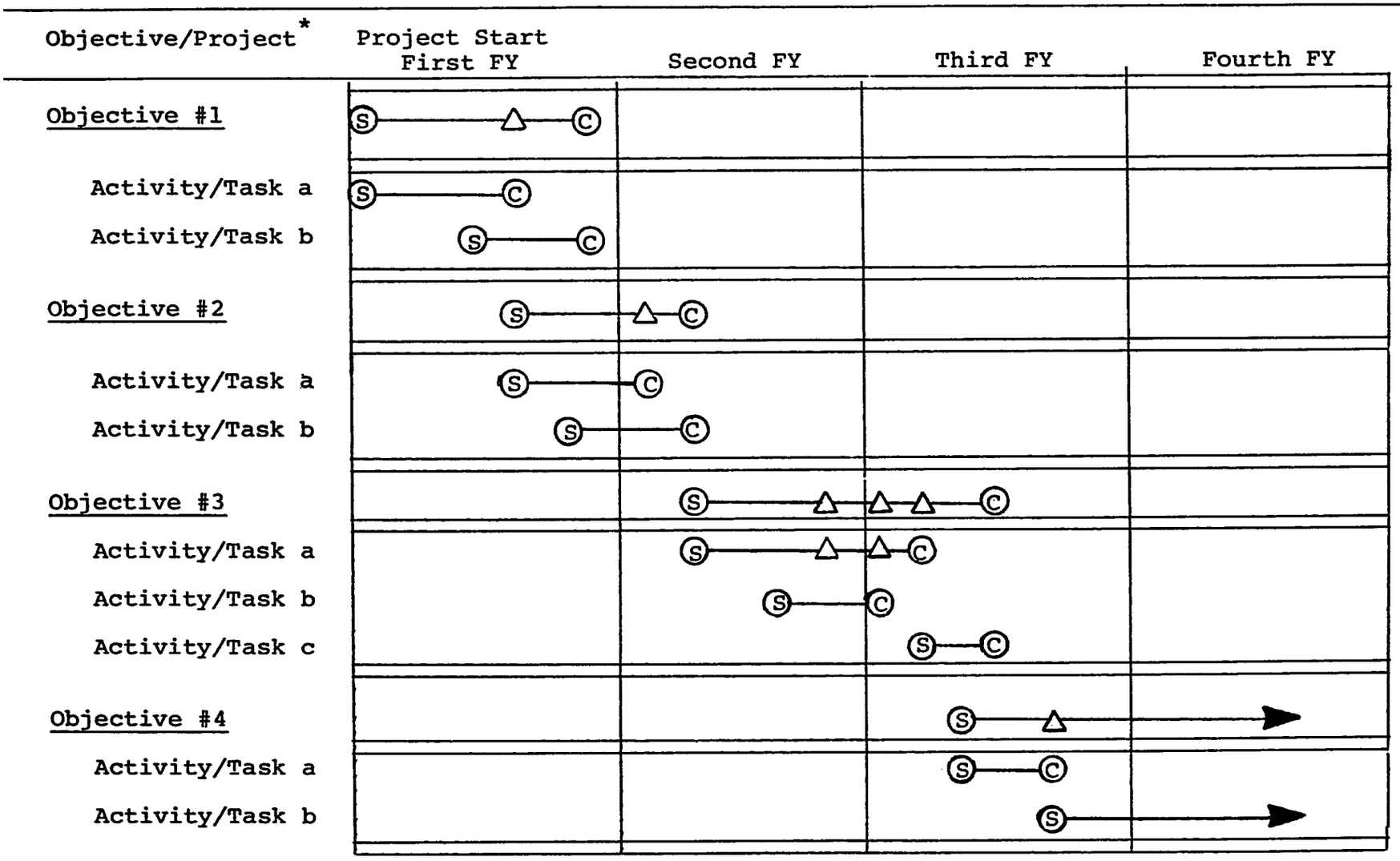
As in the case of demonstrating feasibility, definition of the substitute material or product to be made will be required before activities can be initiated toward commercial production to implement a given substitution opportunity. However, the task of planning, designing and developing a commercial operation will always involve studies related to details of siting, transportation routes, raw material logistics, waste disposal or utilization, building types, power supply, physical plant arrangement, and other aspects.

These will be undertaken as may be appropriate to the particular project, with maximum possible input by developing country forces and perhaps with expertise from consultants as may be required. Further economic studies will be necessary prior to activation of the development plan to minimize the occurrence of unwelcome surprises in areas of production costs, capital investment, and overall soundness of the import substitution as regards its saving in foreign exchange over the foreseeable future.

Figure 3 is a Milestone Life of Project Schedule listing objectives and tasks insofar as they can be visualized at this time, and showing estimated time periods for accomplishing tasks and objectives. This schedule assumes studying materials substitution in one (1) country as the initial project. It is felt that schedules for subsequent studies in other countries are likely to differ from the initial one as a result of experience gained. Estimates of performance times are rough and subject to revision, especially for those activity/task areas where scope of work is definable only in general terms.

Reports

As part of the proposed research, reports appropriate to the needs of the programs will be prepared and submitted as required by AID.



* Same program categories as used in Section VIII, Research Design, Methodology and Plans

Key

Ⓢ - Starting event

Ⓒ - Completion event

Δ - Interim target/milestone

FIGURE 3. MILESTONE LIFE-OF-PROJECT SCHEDULE.

IX. OVERALL COST ESTIMATES

The activities and scope of work to be undertaken for accomplishment of the first two objectives and a portion of the third objective are sufficiently definable to provide some basis for estimation of costs over the first two (2) fiscal years, based on SwRI performing the work. These are given in the following breakdown, but only as approximations at this time; firmer estimates can be provided when requirements and scope of work are defined for projects that AID may design on the basis of this report.

COST ESTIMATES

	First Two Fiscal Years				Work plan Sub-total	
Inputs	Man Mos.	Est'd Cost	Man Mos.	Est'd Cost	Man Mos.	Est'd Cost
1. Salaries	14	$35,000	18	$45,000	32	$80,000
2. Consultants	--	--	1	4,000	1	4,000
3. Fringe Benefits (30%)	--	10,500	--	13,500	--	24,000
4. Overhead (110%)	--	50,050	--	64,350	--	114,400
5. Travel & Trans.	--	15,000	--	20,000	--	35,000
6. Reports	--	2,500	--	3,200	--	5,700
7. Fee	--	7,914	--	10,224	--	18,138
Total Costs by Inputs	14	$120,964	19	$160,274	33	$281,238

COST ESTIMATES (Continued)

Outputs*	First Two Fiscal Years				Work plan Sub-total	
	Man Mos.	Est'd Cost	Man Mos.	Est'd Cost	Man Mos.	Est'd Cost
Objective #1						
Devel'pt. & Analy. of Background Info.	8	$68,950	--	--	8	$68,950
Objective #2						
Detm'n. & Eval. of Mat'ls. Subst'n. Opportunities	5	$43,547	8	$67,315	13	$110,862
Objective #3						
Appraisal of Tech. & Economic Requirements and Judge Feasibility	1	$ 8,467	11	$92,959	12	$101,426
Total Costs by Outputs	14	$120,964	19	$160,274	33	$281,238

*Research objectives are as described in Section VIII.

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e. "The Mineral Industry of the Philippines"
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APPENDIX I

DESCRIPTIVE TITLES OF CURRENT AND PAST INSTITUTE'S PROJECTS INVOLVING WORK RELEVANT TO THE PROPOSED RESEARCH

The following list gives descriptive titles of some current and past Institute projects in which the type of work done was relevant to materials substitution and experience that will be employed in the proposed program.

... The Use of Sulphur as a Highway Marking Material

... Development of Lightweight Lead Sheet Roofing System

... Pumice Building Unit with a Fused Binder

... Pressed Fiber Board

... Demonstration Houses Built of Modular Prefabricated Wall Components

... Corrugated Asbestos Cement Sheets

... Development of Bloated Lightweight Aggregate Industry

... Mono-Panel & Roof Sheet

... Investigation of Raw Materials for Production of Glazed Structural Tile

... Investigation of Building Materials

... Uses for High-Lime Fly Ash in the Construction Industry

... Design of Insulated Panels for Butler Buildings

... Study of Reactivity of Power Plant Fly Ash and Its Use in Producing Cellular Concrete Panels for Building Construction

... Studies of Raw Materials for Stabilized Adobe Brick

... Development of New Finishing Materials and Processes for Plywood

... Laboratory Study of Feasibility of Producing Colored Roof Chats from Lightweight Aggregates

... Survey for Raw Materials Suitable for Cement Manufacture in the the Corpus Christi, Texas, Area

... Technical Feasibility Study for the Establishment of an Artificial Aggregate Industry

... The Facing of Cinder Blocks with Sulfur

... Investigation of Method of Forming Construction Materials

... Preliminary Studies of Pozzolanic Materials

... Compilation of Available Information on Arizona's Nonmetallic Mineral Resources

... The Utilization of Traprock (Basalt) by Melting, Casting and Thermal Treatment to Achieve Controlled Microcrystalline Structures

... Materials for Use in Production of Calcium Silicate Building Products by Hydrothermal Treatment

... Studies of Utilization of Red Muds

... Studies of Utilization of Fly Ash in Brick Manufacture

... Development of a Lightweight Sulfur Foam for Use in Roads, Runways, and Building Materials in Cold Climates

... Literature Survey of the Use of Banana Stalks

... Kenaf Fiber

... Analysis and Evaluation of Utilization of Residual Waste Products as Additions to Portland Cement (Clinker)

APPENDIX II

DATA ON IMPORTS

Bolivia
Ghana
Guatemala
Philippines
Tanzania
Thailand

BOLIVIA

Imports of domestic merchandise from the United States, 1974

Total - $103,053,229

001	ANIMALS--LIVE	23 675
013	MEAT--IN AIRTIGHT CONTAIN; MEAT PREPS	2 729
022	MILK AND CREAM	877 136
025	EGGS--BIRDS , EXCEPT SEPARATE ALBUMIN	2 572
031	FISH & SHELLFISH--FRESH OR SIMPLY PREP.	3 112
032	FISH--IN AIRTIGHT CONTAIN; FISH PREPS	25 677
041	WHEAT, INCL SPELT OR MESLIN--UNMILLED	8 820 743
044	CORN OR MAIZE--UNMILLED	132 271
045	CEREALS, NEC--UNMILLED	22 137
046	WHEAT FLOUR, MEAL, AND GROATS	13 321 538
047	CEREAL FLOURS, MEAL, AND GROATS, NEC.	82 777
048	PREPS OF CEREAL, FLOUR, STARCH, ETC	1 249 833
051	FRUITS--FRESH; NUTS, EXCEPT OIL NUTS.	2 736
052	FRUITS--DRIED, INCL ARTIFIC DEHYDRATED.	54 520
053	FRUITS & NUTS--PREP OR PRES, NEC.	28 080
054	VEG,FRSH,ETC;DRIED LEGUM VEG;VEG PROD	361 748
055	VEG, ROOTS & TUBERS, PREP OR PRES, NEC.	7 279
061	SUGAR, SIRUPS, MOLASSES, AND HONEY.	98 581
062	SUGAR CONFECTIONERY, NO COCOA, ETC.	133 049
073	CHOC & FOOD PREPS CONT COCOA OR CHOC.	8 586
074	TEA AND MATE--CRUDE OR PREPARED	25 042
075	SPICES.	14 864
081	ANIMAL FEEDING-STUFF, EXCL UNML CEREAL.	11 233
091	MARGARINE, SHORTENING, PREP EDIBLE FAT.	229 424
099	FOOD PREPARATIONS, NEC.	389 596
111	BEVERAGES, NEC--NONALCOHOLIC.	18 259
112	BEVERAGES--ALCOHOLIC.	11 430
121	TOBACCO--UNMANUFACTURED	129 976
122	TOBACCO MANUFACTURES.	174 158
221	OILSEEDS, OIL NUTS, OIL KERNELS, ETC.	854 785
231	RUBBER, EXCL CMPDED, SEMIPROCD & MFRS	119 575
243	WOOD--SHAPED OR SIMPLY WORKED	91 983
251	PULPS, AND WASTE PAPER.	530
262	WOOL AND OTHER ANIMAL HAIR.	1 835
265	VEGETABLE FIBERS, EXCEPT COTTON & JUTE.	5 100
266	MANMADE FIBR & THEIR WASTE, EXC GLASS	924
267	TEXTILE FABRIC WASTE, INCLUDING RAGS.	21 048
273	STONE, SAND AND GRAVEL.	7 130
275	NAT ABRASIVES INCL INDUSTRIAL DIAMONDS.	30 500
276	CRUDE MINERALS, NEC	36 017
282	IRON AND STEEL SCRAP.	190 650
288	NONFERROUS METAL SCRAP.	1 760
291	ANIMAL MATERIALS, NEC--CRUDE.	3 873
292	VEGETABLE MATERIALS, NEC--CRUDE	51 366
321	COAL, COKE, AND BRIQUETS.	2 130
332	PETROLEUM PRODUCTS.	768 160
411	ANIMAL OILS AND FATS, NEC	99 821
421	VEGETABLE OILS--FIXED, SOFT, FXC HYDR	887 132
431	FATTY ACIDS, WAXES, ETC, EXCL PET PROD.	6 904
512	ORGANIC CHEMICALS	648 871
513	INORG CHEM ELMNTS OXDS HYDROXDS ETC	373 855
514	INORGANIC CHEMICALS, NEC.	24 778
515	RADIOACTIVE & STABLE ISOTOPES & CPDS ETC	7 752
521	MIN TAR & OILS & CRUDE CHEMICALS ETC.	16 873
531	SYN ORG DYES ETC, LAKES AND TANNINS.	15 581
532	DYEING & TANNING EXTRACTS & ART BATES	6 807
533	PIGMENTS, PAINTS, VARNISHES ETC	292 305
541	MEDICINAL AND PHARMACEUTICAL PRODUCTS	554 508
551	ESSENTIAL OILS, PERFUME ETC MATERIALS	30 418
553	PERFUMERY, COSMETICS, DENTIFRICES ETC	242 739
554	SOAPS, CLEANSERS, POLISHES ETC.	137 944
561	FERTLZRS--MFRD & FERTLZR MTRLS NEC.	284 194
571	EXPLOSIVES AND PYROTECHNIC PRODUCTS	1 010 912
581	SYNTHETIC RESINS AND PLASTIC MATERIALS.	713 783
599	CHEMICAL PRODUCTS & MATERIALS, NEC.	1 994 336
611	LEATHER	668
612	LEATHER MANUFACTURES, NEC	8 357
621	RUBBER ARTICLES IN SPECIFIED FORMS.	288 994
629	RUBBER MANUFACTURES--FINISHED, NEC.	642 460
632	WOOD MANUFACTURES, NEC.	4 076
633	CORK MFRS, & AGGLOMERATED CORK & MFRS	1 311
641	PAPER AND PAPERBOARD.	814 437
642	PAPER,PAPER PULP, & PAPERBOARD ART,NEC.	188 136
651	TEXTILE YARN AND THREAD	307 329
652	COTTON FABRIC, WOVEN EX SPEC OR NARROW.	125 434
653	TEXTILE FABRIC WOVEN EX COTTON, ETC	1 119 254
654	TULLE, LACE ETC AND OTHER SMALL WARES	27 188
655	SPECIAL TEXT FABRIC AND PRODUCTS.	323 953
656	MADE-UP TEXT ARTICLES AND PRODUCTS.	459 726
657	FLOOR COVERINGS, TAPESTRIES ETC	22 296
661	LIME CEMENT & FOR BLDG MTL NEC.	2 000
662	CLAY AND REFRACTORY CONSTRUCTION MTLS	48 861
663	MINERAL MANUFACTURES, NEC	43 712
664	GLASS	59 614
665	GLASSWARE	112 120
666	POTTERY	6 334
671	PIG IRON ETC AND FERROALLOYS.	158 648
672	IRON OR STEEL PRIMARY FORMS	3 409
673	IRON OR STEEL BARS, RODS, ANGLES, ETC	334 142
674	IRON OR STEEL PLATES AND SHEETS	871 158
675	IRON OR STEEL HOOP AND STRIP.	3 645
676	IR & ST RAILS & RAILWAY TRACK MTL	55 787
677	IRON OR STEEL WIRE EXC INSULATED ELECT.	13 200
678	IRON OR STEEL TUBES PIPES & FITTINGS.	424 511
679	IR OR ST CASTINGS & FORGINGS--ROUGH	60 384
681	SILVER & PLATINUM--UNWK & PTLY WORKED	3 764
682	COPPER & COPPER ALLOYS--WR & UNWR	41 794
683	NICKEL & NICKEL ALLOYS--WR & UNWR	3 768
684	ALUMINUM & ALUMINUM ALLOYS--WR & UNWR	98 408
685	LEAD & LEAD ALLOYS--WR & UNWR	3 383
691	STRUCTURES & PARTS--IR, ST, ALUM, ZINC.	184 833
692	METAL CONTAINERS FOR STORAGE & TRANS.	30 748
693	WIRE PRODS EXC INSULATED ELECTRIC	167 800
694	NAILS BOLTS & SIMILAR ARTS, IR ST COPP.	54 027
695	TOOLS FOR USE IN HAND OR IN MACHINES.	598 408
696	TABLE FLATWARE AND CUTLERY.	9 257
697	HOUSEHOLD EQUIPMENT OF BASE METALS.	79 365
698	MANUFACTURES OF BASE METAL, NEC	612 147
711	POWER GENERATING MACH EXC ELECT, & PTS.	3 548 413
712	AGRICULTURAL MACH & APPLIANCES, & PTS	5 100 403
714	OFFICE MACHINES AND PARTS	431 152
715	METALWORKING MACHINERY.	152 045
717	TEXTILE AND LEATHER MACHINERY, & PARTS.	782 783
718	MACHINES FOR SPECIAL INDUSTRIES, & PTS.	7 570 606
719	MACHINERY & APPL, & MACH PARTS, NEC	4 196 367
722	ELECTRIC POWER MACH, SWITCHGEAR, & PTS.	1 392 512
723	EQUIPMENT FOR DISTRIBUTING ELECTRICITY.	183 217
724	TELECOMMUNICATIONS APPARATUS, & PARTS	2 626 146
725	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS	219 916
726	ELECT MEDICAL & RADIOLOGICAL APPARATUS.	96 421
729	ELECT MACH & APPARATUS, & PTS, NEC.	1 441 958
731	RAILWAY VEHICLES AND PARTS.	269 802
732	ROAD MOTOR VEHICLES AND PARTS, NEC.	9 848 473
733	VEHICLES, EXC ROAD MOTOR VEH, & PARTS	136 741
734	AIRCRAFT AND SPACECRAFT, AND PARTS.	13 542 964
735	SHIPS, BOATS & FLOATING STRUCTURES.	183 726
812	PLUMBING, ETC FIX, FIT, LAMPS AND PTS	220 558
821	FURNITURE	164 506
831	TRAVEL GOODS, HANDBAGS ETC.	6 765
841	CLTHNG EX FUR, KNIT ELAS FAB, ART, ETC.	462 708
851	FOOTWEAR--NEW, EXC MILITARY & ORTHOPED.	16 137
861	SCIENTIFIC, OPTICAL ETC APPARATUS	2 268 758
862	PHOTOGRAPHIC & MOTION PICTURE SUPPLIES.	123 282
863	MOVIE FILM--EXPOSED AND DEVELOPED	3 032
864	WATCHES AND CLOCKS, INCLUDING PARTS	12 164
891	SOUND RECORDERS, MUSIC INSTRUMENTS ETC.	240 791
892	PRINTED MATTER.	83 458
893	ARTICLES OF ARTIFICIAL PLASTICS NEC	56 248
894	BABY CARRIAGES, TOYS, SPORTS GOODS ETC.	154 709
895	OFFICE & STATIONER SUPPLIES NEC	146 988
896	ARTWORKS, COLLECTORS PIECES & ANTIQUES.	1 250
897	JEWELRY & RELATED ARTICLES.	553
899	MANUFACTURED ARTICLES NEC	58 336
931	SPEC TRANSACTIONS NOT CLASSED BY KIND	2 129 110
941	ANIMALS, NEC--INCL ZOO ANIMALS.	11 469
022.2	MILK AND CREAM--DRY	877 136
041.0	WHEAT, INCL SPELT OR MESLIN--UNMILLED	8 820 743
044.0	CORN OR MAIZE--UNMILLED	132 271
046.0	WHEAT FLOUR, MEAL, GROATS	13 321 538
048.1	BREAKFAST CEREALS--PREPARED	266 248
048.8	MALT EXTRACT, PREP OF FLOUR,STARCH,ETC.	975 770
054.2	VEGETABLES--LEGUMINOUS, DRIED	121 069
054.8	VEGETABLE PRODUCTS,NEC--FRESH OR DRIED.	240 680
062.0	SUGAR CONFECTIONERY, NO COCOA, ETC.	133 049
091.3	LARD & OTHER RENDERED PIG & POULTRY FAT	216 394
099.1	FOOD PREPARATIONS, NEC.	292 433
121.0	TOBACCO--UNMANUFACTURED	129 976
122.3	CHEWING AND SMOKING TOBACCO,AND SNUFF	173 546
221.6	COTTONSEED.	684 745

Bolivia - Imports from the United States (Continued)

282.0	IRON AND STEEL SCRAP.	190 650
332.5	LUBRICATING OILS AND GREASES.	427 984
332.9	PITCH, ASPHALT & OTH BYPROD EXC CHEM. .	276 471
421.2	SOYBEAN OIL, EXCEPT HYDROGENATED. . . .	876 197
512.0	ORGANIC CHEMICALS	648 871
513.6	AMMONIA,INORGANIC BASES,HYDROXIDES,ETC.	294 483
533.3	PREPARED PAINTS,ENAMELS,LACQUERS,ETC. .	249 039
541.7	MED & PHARM PREP,CMPNDS,MIXTURES,ETC. .	396 162
553.0	COSMETICS & OTH TOILET PREPARATION,NEC.	242 739
561.9	FERTILIZERS, N.E.C.	276 642
571.1	PROPELLENT PWDR,DYNAMITE,OTH EXPLOSIVE.	296 465
571.2	CAPS & FUSES FOR BLASTING, ETC.	590 856
571.4	SHOTGUN SHELLS,HUNT & SPORT AMMO & PTS.	123 591
581.2	POLYMERIZATION,COPOLY, PROD--UNFINSHD .	536 622
599.2	INSECTICIDES,FUNGICIDES,& SIMILAR PROD.	222 738
599.7	ARTIFICIAL WAXES,PREP ADDITIVES,ETC . .	705 935
599.9	CHEM PROD, NEC INCL REAGENTS ETC. . . .	1 018 166
621.0	RBR IN VARIOUS FORMS--UNVULCANIZED,ETC.	288 994
629.1	RBR TIRES & TUBES FOR VEHICLES & PLANE.	407 706
629.4	RBR BELTS & BELTING--TRANSMISSION, ETC.	128 666
641.2	PRINTING AND WRITING PAPER, NFC	482 593
641.5	PAPER AND PAPERBOARD, MACHINE-MADE,ETC.	217 968
642.9	ART OF PAPER PULP,PAPER,OR PAPERBOARD .	161 707
651.6	YARN & THREAD ETC OF NONCELLULOSIC FIB.	298 325
653.5	WOVEN FABRICS OF NONCELLULOSIC FIBERS .	392 985
653.6	WOVEN FABRICS OF CELLULOSIC FIBERS. . .	619 985
655.4	COATED OR IMPREGNATED TEXT FAB & PROD .	248 095
656.9	MADE-UP ARTICLES OF TEXTILE MTL, NEC. .	364 701
671.5	FERROALLOYS, N.E.C.	156 931
673.2	IR & ST BARS & RODS, & HOLLOW DRILL ST.	241 524
674.9	IRON & STEEL PLATES & SHEETS--UNCOATED.	378 068
674.7	TIN PLATE AND TIN COATED SHEET.	191 320
678.3	IR & ST TUBES & PIPES--WELDED, ETC. . .	226 191
678.5	IRON OR STEEL TUBE AND PIPE FITTINGS. .	136 213
691.2	FINSHD STRUC PTS & STRUCTURES--ALUM . .	133 817
693.3	WIRE GAUZE, ETC--IR, ST, COPP, ALUM . .	123 184
695.2	TOOLS, NEC, FOR HAND OR MACHINE USE . .	598 408
698.8	CHAINS--COPPER, & MISC BA MET ARTICLES.	258 540
698.9	ARTICLES OF BASE METALS, NEC.	213 308
711.4	ENGINES AND JET,GAS TURBINES--A/C, ETC.	967 100
711.5	ENGINES--INT COM, EXC AIRCRAFT,& PARTS.	2 541 787
712.1	AGRI MACH FOR CULT, ETC SOIL, & PARTS .	333 254
712.2	AGRI MACH FOR HARVESTING, ETC, & PARTS.	774 642
712.5	TRACTORS, EXCEPT ROAD AND INDUSTRIAL. .	3 200 190
712.9	AGRI MACH & APPR NEC, & PTS & ATT, NEC.	792 317
714.2	ELECTRONIC COMPUTERS EXC PUN CARD TYPE.	175 944
714.9	OFFICE MACHINES, NEC, & OFC MACH PARTS.	136 905
717.1	TEXTILE MACH, ETC EXC DOM WASHING MACH.	697 637
718.2	PRINTING & BOOKBINDING MACHINES, & PTS.	247 023
718.3	FOOD PROCESSING MACH, EXC DOM, & PARTS.	227 214
718.4	CONSTRUCTION & MINING MACH, NFC & PTS .	6 321 681
718.5	MINERAL WRKG & GLASS-WRKG MACH, & PTS .	746 904
719.1	HEATING & COOLING MACH & EQUIP, & PTS .	261 694
719.2	PUMPS, CENTRIFUGES, ETC, AND PARTS. . .	1 596 573
719.3	MECHANICAL HNDLNG MACH & EQUIP, & PTS .	683 918
719.5	POWERED TOOLS, NEC, & ACCESS, & PARTS .	173 235
719.6	NONELECTRICAL MACHINES, NEC, AND PARTS.	211 304
719.7	BEARINGS--BALL, ROLLER, ETC, AND PARTS.	260 684
719.8	MACHINERY & MECHANICAL APPLIANCES, NEC.	377 995
719.9	PARTS & ACCESSORIES FOR MACHINERY, NEC.	527 096
722.1	ELECTRIC POWER MACHINERY AND PARTS. . .	1 254 596
722.2	ELECT APPR FOR MAKING ETC ELECT CIRCTS.	137 914
723.1	WIRE AND CABLE--INSULATED	165 383
724.1	TELEVISION BROADCAST RECEIVERS.	1 278 089
724.9	TELECOMMUNICATIONS EQUIPMENT, NEC . . .	1 245 788
725.0	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS .	219 916
729.4	ELECT IGNITION, ETC EQUIP--INT COM ENG.	385 411
729.5	ELECT MEASURING & CONTROLLING APPR,NEC.	634 183
729.9	ELECTRICAL MACH & APPR, NFC, & PARTS. .	202 001
731.0	RAILWAY LOCOMOTIVES, ETC, & STREETCARS.	147 823
731.7	PARTS OF RAILWAY VEHICLES, NEC.	121 979
732.0	PASSENGER CARS, TRUCKS, ETC--ALL FUELS.	6 092 136
732.8	MOTOR VEHICLE & TRAC PTS & ACCESS, NEC.	3 748 338
733.3	TRAILERS & OTHER VEH & PTS--NOT MOTOR .	136 741
734.1	AIRCRAFT--HEAVIER THAN AIR.	12 052 509
734.9	AIRCRAFT, NEC, & AIRCRAFT PTS & ACCESS.	1 490 455
735.5	SHIPS & BOATS EXC MILTY, INCL SPEC PUR.	183 726
812.4	LIGHTING FIX & FIT, LAMPS, ETC, & PTS .	145 056
821.0	FURNITURE	164 506
841.1	CLOTHING--TEXT FAB, NOT KNIT OR CROCH .	226 255
841.5	CLOTHING ETC EXC NEW FOR RELIEF	188 723
861.6	PHOTO & MOTION PICTURE EQUIP & PTS,NEC.	210 031
861.7	MEDICAL INST ETC EXC ELECTRO-MEDICAL. .	192 226
861.9	MEASURING, CONTROL, ETC INSTRMNTS, NEC.	1 770 021
891.1	PHONOGRAPHS,TAPE RECORDERS,& SMLR MACH.	139 983
931.0	SPEC TRANSACTIONS NOT CLASSED BY KIND .	2 129 110
---.-	SUBGPS AVG UN $10,000 A MO BY ALL MOT .	5 790 474
---.-	SPECIAL CATEGORY*	1 045 276

GHANA

Imports of domestic merchandise from the United States, 1974

Total - $76,680,314

011	MEAT--FRESH, CHILLED, OR FROZEN	178 028
012	MEAT--DRIED, SALTED, OR SMOKED.	1 294
013	MEAT--IN AIRTIGHT CONTAIN; MEAT PREPS .	2 421
022	MILK AND CREAM.	9 552
024	CHEESE AND CURD	1 054
031	FISH & SHELLFISH--FRESH OR SIMPLY PREP.	2 299
032	FISH--IN AIRTIGHT CONTAIN; FISH PREPS .	7 578
041	WHEAT, INCL SPELT OR MESLIN--UNMILLED .	6 006 546
042	RICE--ROUGH,BROWN,MILLED,GLAZED,POLISH.	11 653
044	CORN OR MAIZE--UNMILLED	10 151
045	CEREALS, NEC--UNMILLED.	229 492
046	WHEAT FLOUR, MEAL, AND GROATS	683 906
047	CEREAL FLOURS, MEAL, AND GROATS, NEC. .	137 502
048	PREPS OF CEREAL, FLOUR, STARCH, ETC . .	725 683
051	FRUITS--FRESH; NUTS, EXCEPT OIL NUTS. .	3 317
053	FRUITS & NUTS--PREP OR PRES, NEC. . . .	2 095
054	VEG,FRSH,ETC;DRIED LEGUM VEG;VEG PROD .	9 495
055	VEG, ROOTS & TUBERS, PREP OR PRES, NEC.	6 437
061	SUGAR, SIRUPS, MOLASSES, AND HONEY. . .	17 983
062	SUGAR CONFECTIONERY, NO COCOA, ETC. . .	978
071	COFFEE.	9 274
073	CHOC & FOOD PREPS CONT COCOA OR CHOC. .	1 172
081	ANIMAL FEEDING-STUFF, EXCL UNML CEREAL.	449 658
099	FOOD PREPARATIONS, NEC.	132 428
112	BEVERAGES--ALCOHOLIC.	1 920
121	TOBACCO--UNMANUFACTURED	2 936 786
122	TOBACCO MANUFACTURES.	14 124
211	HIDES, SKINS, EXC FURSKINS--UNDRESSED .	35 705
221	OILSEDS, OIL NUTS, OIL KERNELS, ETC. .	3 698
231	RUBBER, EXCL CMPDED, SEMIPROD & REFS .	355 219
243	WOOD--SHAPED OR SIMPLY WORKED	3 000
251	PULPS, AND WASTE PAPER.	9 565
263	COTTON.	6 374 786
267	TEXTILE FABRIC WASTE, INCLUDING RAGS. .	1 218 173
273	STONE, SAND AND GRAVEL.	7 308
274	SULFUR AND UNROASTED IRON PYRITES . . .	1 654
275	NAT ABRASIVES INCL INDUSTRIAL DIAMONDS.	24 123
279	CRUDE MINERALS, NEC	293 513
284	NONFERROUS METAL SCRAP.	50 000
292	VEGETABLE MATERIALS, NEC--CRUDE	62 298
321	COAL, COKE, AND BRIQUETS.	7 763
332	PETROLEUM PRODUCTS.	7 538 225
411	ANIMAL OILS AND FATS, NEC	1 619 064
421	VEGETABLE OILS--FIXED, SOFT, EXC HYDR .	627 826
422	VEGETABLE OILS--FIXED, NEC.	2 724
431	FATTY ACIDS, WAXES, ETC, EXCL PET PROD.	40 043
512	ORGANIC CHEMICALS	662 670
513	INORG CHEM ELMNTS OXDS HYDROXDS ETC . .	16 184 907
514	INORGANIC CHEMICALS, NEC.	2 098 466
521	MIN TAR & OILS & CRUDE CHEMICALS ETC. .	11 807
531	SYN ORG DYES ETC, LAKES AND TONERS. . .	8 103
533	PIGMENTS, PAINTS, VARNISHES ETC	99 437
541	MEDICINAL AND PHARMACEUTICAL PRODUCTS .	627 107
551	ESSENTIAL OILS, PERFUME ETC MATERIALS .	154 146
553	PERFUMERY, COSMETICS, DENTIFRICES ETC .	51 184
554	SOAPS, CLEANSERS, POLISHES ETC.	80 984
581	SYNTHETIC RESINS AND PLASTIC MATERIALS.	587 654
599	CHEMICAL PRODUCTS & MATERIALS, NEC. . .	499 869
611	LEATHER	43 395
612	LEATHER MANUFACTURES, NEC	18 104
621	RUBBER ARTICLES IN SPECIFIED FORMS. . .	19 049
629	RUBBER MANUFACTURES--FINISHED, NEC. . .	305 696
632	WOOD MANUFACTURES, NEC.	4 342
641	PAPER AND PAPERBOARD.	824 798
642	PAPER,PAPER PULP, & PAPERBOARD ART,NEC.	132 819
651	TEXTILE YARN AND THREAD	1 062 515
652	COTTON FABRIC, WOVEN EX SPEC OR NARROW.	28 515
653	TEXTILE FABRIC WOVEN EX COTTON, ETC . .	614 303
654	TULLE, LACE ETC AND OTHER SMALL WARES .	7 047
655	SPECIAL TEXT FABRIC AND PRODUCTS. . . .	777 227
656	MADE-UP TEXT ARTICLES AND PRODUCTS. . .	333 048
657	FLOOR COVERINGS, TAPESTRIES ETC	10 069
661	LIME CEMENT & FBR BLDG MTL NEC.	46 708
662	CLAY AND REFRACTORY CONSTRUCTION MTLS .	592 025
663	MINERAL MANUFACTURES, NEC	210 568
664	GLASS	42 086
665	GLASSWARE	168 696
666	POTTERY	5 613
671	PIG IRON ETC AND FERROALLOYS.	39 055
673	IRON OR STEEL BARS, RODS, ANGLES, ETC .	751 258
674	IRON OR STEEL PLATES AND SHEETS	737 421
675	IRON OR STEEL HOOP AND STRIP.	46 602
676	IR & ST RAILS & RAILWAY TRACK MTL . . .	648
677	IRON OR STEEL WIRE EXC INSULATED ELECT.	24 711
678	IRON OR STEEL TUBES PIPES & FITTINGS. .	956 129
679	IR OR ST CASTINGS & FORGINGS--ROUGH . .	1 203
681	SILVER & PLATINUM--UNWK & PTLY WORKED .	2 980
682	COPPER & COPPER ALLOYS--WR & UNWR . . .	28 746
683	NICKEL & NICKEL ALLOYS--WR & UNWR . . .	24 478
684	ALUMINUM & ALUMINUM ALLOYS--WR & UNWR .	299 501
685	LEAD & LEAD ALLOYS--WR & UNWR	894
689	BASE METALS & ALLOYS, NEC--WR & UNWR. .	1 120 066
691	STRUCTURES & PARTS--IR, ST, ALUM, ZINC.	293 435
692	METAL CONTAINERS FOR STORAGE & TRANS. .	75 072
693	WIRE PRODS EXC INSULATED ELECTRIC . . .	91 283
694	NAILS BOLTS & SIMILAR ARTS, IR ST COPP.	50 585
695	TOOLS FOR USE IN HAND OR IN MACHINES. .	294 574
696	TABLE FLATWARE AND CUTLERY.	837
697	HOUSEHOLD EQUIPMENT OF BASE METALS. . .	7 135
699	MANUFACTURES OF BASE METAL, NEC	278 147
711	POWER GENERATING MACH EXC ELECT, & PTS.	696 568
712	AGRICULTURAL MACH & APPLIANCES, & PTS .	1 497 416
714	OFFICE MACHINES AND PARTS	129 527
715	METALWORKING MACHINERY.	81 941
717	TEXTILE AND LEATHER MACHINERY, & PARTS.	84 558
718	MACHINES FOR SPECIAL INDUSTRIES, & PTS.	2 135 711
719	MACHINERY & APPL, & MACH PARTS, NEC . .	4 805 562
722	ELECTRIC POWER MACH, SWITCHGEAR, & PTS.	226 836
723	EQUIPMENT FOR DISTRIBUTING ELECTRICITY.	36 929
724	TELECOMMUNICATIONS APPARATUS, & PARTS .	92 349
725	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS .	220 973
726	ELECT MEDICAL & RADIOLOGICAL APPARATUS.	2 501
729	ELECT MACH & APPARATUS, & PTS. NEC. . .	912 673
731	RAILWAY VEHICLES AND PARTS.	16 662
732	ROAD MOTOR VEHICLES AND PARTS, NEC. . .	1 921 596
733	VEHICLES, EXC ROAD MOTOR VEH, & PARTS .	95 115
734	AIRCRAFT AND SPACECRAFT, AND PARTS. . .	20 267
735	SHIPS, BOATS & FLOATING STRUCTURES. . .	15 196
812	PLUMBING, ETC FIX, FIT, LAMPS AND PTS .	76 601
821	FURNITURE	109 148
831	TRAVEL GOODS, HANDBAGS ETC.	1 175
841	CLTHNG EX FUR, KNIT ELAS FAB, ART, ETC.	470 481
851	FOOTWEAR--NEW, EXC MILITARY & ORTHOPED.	40 434
861	SCIENTIFIC, OPTICAL ETC APPARATUS . . .	331 307
862	PHOTOGRAPHIC & MOTION PICTURE SUPPLIES.	74 593
863	MOVIE FILM--EXPOSED AND DEVELOPED . . .	3 875
864	WATCHES AND CLOCKS, INCLUDING PARTS . .	1 224
891	SOUND RECORDERS, MUSIC INSTRUMENTS ETC.	60 602
892	PRINTED MATTER.	222 445
893	ARTICLES OF ARTIFICIAL PLASTICS NEC . .	44 354
894	BABY CARRIAGES, TOYS, SPORTS GOODS ETC.	20 829
895	OFFICE & STATIONER SUPPLIES NEC	42 330
897	JEWELRY & RELATED ARTICLES.	2 698
899	MANUFACTURED ARTICLES NEC	37 022
931	SPEC TRANSACTIONS NOT CLASSED BY KIND .	678 926
011.4	POULTRY, OFFALS EXC LIVER--FRSH, FRZN .	160 688
041.0	WHEAT, INCL SPELT OR MESLIN--UNMILLED .	6 006 546
045.9	CEREALS, NEC--UNMILLED.	229 492
046.0	WHEAT FLOUR, MEAL, GROATS	683 906
047.0	CEREAL FLOURS, MEAL, GROATS, EXC WHEAT.	137 502
048.1	BREAKFAST CEREALS--PREPARED	210 010
048.8	MALT EXTRACT, PREP OF FLOUR,STARCH,ETC.	514 857
081.3	OILSEED CAKE, MEAL, RESIDUES.	146 145
081.4	MEAT MEAL,INCL TANKAGE ETC--INEDIBLE. .	156 000
081.9	FOOD WASTES & PREPARED ANIMAL FEED,NEC.	197 513
121.0	TOBACCO--UNMANUFACTURED	2 936 786
231.2	RUBBER--SYNTHETIC,& RUBBER SUBSTITUTES.	330 155
263.1	RAW COTTON, OTHER THAN LINTERS.	6 374 786
267.0	WASTE MATERIALS FROM TEXT FAB,INCL RAG.	1 218 173
332.5	LUBRICATING OILS AND GREASES.	1 881 395
332.9	PITCH, ASPHALT & OTH BYPROD EXC CHEM. .	5 [illegible] 446
411.3	ANIMAL FATS & OIL,NEC INCL WOOL GREASE.	1 519 064
421.2	SOYBEAN OIL, EXCEPT HYDROGENATED. . . .	627 237
512.0	ORGANIC CHEMICALS	662 670
513.2	CHEMICAL ELEMENTS, NEC.	395 659
513.6	AMMONIA,INORGANIC BASES,HYDROXIDES,ETC.	15 734 252
514.5	ALUMINUM COMPOUNDS, NEC	1 925 091
514.7	INORGANIC CHEMICALS, NEC EXC MED CHEM .	125 555
541.7	MED & PHARM PREP,CMPNDS,MIXTURES,ETC. .	376 663
541.8	MEDICINAL & PHARM PRODUCTS FOR RELIEF .	141 880
551.2	SYN PERFUME & FLAVOR MTL & CONCEN, ETC.	146 846
581.2	POLYMERIZATION,COPOLY, PROD--UNFINSHD .	285 729
581.3	VULCANIZED FIB & CELLULOSIC PLAST MTRL.	162 913
599.2	INSECTICIDES,FUNGICIDES,& SIMILAR PROD.	121 784
599.9	CHEM PROD, NEC INCL REAGENTS ETC. . . .	256 119

Ghana - Imports from the United States (Continued)

629.1	RBR TIRES & TUBES FOR VEHICLES & PLANE.	256 664
641.1	STANDARD NEWSPRINT PAPER.	264 283
641.3	KRAFT PAPER & PAPERBOARD IN ROLLS ETC .	477 380
651.6	YARN & THREAD ETC OF NONCELLULOSIC FIB.	721 830
651.7	YARN & THREAD ETC OF CELLULOSIC FIBER .	300 082
653.5	WOVEN FABRICS OF NONCELLULOSIC FIBERS .	446 557
655.4	COATED OR IMPREGNATED TEXT FAB & PROD .	702 724
656.2	TARPAULINS,TENTS,OTHER CANVAS GOODS . .	293 902
662.3	BRICKS & OTHER REFRACTORY CONST MTLS. .	586 485
663.6	MFRS OF MINERAL MTLS, NEC, EXC CERAMIC.	136 372
665.1	CONTAINERS AND CLOSURES OF GLASS. . . .	122 231
673.2	IR & ST BARS & RODS, & HOLLOW DRILL ST.	538 765
673.4	IR & ST ANGLES, ETC--SP DMN, & SHT PLG.	207 622
674.7	TIN PLATE AND TIN COATED SHEET.	551 736
676.2	IR & ST TUBES & PIPES--SEAMLESS	896 978
684.2	ALUMINUM & ALUM ALLOYS--WROUGHT, NEC. .	230 672
689.3	BRYL & MGN, EXC MGN SCRAP--UNWR OV WR .	1 022 091
691.1	FINSHD STRUC PTS & STRUCTURES--IR & ST.	218 905
695.2	TOOLS, NEC, FOR HAND OR MACHINE USE . .	293 267
711.5	ENGINES--INT COM, EXC AIRCRAFT,& PARTS.	646 723
712.1	AGRI MACH FOR CULT, ETC SOIL, & PARTS .	162 431
712.5	TRACTORS, EXCEPT ROAD AND INDUSTRIAL. .	1 292 128
718.4	CONSTRUCTION & MINING MACH, NEC & PTS .	1 952 130
718.5	MINERAL WRKG & GLASS-WRKG MACH, & PTS .	133 303
719.1	HEATING & COOLING MACH & EQUIP, & PTS .	614 506
719.2	PUMPS, CENTRIFUGES, ETC, AND PARTS. . .	381 693
719.3	MECHANICAL HNDLNG MACH & EQUIP, & PTS .	2 222 859
719.5	POWERED TOOLS, NEC, & ACCESS, & PARTS .	324 666
719.6	NONELECTRICAL MACHINES, NEC, AND PARTS.	310 262
719.8	MACHINERY & MECHANICAL APPLIANCES, NEC.	665 734
719.9	PARTS & ACCESSORIES FOR MACHINERY, NEC.	273 040
722.2	ELECT APPR FOR MAKING ETC ELECT CIRCTS.	122 105
725.0	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS .	220 973
729.1	BATTERIES, AND PARTS NEC.	145 884
729.5	ELECT MEASURING & CONTROLLING APPR,NEC.	362 974
729.9	ELECTRICAL MACH & APPR, NEC, & PARTS. .	306 005
732.0	PASSENGER CARS, TRUCKS, ETC--ALL FUELS.	1 149 300
732.8	MOTOR VEHICLE & TRAC PTS & ACCESS, NEC.	772 296
841.8	CLOTHING ETC EXC NEW FOR RELIEF	338 893
861.9	MEASURING, CONTROL, ETC INSTRMNTS, NEC.	193 462
892.1	MAPS,CHARTS,BOOKS,PAMPHLETS,GLOBES ETC.	151 756
931.0	SPEC TRANSACTIONS NOT CLASSED BY KIND .	878 926
---.-	SUBTPS AVG OV $10,000 A MO BY ALL MOT .	5 420 540
---.-	SPECIAL CATEGORY*	107 907

GUATEMALA

Imports of domestic merchandise from the United States, 1974

Total - $235,424,487

001	ANIMALS--LIVE	826 786
011	MEAT--FRESH, CHILLED, OR FROZEN	86 657
012	MEAT--DRIED, SALTED, OR SMOKED	91 732
013	MEAT--IN AIRTIGHT CONTAIN; MEAT PREPS	68 233
022	MILK AND CREAM	193 171
023	BUTTER AND ANHYDROUS MILK FAT	4 910
024	CHEESE AND CURD	16 414
025	EGGS--BIRDS , EXCEPT SEPARATE ALBUMIN	25 525
031	FISH & SHELLFISH--FRESH OR SIMPLY PREP.	1 611
032	FISH--IN AIRTIGHT CONTAIN; FISH PREPS	4 052
041	WHEAT, INCL SPELT OR MESLIN--UNMILLED	12 720 342
042	RICE--ROUGH,BROWN,MILLED,GLAZED,POLISH.	2 239 202
043	BARLEY--UNMILLED	3 760
044	CORN OR MAIZE--UNMILLED	9 189 694
045	CEREALS, NEC--UNMILLED	105 155
046	WHEAT FLOUR, MEAL, AND GROATS	625 350
047	CEREAL FLOURS, MEAL, AND GROATS, NEC.	106 862
048	PREPS OF CEREAL, FLOUR, STARCH, ETC	1 197 466
051	FRUITS--FRESH; NUTS, EXCEPT OIL NUTS.	794 707
052	FRUITS--DRIED, INCL ARTIFIC DEHYDRATED.	224 204
053	FRUITS & NUTS--PREP OR PRES, NEC.	171 833
054	VEG,FRSH,ETC;DRIED LEGUM VEG;VEG PROD	209 179
055	VEG, ROOTS & TUBERS, PREP OR PRES, NEC.	109 248
061	SUGAR, SIRUPS, MOLASSES, AND HONEY.	258 533
062	SUGAR CONFECTIONERY, NO COCOA, ETC.	154 750
071	COFFEE	7 494
072	COCOA	2 658
073	CHOC & FOOD PREPS CONT COCOA OR CHOC.	88 394
074	TEA AND MATE--CRUDE OR PREPARED	4 906
075	SPICES	29 991
081	ANIMAL FEEDING-STUFF, EXCL UNML CEREAL.	2 389 480
091	MARGARINE, SHORTENING, PREP EDIBLE FAT.	62 447
099	FOOD PREPARATIONS, NEC.	2 387 172
111	BEVERAGES, NEC--NONALCOHOLIC	69 418
112	BEVERAGES--ALCOHOLIC	108 896
121	TOBACCO--UNMANUFACTURED	35 729
122	TOBACCO MANUFACTURES	81 630
211	HIDES, SKINS, EXC FURSKINS--UNDRESSED	248 715
221	OILSEEDS, OIL NUTS, OIL KERNELS, ETC.	363 206
231	RUBBER, EXCL CMPDED, SEMIPROCD & MFRS	564 926
251	PULPS, AND WASTE PAPER	4 428 178
262	WOOL AND OTHER ANIMAL HAIR	908
263	COTTON	5 981
265	VEGETABLE FIBERS, EXCEPT COTTON & JUTE.	2 534
266	MANMADE FIBR & THEIR WASTE, EXC GLASS	475 198
267	TEXTILE FABRIC WASTE, INCLUDING RAGS.	45 011
271	FERTILIZERS--CRUDE	3 500
273	STONE, SAND AND GRAVEL	115 903
274	SULFUR AND UNROASTED IRON PYRITES	19 894
275	NAT ABRASIVES INCL INDUSTRIAL DIAMONDS.	38 436
276	CRUDE MINERALS, NEC	904 024
282	IRON AND STEEL SCRAP	807
283	ORES & CONCEN OF NONFERROUS BASE METAL.	159 015
284	NONFERROUS METAL SCRAP	594
291	ANIMAL MATERIALS, NEC--CRUDE	172 161
292	VEGETABLE MATERIALS, NEC--CRUDE	499 415
321	COAL, COKE, AND BRIQUETS	27 657
332	PETROLEUM PRODUCTS	3 278 501
341	GAS--NATURAL AND MANUFACTURED	243 141
411	ANIMAL OILS AND FATS, NEC	3 586 654
421	VEGETABLE OILS--FIXED, SOFT, EXC HYDR	554 083
422	VEGETABLE OILS--FIXED, NEC	146 950
431	FATTY ACIDS, WAXES, ETC, EXCL PET PROD.	144 991
512	ORGANIC CHEMICALS	7 868 534
513	INORG CHEM ELMNTS OXDS HYDROXDS ETC	765 266
514	INORGANIC CHEMICALS, NEC	1 795 595
515	R-ACTIVE & STABLE ISOTOPES & CPDS ETC	10 271
521	MIN TAR & OILS & CRUDE CHEMICALS ETC.	20 804
531	SYN ORG DYES ETC, LAKES AND TONERS.	829 421
532	DYEING & TANNING EXTRACTS & ART BATES	56 088
533	PIGMENTS, PAINTS, VARNISHES ETC	949 253
541	MEDICINAL AND PHARMACEUTICAL PRODUCTS	4 418 986
551	ESSENTIAL OILS, PERFUME ETC MATERIALS	685 181
553	PERFUMERY, COSMETICS, DENTIFRICES ETC	583 767
554	SOAPS, CLEANSERS, POLISHES ETC.	776 401
561	FERTLZRS--MFRD & FERTLZR MTRLS NEC.	7 722 738
571	EXPLOSIVES AND PYROTECHNIC PRODUCTS	137 405
581	SYNTHETIC RESINS AND PLASTIC MATERIALS.	5 719 415
599	CHEMICAL PRODUCTS & MATERIALS, NEC.	4 405 385
611	LEATHER	32 417
612	LEATHER MANUFACTURES, NEC	132 655
613	FURSKINS--DRESSED, INCLUDING DYED	26 221
621	RUBBER ARTICLES IN SPECIFIED FORMS.	960 942
629	RUBBER MANUFACTURES--FINISHED, NEC.	1 135 858
631	WOOD VENEERS, PLYWOOD BOARDS, ETC, NEC.	30 043
632	WOOD MANUFACTURES, NEC.	103 775
633	CORK MFRS, & AGGLOMERATED CORK & MFRS	5 265
641	PAPER AND PAPERBOARD.	11 249 864
642	PAPER,PAPER PULP, & PAPERBOARD ART,NEC.	1 048 741
651	TEXTILE YARN AND THREAD	4 367 559
652	COTTON FABRIC, WOVEN EX SPEC OR NARROW.	433 363
653	TEXTILE FABRIC WOVEN EX COTTON, ETC	1 071 420
654	TULLE, LACE ETC AND OTHER SMALL WARES	269 380
655	SPECIAL TEXT FABRIC AND PRODUCTS.	959 043
656	MADE-UP TEXT ARTICLES AND PRODUCTS.	543 913
657	FLOOR COVERINGS, TAPESTRIES ETC	427 310
661	LIME CEMENT & FBR BLDG MTL NEC.	133 888
662	CLAY AND REFRACTORY CONSTRUCTION MTLS	1 092 414
663	MINERAL MANUFACTURES, NEC	537 448
664	GLASS	541 723
665	GLASSWARE	1 184 761
666	POTTERY	65 500
667	DIAMONDS & OTHER PRECIOUS STONES.	23 577
671	PIG IRON ETC AND FERROALLOYS.	16 165
672	IRON OR STEEL PRIMARY FORMS	1 587 470
673	IRON OR STEEL BARS, RODS, ANGLES, ETC	1 534 528
674	IRON OR STEEL PLATES AND SHEETS	1 106 162
675	IRON OR STEEL HOOP AND STRIP.	94 371
676	IR & ST RAILS & RAILWAY TRACK MTL	26 567
677	IRON OR STEEL WIRE EXC INSULATED ELECT.	460 628
678	IRON OR STEEL TUBES PIPES & FITTINGS.	2 536 448
679	IR OR ST CASTINGS & FORGINGS--ROUGH	19 760
681	SILVER & PLATINUM--UNWK & PTLY WORKED	11 549
682	COPPER & COPPER ALLOYS--WR & UNWR	217 571
683	NICKEL & NICKEL ALLOYS--WR & UNWR	34 603
684	ALUMINUM & ALUMINUM ALLOYS--WR & UNWR	701 595
685	LEAD & LEAD ALLOYS--WR & UNWR	34 236
686	ZINC & ZINC ALLOYS--WR & UNWR	858 325
687	TIN & TIN ALLOYS--WR & UNWR	53 678
689	BASE METALS & ALLOYS, NEC--WR & UNWR.	29 206
691	STRUCTURES & PARTS--IR, ST, ALUM, ZINC.	1 035 035
692	METAL CONTAINERS FOR STORAGE & TRANS.	491 170
693	WIRE PRODS EXC INSULATED ELECTRIC	267 291
694	NAILS BOLTS & SIMILAR ARTS, IR ST COPP.	425 277
695	TOOLS FOR USE IN HAND OR IN MACHINES.	1 002 524
696	TABLE FLATWARE AND CUTLERY.	65 451
697	HOUSEHOLD EQUIPMENT OF BASE METALS.	612 110
698	MANUFACTURES OF BASE METAL, NEC	2 721 862
711	POWER GENERATING MACH EXC ELECT, & PTS.	3 683 620
712	AGRICULTURAL MACH & APPLIANCES, & PTS	4 712 839
714	OFFICE MACHINES AND PARTS	995 454
715	METALWORKING MACHINERY.	555 648
717	TEXTILE AND LEATHER MACHINERY, & PARTS.	6 086 057
718	MACHINES FOR SPECIAL INDUSTRIES, & PTS.	7 215 369
719	MACHINERY & APPL, & MACH PARTS, NEC	20 269 945
722	ELECTRIC POWER MACH, SWITCHGEAR, & PTS.	4 886 840
723	EQUIPMENT FOR DISTRIBUTING ELECTRICITY.	458 941
724	TELECOMMUNICATIONS APPARATUS, & PARTS	2 886 358
725	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS	1 938 802
726	ELECT MEDICAL & RADIOLOGICAL APPARATUS.	300 590
729	ELECT MACH & APPARATUS, & PTS, NEC.	3 334 910
731	RAILWAY VEHICLES AND PARTS.	49 162
732	ROAD MOTOR VEHICLES AND PARTS, NEC.	19 317 763
733	VEHICLES, EXC ROAD MOTOR VEH, & PARTS	1 252 932
734	AIRCRAFT AND SPACECRAFT, AND PARTS.	4 123 790
735	SHIPS, BOATS & FLOATING STRUCTURES.	285 411
812	PLUMBING, ETC FIX, FIT, LAMPS AND PTS	1 504 063
821	FURNITURE	588 010
831	TRAVEL GOODS, HANDBAGS ETC.	137 486
841	CLTHNG EX FUR, KNIT ELAS FAB, ART, ETC.	1 598 803
842	FUR CLOTHING & FURSKIN ARTICLES, ETC.	5 234
851	FOOTWEAR--NEW, EXC MILITARY & ORTHOPED.	32 014
861	SCIENTIFIC, OPTICAL ETC APPARATUS	1 989 759
862	PHOTOGRAPHIC & MOTION PICTURE SUPPLIES.	385 448
863	MOVIE FILM--EXPOSED AND DEVELOPED	24 181
864	WATCHES AND CLOCKS, INCLUDING PARTS	47 905
891	SOUND RECORDERS, MUSIC INSTRUMENTS ETC.	1 154 514
892	PRINTED MATTER.	670 949
893	ARTICLES OF ARTIFICIAL PLASTICS NEC	1 327 576
894	BABY CARRIAGES, TOYS, SPORTS GOODS ETC.	1 026 245
895	OFFICE & STATIONER SUPPLIES NEC	503 272
896	ARTWORKS, COLLECTORS PIECES & ANTIQUES.	8 133
897	JEWELRY & RELATED ARTICLES.	201 458
899	MANUFACTURED ARTICLES NEC	637 752
931	SPEC TRANSACTIONS NOT CLASSED BY KIND	8 842 235
941	ANIMALS, NEC--INCL ZOO ANIMALS.	800
001.1	CATTLE--LIVE.	495 880
001.4	POULTRY--LIVE	210 081
022.2	MILK AND CREAM--DRY	189 130
041.0	WHEAT, INCL SPELT OR MESLIN--UNMILLED	12 720 342
042.2	RICE--MILLED.	2 234 959
044.0	CORN OR MAIZE--UNMILLED	9 189 694

Guatemala - Imports from the United States, 1974 (Continued)

046.0	WHEAT FLOUR, MEAL, GROATS	625 350
048.1	BREAKFAST CEREALS--PREPARED	389 544
048.2	MALT AND MALT FLOUR	189 291
048.8	MALT EXTRACT, PREP OF FLOUR,STARCH,ETC.	568 443
051.4	APPLES--FRESH	262 092
051.5	GRAPES--FRESH	345 244
051.7	EDIBLE NUTS,EXC OIL NUTS--FRESH OR DRY.	166 687
052.0	FRUITS--DRIED, INCL ARTIFICAL DEHYDR. .	224 204
054.8	VEGETABLE PRODUCTS,NEC--FRESH OR DRIED.	163 520
061.9	SUGARS AND SIRUPS, N.E.C.	253 982
062.0	SUGAR CONFECTIONERY, NO COCOA, ETC. . .	154 750
071.3	OILSEED CAKE, MEAL, RESIDUES.	1 726 667
081.4	MEAT MEAL,INCL TANKAGE ETC--INEDIBLE. .	186 657
081.9	FOOD WASTES & PREPARED ANIMAL FEED,NEC.	447 856
099.1	FOOD PREPARATIONS, NEC.	1 764 331
099.9	FOOD DONATED FOR RELIEF OR CHARITY,NEC.	582 468
211.1	HIDES--CATTLE & EQUINE, UNDRESSED ETC .	248 715
221.6	COTTONSEED.	219 064
221.9	FLOUR & MEAL OF OILSEDS,OIL NUTS,ETC .	143 542
231.2	RUBBER--SYNTHETIC,& RUBBER SUBSTITUTES.	553 146
251.1	PAPER--WASTE, AND OLD PAPER	1 845 561
251.6	WOODPULP--CHEMICAL, DISSOLVING GRADES .	155 424
251.7	WOODPULP--SULPHATE.	1 849 677
251.8	WOODPULP--SULPHITE.	577 516
266.2	NONCELLULOSIC MANMADE FIBERS.	306 225
266.3	CELLULOSIC MANMADE FIBERS	156 774
276.2	CLAY & OTHER REFRACTORY MINERALS NEC. .	771 481
283.7	MANGANESE ORES & CONCENTRATES ETC . . .	155 577
291.0	ANIMAL MATERIALS, NEC--CRUDE.	172 161
292.5	SEEDS,FRUIT,SPORES, NEC, FOR PLANTING .	219 935
292.9	OTHER CRUDE VEGETABLE MATERIALS, NEC. .	124 547
332.5	LUBRICATING OILS AND GREASES.	1 608 156
332.6	PETROLEUM JELLY AND MINERAL WAXES . . .	1 129 448
332.9	PITCH, ASPHALT & OTH BYPROD EXC CHEM. .	540 388
341.1	NATURAL GAS	243 141
411.3	ANIMAL FATS & OIL,NEC INCL WOOL GREASE.	3 586 654
421.2	SOYBEAN OIL, EXCEPT HYDROGENATED. . . .	546 723
422.9	VEGETABLE OILS--FIXED, NEC.	127 767
512.0	ORGANIC CHEMICALS	7 868 534
513.2	CHEMICAL ELEMENTS, NEC.	210 061
513.3	INORGANIC ACIDS & OXYGEN CMPND--NONMET.	154 771
513.5	OXIDES--METALLIC,PGMT & NONPGMT GRADES.	153 400
513.6	AMMONIA,INORGANIC BASES,HYDROXIDES,ETC.	237 032
514.5	ALUMINUM COMPOUNDS, NEC	229 753
514.6	SODIUM AND POTASSIUM COMPOUNDS, NEC . .	523 494
514.7	INORGANIC CHEMICALS, NEC EXC MED CHEM .	915 695
531.0	SYN ORGANIC DYESTUFFS,NAT INDIGO,ETC. .	829 421
533.2	PRINTING INKS	251 452
533.3	PREPARED PAINTS,ENAMELS,LACQUERS,ETC. .	628 176
541.3	ANTIBIOTICS--BULK	1 474 322
541.5	HORMONES--BULK.	275 062
541.6	GLYCOSIDES,GLANDS, ETC,VACCINES--BULK .	426 579
541.7	MED & PHARM PREP,CMPNDS,MIXTURES,ETC. .	1 589 477
541.9	PHARMACEUTAL GOODS & PREPARATIONS,NEC .	436 783
551.1	ESSENTIAL OILS AND RESINOIDS.	211 125
551.2	SYN PERFUME & FLAVOR MTL & CONCEN, ETC.	474 056
553.0	COSMETICS & OTH TOILET PREPARATION,NEC.	583 767
554.2	SURFACE ACTIVE AGENTS,DETERGENTS,ETC. .	547 340
554.3	SCOURING CLEANSERS,SHOE POLISHES,ETC. .	142 875
561.1	NITROGENOUS FERTILIZERS, NEC, EX NATRL.	3 236 020
561.9	FERTILIZERS, N.E.C.	4 481 644
581.1	CONDENSATION,POLYCONDENSATION,ETC,PROD.	446 177
581.2	POLYMERIZATION,COPOLY, PROD--UNFINSHD .	3 634 050
581.3	VULCANIZED FIB & CELLULOSIC PLAST MTRL.	1 440 288
581.9	HARDENED PROTEINS,MODI NAT RESINS,ETC .	198 900
599.2	INSECTICIDES,FUNGICIDES,& SIMILAR PROD.	2 995 210
599.5	ALBUMINOIDAL SUBSTANCES,STARCHES,ETC. .	234 922
599.7	ARTIFICIAL WAXES,PREP ADDITIVES,ETC . .	463 378
599.9	CHEM PROD, NEC INCL REAGENTS ETC. . . .	634 685
621.0	RBR IN VARIOUS FORMS--UNVULCANIZED,ETC.	960 942
629.1	RBR TIRES & TUBES FOR VEHICLES & PLANE.	794 072
629.4	RBR BELTS & BELTING--TRANSMISSION, ETC.	134 370
629.9	ARTICLES OF RUBBER, NEC	130 044
641.1	STANDARD NEWSPRINT PAPER.	1 359 700
641.2	PRINTING AND WRITING PAPER, NEC	1 611 813
641.3	KRAFT PAPER & PAPERBOARD IN ROLLS ETC .	5 332 951
641.4	CIGARETTE PAPER IN BULK,ROLLS,SHEETS. .	163 893
641.5	PAPER AND PAPERBOARD, MACHINE-MADE,ETC.	810 032
641.9	PAPER & PAPERBOARD--COATED,IMPREG,ETC .	1 874 116
642.1	PAPER BAGS,PAPERBOARD BOXES,CONTAINERS.	300 202
642.9	ART OF PAPER PULP,PAPER,OR PAPERBOARD .	646 889
651.4	COT YARN, THREAD--BLEACHED,DYED,FINSHD.	307 269
651.6	YARN & THREAD ETC OF NONCELLULOSIC FIB.	2 330 221
651.7	YARN & THREAD ETC OF CELLULOSIC FIBER .	1 714 178
652.2	COTTON FABRICS--WOVEN, BLEACHED,FINSHD.	390 640
653.5	WOVEN FABRICS OF NONCELLULOSIC FIBERS .	532 667
653.6	WOVEN FABRICS OF CELLULOSIC FIBERS. . .	385 078
654.0	TULLE,LACE,RIBBONS,OTHER SMALL WARES. .	269 380
655.4	COATED OR IMPREGNATED TEXT FAB & PROD .	669 034
655.9	MADE-UP ARTICLES OF TEXTILE MTL, NEC. .	432 447
657.3	CARPETS AND RUGS.	286 734
657.4	LINOLEUM AND SIMILAR FLOOR COVERINGS. .	137 380
661.2	CEMENT.	121 782
662.3	BRICKS & OTHER REFRACTORY CONST MTLS. .	1 082 581
663.5	MINERAL INSULATING MATERIALS, NEC . . .	149 613
663.8	ASBESTOS MFRS AND FRICTION MATERIALS. .	177 089
664.4	PLATE & FLOAT GLASS--IN REC, UNWORKED .	159 271
664.9	GLASS, NEC.	271 406
665.1	CONTAINERS AND CLOSURES OF GLASS. . . .	598 415
665.2	TABLEWARE, HOUSEHOLDWARE, ETC OF GLASS.	445 096
665.8	GLASS ARTICLES, NEC	141 248
672.5	IR & ST BLOOMS, BILLETS, SLABS, ETC.. .	1 582 325
673.1	IRON OR STEEL WIRE RODS	175 409
673.2	IR & ST BARS & RODS, & HOLLOW DRILL ST.	560 486
673.4	IR & ST ANGLES, ETC--SP DMN, & SHT PLG.	326 531
673.5	IR & ST ANGLES, SHAPES, ETC--SP DMN . .	472 102
674.4	IRON & STEEL PLATES & SHEETS--UNCOATED.	965 585
677.0	IR & ST WIRE, EXC INSULATED ELECTRIC. .	480 628
678.2	IR & ST TUBES & PIPES--SEAMLESS	1 686 101
678.3	IR & ST TUBES & PIPES--WELDED, ETC. . .	324 705
678.5	IRON OR STEEL TUBE AND PIPE FITTINGS. .	467 826
682.2	COPPER AND COPPER ALLOYS--WROUGHT . . .	212 390
684.2	ALUMINUM & ALUM ALLOYS--WROUGHT, NEC. .	682 112
686.1	ZINC AND ZINC ALLOYS--UNWROUGHT	830 524
691.1	FINSHD STRUC PTS & STRUCTURES--IR & ST.	793 999
691.2	FINSHD STRUC PTS & STRUCTURES--ALUM . .	241 036
692.1	TANKS FOR STOR ETC--IR, ST, COPP, ALUM.	129 829
692.2	CONTAINERS FOR TRANS GOODS--IR,ST,ALUM.	196 955
692.3	COMPRESS GAS CYLINDERS--IR, ST, ALUM. .	164 386
693.3	WIRE GAUZE, ETC--IR, ST, COPP, ALUM . .	147 099
694.2	BOLTS, NUTS, SCREWS, ETC--IR, ST, COPP.	375 917
695.2	TOOLS, NEC, FOR HAND OR MACHINE USE . .	943 728
697.2	DOMESTIC UTENSILS, ETC, OF BASE METALS.	492 474
698.1	HARDWARE OF BASE METALS, INCL LOCKS . .	659 619
698.3	CHAINS & PARTS THEREOF--IRON OR STEEL .	225 758
698.5	PINS, ETC--IR,ST, & BA MET HOOKS, ETC .	161 172
698.8	CHAINS--COPPER, & MISC BA MET ARTICLES.	606 761
698.9	ARTICLES OF BASE METALS, NEC.	1 019 322
711.1	STEAM GENERATING POWER BOILERS & PARTS.	701 016
711.2	STEAM GENERATING POWER BOILER ACCESS. .	180 988
711.4	ENGINES AND JET,GAS TURBINES--A/C, ETC.	144 205
711.5	ENGINES--INT COM, EXC AIRCRAFT,& PARTS.	2 385 771
711.6	GAS TURBINES & PTS,NEC FOR MECH DRIVES.	136 080
712.1	AGRI MACH FOR CULT, ETC SOIL, & PARTS .	886 208
712.2	AGRI MACH FOR HARVESTING, ETC, & PARTS.	553 779
712.5	TRACTORS, EXCEPT ROAD AND INDUSTRIAL. .	2 770 674
712.9	AGRI MACH & APPR NEC, & PTS & ATT, NEC.	394 595
714.2	ELECTRONIC COMPUTERS EXC PUN CARD TYPE.	467 410
714.3	STATISTICAL MACH, NEC, INCL AUXIL MACH.	144 609
714.9	OFFICE MACHINES, NEC, & OFC MACH PARTS.	313 399
715.1	MACHINE TOOLS FOR WORKING METAL	354 697
715.2	METALWRKNG MACH, EXC MACH TOOLS, & PTS.	200 951
717.1	TEXTILE MACH, ETC EXC DOM WASHING MACH.	5 623 184
717.2	MACHINERY EXC SEWING--LEATHER WORKING .	191 467
717.3	SEWING MACHINES AND PARTS	271 406
718.1	PULP & PAPER PROCESSING MACHINES & PTS.	267 518
718.2	PRINTING & BOOKBINDING MACHINES, & PTS.	503 708
718.3	FOOD PROCESSING MACH, EXC DOM, & PARTS.	2 518 932
718.4	CONSTRUCTION & MINING MACH, NEC & PTS .	2 681 967
718.5	MINERAL WRKG & GLASS-WRKG MACH, & PTS .	1 243 244
719.1	HEATING & COOLING MACH & EQUIP, & PTS .	2 782 370
719.2	PUMPS, CENTRIFUGES, ETC, AND PARTS. . .	3 032 326
719.3	MECHANICAL HNDLNG MACH & EQUIP, & PTS .	5 861 404
719.5	POWERED TOOLS, NEC, & ACCESS, & PARTS .	794 154
719.6	NONELECTRICAL MACHINES, NEC, AND PARTS.	2 491 180
719.7	BEARINGS--BALL, ROLLER, ETC, AND PARTS.	683 337
719.8	MACHINERY & MECHANICAL APPLIANCES, NEC.	3 305 485
719.9	PARTS & ACCESSORIES FOR MACHINERY, NEC.	1 287 622
722.1	ELECTRIC POWER MACHINERY AND PARTS. . .	2 297 274
722.2	ELECT APPR FOR MAKING ETC ELECT CIRCTS.	2 589 566
723.1	WIRE AND CABLE--INSULATED	274 029
723.2	ELECTRICAL INSULATORS, FITTINGS, ETC. .	184 912
724.1	TELEVISION BROADCAST RECEIVERS.	756 741
724.2	RADIO BROADCAST RECEIVERS	139 494
724.9	TELECOMMUNICATIONS EQUIPMENT, NEC . . .	1 990 123
725.0	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS .	1 938 802
726.1	ELECTRO-MEDICAL APPR & PTS, EXC X-RAY .	143 231
726.2	X-RAY & RADIOLOGICAL APPARATUS, & PTS .	157 359
729.1	BATTERIES, AND PARTS NEC.	283 164
729.2	ELECTRIC LAMPS, AND PARTS, NEC.	437 880
729.3	ELECTRON TUBES, ETC, NEC, AND PARTS . .	557 829
729.4	ELECT IGNITION, ETC EQUIP--INT COM ENG.	649 477
729.5	ELECT MEASURING & CONTROLLING APPR,NEC.	772 885
729.9	ELECTRICAL MACH & APPR, NEC, & PARTS. .	532 059
732.0	PASSENGER CARS, TRUCKS, ETC--ALL FUELS.	12 629 276
732.8	MOTOR VEHICLE & TRAC PTS & ACCESS, NEC.	6 624 739
733.3	TRAILERS & OTHER VEH & PTS--NOT MOTOR .	1 251 796
734.1	AIRCRAFT--HEAVIER THAN AIR.	3 878 882
734.9	AIRCRAFT, NEC, & AIRCRAFT PTS & ACCESS.	244 908
735.5	SHIPS & BOATS EXC MILTY, INCL SPEC PUR.	281 376
812.2	SANITARY & PLUMBING FIX & FIT--CERAMIC.	636 017
812.3	SANITARY, ETC FIX & FIT--IRON OR STEEL.	123 253
812.4	LIGHTING FIX & FIT, LAMPS, ETC, & PTS .	677 862
821.0	FURNITURE	588 010
831.0	TRAVEL GOODS, HANDBAGS, PERSONAL GOODS.	137 486
841.1	CLOTHING--TEXT FAB, NOT KNIT OR CROCH .	380 037
841.2	ACCESS--TEXT FAB, NOT KNIT OR CROCH . .	123 054
841.4	CLOTHING, ACCESS, ETC--KNIT OR CROCH. .	516 449
841.8	CLOTHING ETC EXC NEW FOR RELIEF	459 459
861.6	PHOTO & MOTION PICTURE EQUIP & PTS,NEC.	319 344
861.7	MEDICAL INST ETC EXC ELECTRO-MEDICAL. .	651 650
861.9	MEASURING, CONTROL, ETC INSTRMNTS, NEC.	689 550
862.4	PHOTO FILM, PLATES, ETC EXC DEV MP FLM.	310 522
891.1	PHONOGRAPHS,TAPE RECORDERS,& SMLR MACH.	329 785
891.2	PHONOGRAPH RECORDS & OTH SOUND MEDIA. .	155 654
891.9	PARTS & ACCESS FOR MUSICAL INSTRUMENTS.	531 229
892.1	MAPS,CHARTS,BOOKS,PAMPHLETS,GLOBES ETC.	230 240
892.2	NEWSPAPERS & PERIODICALS--UNBOUND . . .	204 155
892.9	CALENDARS, CATALOGS, PRINT MATTER NEC .	188 181
893.0	ARTICLES,NEC--FINSHD, ARTIFICIAL PLAST.	1 327 576
894.2	CHILDREN'S TOYS, CHRISTMAS DECORAT,ETC.	382 348
894.4	FISH & HUNT EQUIP, SPORTS EQUIP, ETC. .	507 150
895.2	PENS,PENCILS,NIBS,POINTS,CRAYONS,CHALK.	328 496
899.5	POWDER PUFFS,BUTTONS,& SMALLWARES NEC .	182 817
899.6	ORTHOPEDIC APPL, ART, HEARING AIDS,ETC.	158 329
931.0	SPEC TRANSACTIONS NOT CLASSED BY KIND .	8 842 235
---.-	SUBGPS AVG UN $10,000 A MO BY ALL MOT .	8 136 583
---.-	SPECIAL CATEGORY*	2 570 951

PHILIPPINES

Imports of domestic merchandise from the United States, 1974

Total - $740,613,666

001	ANIMALS--LIVE	1 268 598
011	MEAT--FRESH, CHILLED, OR FROZEN	943 838
012	MEAT--DRIED, SALTED, OR SMOKED	1 014 990
013	MEAT--IN AIRTIGHT CONTAIN; MEAT PREPS	96 073
022	MILK AND CREAM	1 114 257
024	CHEESE AND CURD	41 318
025	EGGS--BIRDS , EXCEPT SEPARATE ALBUMIN	8 562
031	FISH & SHELLFISH--FRESH OR SIMPLY PREP	347 806
032	FISH--IN AIRTIGHT CONTAIN; FISH PREPS	425 935
041	WHEAT, INCL SPELT OR MESLIN--UNMILLED	62 633 914
042	RICE--ROUGH,BROWN,MILLED,GLAZED,PRTISH	20 056
044	CORN OR MAIZE--UNMILLED	19 641 435
045	CEREALS, NEC--UNMILLED	74 477
046	WHEAT FLOUR, MEAL, AND GROATS	5 379 065
047	CEREAL FLOURS, MEAL, AND GROATS, NEC	323 092
048	PREPS OF CEREAL, FLOUR, STARCH, ETC	5 693 450
051	FRUITS--FRESH; NUTS, EXCEPT OIL NUTS	294 312
052	FRUITS--DRIED, INCL ARTIFIC DEHYDRATED	302 857
053	FRUITS & NUTS--PREP OR PRES, NEC	681 292
054	VEG,FRSH,ETC;DRIED LEGUM VEG;VEG PROD	1 607 371
055	VEG, ROOTS & TUBERS, PREP OR PRES, NEC	104 159
061	SUGAR, SIRUPS, MOLASSES, AND HONEY	319 949
062	SUGAR CONFECTIONERY, NO COCOA, ETC	490 384
072	COCOA	3 600
073	CHOC & FOOD PREPS CONT COCOA OR CHOC	1 070
074	TEA AND MATE--CRUDE OR PREPARED	78 345
075	SPICES	236 117
081	ANIMAL FEEDING-STUFF, EXCL UNML CEREAL	7 954 063
091	MARGARINE, SHORTENING, PREP EDIBLE FAT	237 343
099	FOOD PREPARATIONS, NEC	3 617 090
112	BEVERAGES--ALCOHOLIC	136 583
121	TOBACCO--UNMANUFACTURED	12 750 674
122	TOBACCO MANUFACTURES	712 492
211	HIDES, SKINS, EXC FURSKINS--UNDRESSED	1 136 831
212	FURSKINS--UNDRESSED	1 780
221	OILSEEDS, OIL NUTS, OIL KERNELS, ETC	1 527 476
231	RUBBER, EXCL CMPDED, SEMIPROCD & MFRS	2 873 893
251	PULPS, AND WASTE PAPER	5 661 460
262	WOOL AND OTHER ANIMAL HAIR	604
263	COTTON	34 710 329
265	VEGETABLE FIBERS, EXCEPT COTTON & JUTE	1 716
269	MANMADE FIBR & THEIR WASTE, EXC GLASS	7 555 126
267	TEXTILE FABRIC WASTE, INCLUDING RAGS	9 257
271	FERTILIZERS--CRUDE	3 322 347
273	STONE, SAND AND GRAVEL	62 516
274	SULFUR AND UNROASTED IRON PYRITES	6 891
275	NAT ABRASIVES INCL INDUSTRIAL DIAMONDS	390 172
276	CRUDE MINERALS, NEC	2 165 501
281	IRON ORES AND CONCENTRATES	4 152
282	IRON AND STEEL SCRAP	2 167 446
283	ORES & CONCEN OF NONFERROUS BASE METAL	838 594
284	NONFERROUS METAL SCRAP	260 347
291	ANIMAL MATERIALS, NEC--CRUDE	119 487
292	VEGETABLE MATERIALS, NEC--CRUDE	1 864 913
321	COAL, COKE, AND BRIQUETS	130 645
332	PETROLEUM PRODUCTS	9 513 096
341	GAS--NATURAL AND MANUFACTURED	2 904
411	ANIMAL OILS AND FATS, NEC	3 143 854
421	VEGETABLE OILS--FIXED, SOFT, EXC HYDR	62 316
429	VEGETABLE OILS--FIXED, NEC	129 655
431	FATTY ACIDS, WAXES, ETC, EXCL PET PROD	353 420
512	ORGANIC CHEMICALS	26 239 848
513	INORG CHEM ELMNTS OXUS HYDROXDS ETC	6 691 636
514	INORGANIC CHEMICALS, NEC	8 110 337
515	RADIOACTIVE & STABLE ISOTOPES & CPDS ETC	16 982
521	COAL TAR & OILS & CRUDE CHEMICALS ETC	598 567
531	SYN ORG DYES ETC, LAKES AND TONERS	1 121 089
532	DYEING & TANNING EXTRACTS & ART BATES	118 200
533	PIGMENTS, PAINTS, VARNISHES ETC	1 920 090
541	MEDICINAL AND PHARMACEUTICAL PRODUCTS	11 673 353
551	ESSENTIAL OILS, PERFUME ETC MATERIALS	2 836 286
553	PERFUMERY, COSMETICS, DENTIFRICES ETC	217 798
554	SOAPS, CLEANSERS, POLISHES ETC	2 047 499
561	FERTLZRS--MFRD & FERTLZR MTRLS NEC	20 145 210
571	EXPLOSIVES AND PYROTECHNIC PRODUCTS	96 404
581	SYNTHETIC RESINS AND PLASTIC MATERIALS	18 086 074
599	CHEMICAL PRODUCTS & MATERIALS, NEC	18 554 643
611	LEATHER	3 713 822
612	LEATHER MANUFACTURES, NEC	73 847
613	FURSKINS--DRESSED, INCLUDING DYED	30 569
621	RUBBER ARTICLES IN SPECIFIED FORMS	984 383
629	RUBBER MANUFACTURES--FINISHED, NEC	5 349 726
631	WOOD VENEERS, PLYWOOD BOARDS, ETC, NEC	162 643
632	WOOD MANUFACTURES, NEC	339 373
633	CORK MFRS, & AGGLOMERATED CORK & MFRS	12 313
641	PAPER AND PAPERBOARD	13 849 757
642	PAPER,PAPER PULP, & PAPERBOARD ART,NEC	1 886 959
651	TEXTILE YARN AND THREAD	4 423 895
652	COTTON FABRIC, WOVEN EX SPEC OR NARROW	5 319 865
653	TEXTILE FABRIC WOVEN EX COTTON, ETC	13 692 921
654	TULLE, LACE ETC AND OTHER SMALL WARES	819 233
655	SPECIAL TEXT FABRIC AND PRODUCTS	3 060 638
656	MADE-UP TEXT ARTICLES AND PRODUCTS	2 503 202
657	FLOOR COVERINGS, TAPESTRIES ETC	119 960
661	LIME CEMENT & FBR BLDG MTL NEC	347 181
662	CLAY AND REFRACTORY CONSTRUCTION MTLS	903 337
663	MINERAL MANUFACTURES, NEC	2 152 355
664	GLASS	820 964
665	GLASSWARE	1 206 249
666	POTTERY	15 790
667	DIAMONDS & OTHER PRECIOUS STONES	8 437
671	PIG IRON ETC AND FERROALLOYS	63 861
672	IRON OR STEEL PRIMARY FORMS	7 145 908
673	IRON OR STEEL BARS, RODS, ANGLES, ETC	1 081 012
674	IRON OR STEEL PLATES AND SHEETS	1 109 387
675	IRON OR STEEL HOOP AND STRIP	451 061
676	IR & ST RAILS & RAILWAY TRACK MTL	91 181
677	IRON OR STEEL WIRE EXC INSULATED ELECT	181 186
678	IRON OR STEEL TUBES PIPES & FITTINGS	3 251 997
679	IR OR ST CASTINGS & FORGINGS--ROUGH	3 264 172
681	SILVER & PLATINUM--UNWK & PTLY WORKED	30 290
682	COPPER & COPPER ALLOYS--WR & UNWR	4 142 770
683	NICKEL & NICKEL ALLOYS--WR & UNWR	34 145
684	ALUMINUM & ALUMINUM ALLOYS--WR & UNWR	8 219 634
685	LEAD & LEAD ALLOYS--WR & UNWR	327 619
686	ZINC & ZINC ALLOYS--WR & UNWR	2 095 379
687	TIN & TIN ALLOYS--WR & UNWR	62 614
689	BASE METALS & ALLOYS, NEC--WR & UNWR	160 158
691	STRUCTURES & PARTS--IR, ST, ALUM, ZINC	1 324 780
692	METAL CONTAINERS FOR STORAGE & TRANS	603 866
693	WIRE PRODS EXC INSULATED ELECTRIC	3 222 643
694	NAILS BOLTS & SIMILAR ARTS, IR ST COPP	682 484
695	TOOLS FOR USE IN HAND OR IN MACHINES	1 222 552
696	TABLE FLATWARE AND CUTLERY	139 926
697	HOUSEHOLD EQUIPMENT OF BASE METALS	328 873
698	MANUFACTURES OF BASE METAL, NEC	7 213 065
711	POWER GENERATING MACH EXC ELECT, & PTS	23 286 839
712	AGRICULTURAL MACH & APPLIANCES, & PTS	11 922 690
714	OFFICE MACHINES AND PARTS	8 460 099
715	METALWORKING MACHINERY	5 057 715
717	TEXTILE AND LEATHER MACHINERY, & PARTS	9 043 049
718	MACHINES FOR SPECIAL INDUSTRIES, & PTS	26 810 572
719	MACHINERY & APPL, & MACH PARTS, NEC	65 037 637
722	ELECTRIC POWER MACH, SWITCHGEAR, & PTS	13 670 392
723	EQUIPMENT FOR DISTRIBUTING ELECTRICITY	2 053 652
724	TELECOMMUNICATIONS APPARATUS, & PARTS	11 537 135
725	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS	993 442
726	ELECT MEDICAL & RADIOLOGICAL APPARATUS	829 442
729	ELECT MACH & APPARATUS, & PTS, NEC	28 471 377
731	RAILWAY VEHICLES AND PARTS	1 387 457
732	ROAD MOTOR VEHICLES AND PARTS, NEC	44 890 566
733	VEHICLES, EXC ROAD MOTOR VEH, & PARTS	685 774
734	AIRCRAFT AND SPACECRAFT, AND PARTS	5 650 001
735	SHIPS, BOATS & FLOATING STRUCTURES	248 834
812	PLUMBING, ETC FIX, FIT, LAMPS AND PTS	1 475 456
821	FURNITURE	251 017
831	TRAVEL GOODS, HANDBAGS ETC	11 270
841	CLTHNG EX FUR, KNIT ELAS FAB, ART, ETC	2 261 869
851	FOOTWEAR--NEW, EXC MILITARY & ORTHOPED	6 333
861	SCIENTIFIC, OPTICAL ETC APPARATUS	8 233 017
862	PHOTOGRAPHIC & MOTION PICTURE SUPPLIES	3 503 470
863	MOVIE FILM--EXPOSED AND DEVELOPED	250 402
864	WATCHES AND CLOCKS, INCLUDING PARTS	124 590
891	SOUND RECORDERS, MUSIC INSTRUMENTS ETC	701 824
892	PRINTED MATTER	5 075 971
893	ARTICLES OF ARTIFICIAL PLASTICS NEC	1 599 445
894	BABY CARRIAGES, TOYS, SPORTS GOODS ETC	374 262
895	OFFICE & STATIONER SUPPLIES NEC	774 740
896	ARTWORKS, COLLECTORS PIECES & ANTIQUES	11 513
897	JEWELRY & RELATED ARTICLES	140 227
899	MANUFACTURED ARTICLES NEC	661 255
931	SPEC TRANSACTIONS NOT CLASSED BY KIND	10 029 171
941	ANIMALS, NEC--INCL ZOO ANIMALS	7 800
001.1	CATTLE--LIVE	510 060
001.3	SWINE--LIVE	203 766
001.4	POULTRY--LIVE	406 722
011.1	MEAT, BOVINE, EXC OFFALS--FRSH OR FRZN	676 500
011.6	OFFALS--BOVINE, EQUINE ETC, FRSH, FRZN	191 972
012.9	MEAT & ED OFFALS,NEC--DRY, SALT,SMOKED	1 014 990
022.2	MILK AND CREAM--DRY	1 007 557
031.3	SHELLFISH--FRESH, FROZEN, SALTED ETC	336 835
032.0	FISH IN AIRTIGHT CONTAINER & FISH PREP	425 935
041.0	WHEAT, INCL SPELT OR MESLIN--UNMILLED	62 633 914

Philippines - Imports from the United States (Continued)

044.0	CORN OR MAIZE--UNMILLED	19 641 435
046.0	WHEAT FLOUR, MEAL, GROATS	5 379 069
047.0	CEREAL FLOURS, MEAL, GROATS, EXC WHEAT.	323 052
048.1	BREAKFAST CEREALS--PREPARED	1 448 800
048.8	MALT EXTRACT, PREP OF FLOUR,STARCH,ETC.	4 440 553
051.4	APPLES--FRESH	159 697
052.0	FRUITS--DRIED, INCL ARTIFICAL DEHYDR.	302 857
053.5	FRUIT & VEGETABLE JUICES--UNFERMENTED	230 064
053.6	FRUITS--TEMPORARILY PRESERVED	375 728
054.2	VEGETABLES--LEGUMINOUS, DRIED	1 569 381
061.9	SUGARS AND SIRUPS, N.E.C.	297 329
062.0	SUGAR CONFECTIONERY, NO COCOA, ETC.	490 384
075.2	SPICES, N.E.C.	224 669
081.3	OILSEED CAKE, MEAL, RESIDUES.	6 571 627
081.4	MEAT MEAL,INCL TANKAGE ETC--INEDIBLE.	525 128
081.9	FOOD WASTES & PREPARED ANIMAL FEED,NEC.	866 308
091.4	MARGARINE & OTHER PREP EDIBLE FATS NEC.	237 343
099.1	FOOD PREPARATIONS, NEC.	3 437 592
099.9	FOOD DONATED FOR RELIEF OR CHARITY,NEC.	124 966
121.0	TOBACCO--UNMANUFACTURED	12 750 674
122.2	CIGARETTES.	422 821
122.3	CHEWING AND SMOKING TOBACCO,AND SNUFF	289 671
211.1	HIDES--CATTLE & EQUINE, UNDRESSED ETC	1 110 831
221.4	SOYBEANS EXC ROASTED COFFEE SUBSTITUTE.	1 274 015
221.9	FLOUR & MEAL OF OILSEEDS,OIL NUTS,ETC	253 461
231.1	RUBBER--NATURAL,& SIMILAR NATURAL GUM	1 253 447
231.2	RUBBER--SYNTHETIC,& RUBBER SUBSTITUTES.	1 614 344
251.1	PAPER--WASTE, AND OLD PAPER	2 579 932
251.5	PULP, EXCEPT WOODPULP	129 601
251.7	WOODPULP--SULPHATE.	2 058 624
251.8	WOODPULP--SULPHITE.	850 474
263.1	RAW COTTON, OTHER THAN LINTERS.	34 710 329
264.2	NONCELLULOSIC MANMADE FIBERS.	3 957 120
266.3	CELLULOSIC MANMADE FIBERS	3 557 421
271.3	NATURAL PHOSPHATES.	3 322 347
275.9	NAT ABRASIVES NEC,INCL DIAMOND DUST	373 713
276.2	CLAY & OTHER REFRACTORY MINERALS NEC.	1 514 145
278.9	CRUDE MINERALS, NEC	498 611
282.0	IRON AND STEEL SCRAP.	2 167 446
283.7	MANGANESE ORES & CONCENTRATES ETC	188 893
283.9	NONFERROUS METAL ORES AND CONCENT, NEC.	649 112
284.0	NONFERROUS METAL SCRAP.	260 347
292.2	GUMS, RESINS, BALSAMS, LACS--NATURAL.	564 671
292.5	SEEDS,FRUIT,SPORES, NEC, FOR PLANTING	331 796
292.8	PLANTS FOR PERFUMERY, PHARMACY, ETC	180 176
292.9	OTHER CRUDE VEGETABLE MATERIALS, NEC.	775 415
321.4	COAL--ANTHRACITE AND BITUMINOUS	127 400
332.5	LUBRICATING OILS AND GREASES.	6 659 152
332.6	PETROLEUM JELLY AND MINERAL WAXES	604 690
332.9	PITCH, ASPHALT & OTH BYPROD EXC CHEM.	2 251 149
411.3	ANIMAL FATS & OIL,NEC INCL WOOL GREASE.	3 143 854
431.3	FATTY ACIDS AND REFINING BYPRODUCTS	150 575
512.1	ORGANIC CHEMICALS	26 239 848
513.2	CHEMICAL ELEMENTS, NEC.	213 076
513.3	INORGANIC ACIDS & OXYGEN CMPND--NONMET.	2 891 497
513.5	OXIDES--METALLIC,PGMT & NONPGMT GRADES.	2 377 962
513.6	AMMONIA,INORGANIC BASES,HYDROXIDES,ETC.	1 190 714
514.4	INORGANIC PIGMENTS, NEC	153 231
514.6	SODIUM AND POTASSIUM COMPOUNDS, NEC	1 563 982
514.7	INORGANIC CHEMICALS, NEC EXC MED CHEM	6 101 255
514.8	INORGANIC MEDICINALS, NEC, IN BULK.	184 231
521.1	BENZENE AND OTH CRUDE PROD OF COAL ETC.	598 567
531.1	SYN ORGANIC DYESTUFFS,NAT INDIGO,ETC.	1 121 089
533.1	TITANIUM WHITES & OTH WHITE COLOR MTRL.	213 793
533.2	PRINTING INKS	191 728
533.3	PREPARED PAINTS,ENAMELS,LACQUERS,ETC.	1 514 569
541.1	VITAMINS AND PROVITAMINS--BULK.	428 473
541.3	ANTIBIOTICS--BULK	1 904 083
541.5	HORMONES--BULK.	229 411
541.6	GLYCOSIDES,GLANDS, ETC,VACCINES--BULK	419 776
541.7	MED & PHARM PREP,CMPNDS,MIXTURES,ETC.	5 758 029
541.8	MEDICINAL & PHARM PRODUCTS FOR RELIEF	2 163 017
541.9	PHARMACEUTAL GOODS & PREPARATIONS,NEC	755 949
551.1	ESSENTIAL OILS AND RESINOIDS.	1 894 587
551.2	SYN PERFUME & FLAVOR MTL & CONCEN, ETC.	941 639
553.0	COSMETICS & OTH TOILET PREPARATION,NEC.	217 796
554.2	SURFACE ACTIVE AGENTS,DETERGENTS,ETC.	1 631 608
554.3	SCOURING CLEANSERS,SHOE POLISHES,ETC.	354 735
561.1	NITROGENOUS FERTILIZERS, NEC, EX NATRL.	6 115 366
561.2	PHOSPHATIC FERTILIZERS AND MATERIALS.	4 367 028
561.3	POTASSIC FERTILIZERS, EX NATURAL SALTS.	4 031 207
561.9	FERTILIZERS, N.E.C.	5 631 609
581.1	CONDENSATION,POLYCONDENSATION,ETC,PROD.	2 131 828
581.2	POLYMERIZATION,COPOLY, PROD--UNFINSHD	8 059 798
581.3	VULCANIZED FIB & CELLULOSIC PLAST MTRL.	7 171 301
581.9	HARDENED PROTEINS,MODI NAT RESINS,ETC	723 147
599.2	INSECTICIDES,FUNGICIDES,& SIMILAR PROD.	4 496 468
599.5	ALBUMINOIDAL SUBSTANCES,STARCHES,ETC.	500 217
599.6	WOOD AND RESIN-BASED CHEMICAL PRODUCTS.	423 234
599.7	ARTIFICIAL WAXES,PREP ADDITIVES,ETC	5 789 336
599.9	CHEM PROD, NEC INCL REAGENTS ETC.	7 345 328
611.5	LEATHER OF BOVINE & EQUINE ANIMALS NEC.	201 501
611.9	LEATHER, NEC.	3 512 321
621.0	RBR IN VARIOUS FORMS--UNVULCANIZED,ETC.	984 383
629.1	RBR TIRES & TUBES FOR VEHICLES & PLANE.	2 158 936
629.3	HYGIENIC & PHARM ART--UNHARDENED RBR.	321 285
629.4	RBR BELTS & BELTING--TRANSMISSION, ETC.	1 279 235
629.9	ARTICLES OF RUBBER, NEC	1 590 270
631.8	WOOD--SIMPLY SHAPED OR WORKED, NEC.	157 868
632.8	ARTICLES MANUFACTURED OF WOOD, NEC.	284 171
641.2	PRINTING AND WRITING PAPER, NEC	3 369 402
641.3	KRAFT PAPER & PAPERBOARD IN ROLLS ETC	3 983 586
641.4	CIGARETTE PAPER IN BULK,ROLLS,SHEETS.	702 648
641.5	PAPER AND PAPERBOARD, MACHINE-MADE,ETC.	3 473 067
641.9	PAPER & PAPERBOARD--COATED,IMPREG,ETC	2 173 775
642.1	PAPER BAGS,PAPERBOARD BOXES,CONTAINERS.	565 403
642.9	ART OF PAPER PULP,PAPER,OR PAPERBOARD	1 236 049
651.4	COT YARN, THREAD--BLEACHED,DYED,FINSHD.	199 653
651.6	YARN & THREAD ETC OF NONCELLULOSIC FIB.	2 967 668
651.7	YARN & THREAD ETC OF CELLULOSIC FIBER	1 100 210
652.2	COTTON FABRICS--WOVEN, BLEACHED,FINSHD.	5 219 087
653.5	WOVEN FABRICS OF NONCELLULOSIC FIBERS	10 496 400
653.6	WOVEN FABRICS OF CELLULOSIC FIBERS.	710 871
653.7	KNIT OR CROCHETED FAB NO ELAST OR RBR	2 054 894
653.8	FABRICS OF GLASS FIBERS	410 753
654.0	TULLE,LACE,RIBBONS,OTHER SMALL WARES.	819 233
655.4	COATED OR IMPREGNATED TEXT FAB & PROD	2 099 742
655.5	ELASTIC FABRICS AND ELASTIC TRIMMINGS	334 933
655.8	WADDING,TEXT FAB, FOR USE IN MACHINERY.	383 076
655.9	TEXTILE BELTING, TUBING, HOSEPIPING	185 835
656.9	MADE-UP ARTICLES OF TEXTILE MTL, NEC.	2 491 895
661.2	CEMENT.	151 127
661.8	BLDG MTLS OF ASPHALT & ASBESTOS-CEMENT.	151 734
662.3	BRICKS & OTHER REFRACTORY CONST MTLS.	698 706
663.1	WHEELS AND STONES--ABRASIVE	124 463
663.2	CLOTHS, PAPERS,ART OF COATED ABRASIVE	829 962
663.5	MINERAL INSULATING MATERIALS, NEC	204 832
663.9	ASBESTOS MFRS AND FRICTION MATERIALS.	769 356
664.2	GLASS--OPTICAL, UNWKD,AND LENS BLANKS	493 284
664.9	GLASS, NEC.	206 450
665.1	CONTAINERS AND CLOSURES OF GLASS.	753 907
665.2	TABLEWARE, HOUSEHOLDWARE, ETC OF GLASS.	127 351
665.8	GLASS ARTICLES, NEC	324 986
672.5	IR & ST BLOOMS, BILLETS, SLABS, ETC.	7 145 908
673.2	IR & ST BARS & RODS, & HOLLOW DRILL ST.	866 863
674.4	IRON & STEEL PLATES & SHEETS--UNCOATED.	728 011
674.7	TIN PLATE AND TIN COATED SHEET.	355 963
675.0	IRON OR STEEL HOOP AND STRIP.	451 061
677.0	IR & ST WIRE, EXC INSULATED ELECTRIC.	181 186
678.2	IR & ST TUBES & PIPES--SEAMLESS	1 440 207
678.3	IR & ST TUBES & PIPES--WELDED, ETC.	799 188
678.5	IRON OR STEEL TUBE AND PIPE FITTINGS.	958 453
679.2	STEEL CASTINGS IN THE ROUGH STATE	1 166 753
679.3	IR & ST FORGINGS IN THE ROUGH STATE	2 068 474
682.1	COPPER AND COPPER ALLOYS--UNWROUGHT	2 306 507
682.2	COPPER AND COPPER ALLOYS--WROUGHT	1 634 263
684.0	ALUMINUM & ALUM AL--UNWR, & BARS, ETC	7 802 842
684.2	ALUMINUM & ALUM ALLOYS--WROUGHT, NEC.	416 792
685.1	LEAD AND LEAD ALLOYS--UNWROUGHT	241 962
686.1	ZINC AND ZINC ALLOYS--UNWROUGHT	1 926 476
686.2	ZINC AND ZINC ALLOYS--WROUGHT	168 903
691.1	FINSHD STRUC PTS & STRUCTURES--IR & ST.	1 761 175
692.2	CONTAINERS FOR TRANS GOODS--IR,ST,ALUM.	160 905
692.3	COMPRESS GAS CYLINDERS--IR, ST, ALUM.	391 546
693.1	WIRE CABLE--UNINS, IR, ST, COPP, ALUM	2 757 400
693.3	WIRE GAUZE, ETC--IR, ST, COPP, ALUM	439 043
694.2	BOLTS, NUTS, SCREWS, ETC--IR, ST, COPP.	566 648
695.1	HAND TOOLS FOR AGRICULTURE OR FORESTRY.	159 891
695.2	TOOLS, NEC, FOR HAND OR MACHINE USE	3 062 661
696.0	TABLE FLATWARE AND CUTLERY.	139 926
697.2	DOMESTIC UTENSILS, ETC, OF BASE METALS.	320 349
698.1	HARDWARE OF BASE METALS, INCL LOCKS	1 490 628
698.2	SAFES, STRONG-ROOMS, ETC--BASE METALS	143 821
698.3	CHAINS & PARTS THEREOF--IRON OR STEEL	651 897
698.5	PINS, ETC--IR,ST, & BA MET HOOKS, ETC	449 942
698.6	SPRINGS & LEAVES--IRON, STEEL, COPPER	136 405
698.8	CHAINS--COPPER, & MISC BA MET ARTICLES.	1 497 511
698.9	ARTICLES OF BASE METALS, NEC.	2 636 091
711.1	STEAM GENERATING POWER BOILERS & PARTS.	1 665 624
711.2	STEAM GENERATING POWER BOILER ACCESS.	687 888
711.3	STEAM ENGINES, TURBINES, AND PARTS.	381 577
711.4	ENGINES AND JET,GAS TURBINES--A/C, ETC.	2 248 307
711.5	ENGINES--INT COM, EXC AIRCRAFT,& PARTS.	18 214 627
712.1	AGRI MACH FOR CULT, ETC SOIL, & PARTS	510 609
712.2	AGRI MACH FOR HARVESTING, ETC, & PARTS.	261 328
712.3	DAIRY MACHINERY, NEC, AND PARTS	165 239
712.5	TRACTORS, EXCEPT ROAD AND INDUSTRIAL.	10 069 305
712.9	AGRI MACH & APPR NEC, & PTS & ATT, NEC.	916 208
714.1	TYPEWRITERS AND CHECK-WRITING MACHINES.	553 333
714.2	ELECTRONIC COMPUTERS EXC PUN CARD TYPE.	2 262 191
714.3	STATISTICAL MACH, NEC, INCL AUXIL MACH.	1 643 268
714.9	OFFICE MACHINES, NEC, & OFC MACH PARTS.	4 001 307
715.1	MACHINE TOOLS FOR WORKING METAL	3 936 078
715.2	METALWRKNG MACH, EXC MACH TOOLS, & PTS.	1 121 637
717.1	TEXTILE MACH, ETC EXC DOM WASHING MACH.	8 621 964
717.3	SEWING MACHINES AND PARTS	389 320
718.1	PULP & PAPER PROCESSING MACHINES & PTS.	1 982 392
718.2	PRINTING & BOOKBINDING MACHINES, & PTS.	1 024 519
718.3	FOOD PROCESSING MACH, EXC DOM, & PARTS.	1 719 700
718.4	CONSTRUCTION & MINING MACH, NEC & PTS	14 070 820
718.5	MINERAL WRKG & GLASS-WRKG MACH, & PTS	8 013 141

Philippines - Imports from the United States (Continued)

719.1	HEATING & COOLING MACH & EQUIP, & PTS .	9 461 982
719.2	PUMPS, CENTRIFUGES, ETC, AND PARTS. . .	13 423 613
719.3	MECHANICAL HNDLNG MACH & EQUIP, & PTS .	13 333 560
719.5	POWERED TOOLS, NEC, & ACCESS, & PARTS .	6 133 156
719.6	NONELECTRICAL MACHINES, NEC, AND PARTS.	4 795 043
719.7	BEARINGS--BALL, ROLLER, ETC, AND PARTS.	2 349 124
719.8	MACHINERY & MECHANICAL APPLIANCES, NEC.	8 261 571
719.9	PARTS & ACCESSORIES FOR MACHINERY, NEC.	7 230 165
722.1	ELECTRIC POWER MACHINERY AND PARTS. . .	7 655 009
722.2	ELECT APPR FOR MAKING ETC ELECT CIRCTS.	6 015 383
723.1	WIRE AND CABLE--INSULATED	1 522 165
723.2	ELECTRICAL INSULATORS, FITTINGS, ETC. .	531 467
72-.1	TELEVISION BROADCAST RECEIVERS.	159 317
72-.9	TELECOMMUNICATIONS EQUIPMENT, NEC . . .	11 377 818
728.1	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS .	598 442
728.1	ELECTRO-MEDICAL APPR & PTS, EXC X-RAY .	414 762
728.2	X-RAY & RADIOLOGICAL APPARATUS, & PTS .	414 680
729.1	BATTERIES, AND PARTS NEC.	506 597
729.2	ELECTRIC LAMPS, AND PARTS, NEC.	808 705
729.3	ELECTRON TUBES, ETC, NEC, AND PARTS . .	15 436 991
729.4	ELECT IGNITION, ETC EQUIP--INT COM ENG.	3 644 626
729.5	ELECT MEASURING & CONTROLLING APPR,NEC.	3 468 188
729.6	ELECTRO-MECHANICAL HAND TOOLS & PARTS .	220 014
729.9	ELECTRICAL MACH & APPR, NEC, & PARTS. .	4 386 254
731.1	RAILWAY LOCOMOTIVES, ETC, & STREETCARS.	725 865
731.7	PARTS OF RAIL-WAY VEHICLES, NEC.	639 842
732.1	PASSENGER CARS, TRUCKS, ETC--ALL FUELS.	16 628 831
732.8	MOTOR VEHICLE & TRAC PTS & ACCESS, NEC.	26 247 972
733.1	TRAILERS & OTHER VEH & PTS--NOT MOTOR .	684 416
734.1	AIRCRAFT--HEAVIER THAN AIR.	2 652 739
734.9	AIRCRAFT, NEC, & AIRCRAFT PTS & ACCESS.	2 997 262
735.8	SHIPS & BOATS EXC MILTY, INCL SPEC PUR.	247 760
7.2..	CENTRAL HEATING APPARATUS AND PARTS . .	542 897
812.-	LIGHTING FIX & FIT, LAMPS, ETC, & PTS .	810 040
821.1	FURNITURE	251 017
841.2	ACCESS--TEXT FAB, NOT KNIT OR CROCH . .	652 784
841.3	CLOTHING AND ACCESSORIES OF LEATHER . .	411 012
841.4	CLOTHING, ACCESS, ETC--KNIT OR CROCH. .	296 984
841.8	CLOTHING ETC EXC NEW FOR RELIEF	641 685
861.1	OPTICAL ELEMENTS.	295 168
861.3	MICROSCOPES, ETC, & OPTICAL APPL, NEC .	122 231
861.4	CAMERAS--STILL, & FLASH APPR, AND PTS .	743 425
861.5	CAMERAS, ETC--MOTION PICTURE, & PARTS .	419 533
861.6	PHOTO & MOTION PICTURE EQUIP & PTS,NEC.	668 261
861.7	MEDICAL INST ETC EXC ELECTRO-MEDICAL. .	1 913 106
861.8	METERS & COUNTERS EXC PTS--NONELECTRIC.	237 734
861.9	MEASURING, CONTROL, ETC INSTRMNTS, NEC.	3 909 602
862.3	PREPARED PHOTOGRAPHIC CHEMICALS	833 372
862.4	PHOTO FILM, PLATES, ETC EXC DEV MP FLM.	3 070 098
863.0	MOTION PICTURE FILM--EXPOSED & DEVELOP.	250 402
891.1	PHONOGRAPHS,TAPE RECORDERS,& RMLR MACH.	401 874
891.2	PHONOGRAPH RECORDS & OTH SOUND MEDIA. .	264 702
892.1	MAPS,CHARTS,BOOKS,PAMPHLETS,GLOBES ETC.	4 143 447
892.2	NEWSPAPERS & PERIODICALS--UNBOUND . . .	161 790
892.9	CALENDARS, CATALOGS, PRINT MATTER NEC .	723 255
894.1	ARTICLES,NEC--FINSHD, ARTIFICIAL PLAST.	1 599 445
894.4	FISH & HUNT EQUIP, SPORTS EQUIP, ETC. .	295 873
895.2	PENS,PENCILS,NIBS,POINTS,CRAYONS,CHALK.	362 823
895.9	INKS & OFFICE STATIONERY SUPPLIES NEC .	328 575
897.1	JEWELRY,GOLDSMITHS WARES,ETC--PREC MET.	131 093
899.1	ART & MFRS OF CARVING OR MOLDING ETC. .	402 509
899.5	POWDER PUFFS,BUTTONS,& SMALLWARES NEC .	193 108
931.0	SPEC TRANSACTIONS NOT CLASSED BY KIND .	10 029 171
---.-	SUBGPS AVG UN $10,000 & NO BY ALL MOT .	6 160 211
---.-	SPECIAL CATEGORY*	9 175 613

PHILIPPINE EXPORTS BY DIVISIONAL COMMODITY AND PERCENTAGE OF PARTICIPATION

F.O.B. Value in U.S. Dollars

(1974)

DIVISIONAL COMMODITY	DOLLARS	%
TOTAL, DOMESTIC AND RE-EXPORT	2,724,989,237	100.00
TOTAL, DOMESTIC	2,722,366,004	100.00
Sugar and sugar preparations	766,400,472	28.15
Metalliferous ores and metal scrap	444,341,043	16.32
Animal and vegetable oils (not essential oils), fats, greases and derivatives	384,363,749	14.12
Wood, lumber and cork	250,872,003	9.22
Fruits and vegetables	151,326,408	5.56
Oil-seeds, oil nuts and oil kernels	141,040,288	5.18
Returned goods and special transactions	105,838,776	3.89
Wood and cork manufactures (excluding furniture)	81,034,570	2.98
Gold, silver, platinum, gems and jewelry	76,718,012	2.82
Textile fibers (not manufactured into yarn, thread or fabrics) and waste silk	38,965,301	1.43
Non-metallic mineral manufactures, n.e.s.	36,474,351	1.34
Tobacco and tobacco manufactures	30,414,723	1.12
Feeding stuff for animals — not including unmilled cereals	28,791,876	1.06
Clothing	23,671,142	0.87
Miscellaneous manufactured articles, n.e.s.	23,291,855	0.86
Textile yarn, fabrics, made-up articles and related products	20,113,502	0.74
Fish and fish preparations	18,366,474	0.67
Mineral fuels, lubricants and related materials	17,317,829	0.64
Animal and vegeable crude materials, inedible, n.e.s.	9,280,337	0.34
Travel goods, handbags and similar articles	7,550,804	0.28
Base metals	6,256,055	0.23
Explosives and miscellaneous chemical materials and products	6,256,055	0.23
Furniture and fixtures	6,139,356	0.20
Pulp and waste paper	5,488,852	0.20
Paper, paperboard and manufactures thereof	4,976,717	0.18
Machinery other than electric	4,217,420	0.15
Chemical elements and compounds	3,977,188	0.15
Footwear	3,723,277	0.14
Coffee, tea, cocoa, spices and manufactures thereof	3,419,826	0.13
Manufactures of metals	3,220,803	0.12
Medicinal and pharmaceutical products	2,525,478	0.09
Crude fertilizers, crude minerals exluding coal, petroleum and precious stones	2,270,370	0.08

DIVISIONAL COMMODITY	DOLLARS	%
Electric machinery, apparatus and appliances	2,128,957	0.08
Beverages	1,556,319	0.06
Essential oils and perfume materials, toilet polishing and cleansing preparations	1,429,389	0.05
Prefabricated building, sanitary, plumbing, heating and lighting fixtures and fittings	1,321,438	0.05
Transport equipment	1,266,652	0.05
Miscellaneous food preparations	1,026,887	0.04
Dyeing, tanning and coloring materials	992,902	0.04
Cereals and cereal preparations	698,037	0.03
Dairy products, eggs, and honey	696,895	0.03
Crude rubber including synthetic and reclaimed	623,982	0.02
Professional, scientific and controlling instruments; photographic and optical goods, watches and clocks	501,589	0.02
Hides, skins and fur skins undressed	238,139	0.01
Rubber manufactures, n.e.s.	208,466	0.01
Leather, leather manufactures, n.e.s. and dressed furs	120,511	0.00
Meat and meat preparations	54,634	0.00
Live animals not for food	40,137	0.00
RE-EXPORTS	2,623,233	100.00
Textile fibers (not manufactured into yarn, thread or fabrics) and waste silk	1,419,476	54.11
Transport equipment	287,411	10.96
Dairy products, eggs and honey	219,236	8.36
Machinery other than electric	198,585	7.57
Explosives and miscellaneous chemical materials and products	169,485	6.46
Essential oils and perfume materials, toilet polishing and cleansing preparations	139,032	5.30
Dyeing, tanning and coloring materials	55,354	2.11
Medicinal and pharmaceutical products	30,597	1.17
Mineral fuels, lubricants and related materials	21,129	0.81
Rubber manufactures, n.e.s.	16,046	0.61
Chemical elements and compounds	14,973	0.57
Paper, paperboard and manufactures thereof	14,758	0.56
Electric machinery, apparatus and appliances	13,194	0.50
Professional, scientific and controlling instruments; photographic and optical goods, watches and clocks	11,061	0.42
Textile yarn, fabrics, made-up articles and related products	8,379	0.32
Manufactures of metals	2,443	0.09
Miscellaneous food preparations	1,582	0.06
Non-metallic mineral manufactures, n.e.s.	492	0.02

Source: Philippine Foreign Trade, 1974 Resume, published by the Bureau of Foreign Trade, Department of Trade, Republic of the Philippines, 22 July 1975.

PHILIPPINE IMPORTS BY DIVISIONAL COMMODITY AND PERCENTAGE OF PARTICIPATION
F.O.B. Value in U.S. Dollars
(1974)

DIVISIONAL COMMODITY	DOLLARS	%
TOTAL	3,143,259,708	100.00
Mineral fuels, lubricants and related materials	653,378,214	20.79
Machinery other than electric	423,988,597	13.49
Base metals	295,669,494	9.41
Transport equipment	265,329,038	8.44
Chemical elements and compounds	216,105,445	6.88
Cereal and cereal preparations	154,945,307	4.93
Returned goods and special transactions	128,866,278	4.10
Explosives and miscellaneous chemical materials and products	113,778,785	3.62
Electric machinery, apparatus and appliances	105,335,002	3.35
Textile fibers (not manufactured into yarn, hread or fabrics) and waste silk	88,684,708	2.82
Fertilizers, manufactured	83,674,117	2.66
Dairy products, eggs and honey	74,464,156	2.37
Textile yarn, fabrics, made-up articles and related products	68,901,996	2.19
Manufactures of metals	60,119,134	1.91
Paper, paperboard and manufactures thereof	55,999,160	1.78
Medicinal and pharmaceutical products	36,305,100	1.16
Fish and fish preparations	31,605,451	1.01
Professional, scientific and controlling instruments; photographic and optical goods, watches and clocks	29,930,393	0.95
Dyeing, tanning and coloring materials	28,362,785	0.90
Miscellaneous manufactured articles, n.e.s.	27,762,979	0.88
Feeding stuff for animals (not including unmilled cereals)	26,216,488	0.83
Non-metallic mineral manufactures, n.e.s.	25,827,797	0.82
Pulp and waste paper	23,891,958	0.76
Rubber manufactures, n.e.s.	21,215,640	0.67
Tobacco and tobacco manufactures	15,451,857	0.49
Crude fertilizers and crude minerals excluding coal, petroleum and precious stones	12,898,782	0.41
Essential oils and perfume materials, toilet polishing and cleansing preparations	12,681,294	0.40
Animal and vegetable oil (not essential oils), fats, greases and derivatives	11,959,087	0.38

DIVISIONAL COMMODITY	DOLLARS	%
Crude rubber, including synthetic and reclaimed	9,811,682	0.31
Coffee, tea, cocoa, spices and manufactures thereof	9,738,842	0.31
Animal and vegetable crude materials, inedible, n.e.s.	6,126,893	0.19
Fruits and vegetables	5,864,402	0.19
Meat and meat preparations	4,548,075	0.15
Prefabricated buildings, sanitary, plumbing, heating and lighting fixtures and fittings	2,955,088	0.09
Metalliferous ores and metal scrap	2,938,057	0.09
Beverages	1,686,129	0.05
Miscellaneous food preparations	1,624,462	0.05
Wood and cork manufactures (excluding furniture)	1,035,619	0.03
Hides, skins and fur skins, undressed	937,668	0.03
Leather, leather manufactures, n.e.s. and dressed furs	845,006	0.03
Furniture and fixtures	466,416	0.01
Live animals, chiefly for food	433,364	0.01
Clothing	215,398	0.01
Wood, lumber and cork	193,005	0.01
Live animals not for food	163,432	0.01
Sugar and sugar preparations	113,526	0.00
Mineral tar and crude from coal, petroleum and natural gas	85,479	0.00
Gold, silver, platinum, gems and jewelry	73,161	0.00
Footwear	33,576	0.00
Travel goods, handbags and similar articles	18,440	0.00
Oil-seeds, oil nuts and oil kernels	2,946	0.00

Source: Philippine Foreign Trade, 1974 Resume, published by the Bureau of Foreign Trade, Department of Trade, Republic of the Philippines, 22 July 1975.

TANZANIA

Imports of domestic merchandise from the United States, 1974

Total - $51,388,800

001	ANIMALS--LIVE	73 600
011	MEAT--FRESH, CHILLED, OR FROZEN	10 500
042	RICE--ROUGH,BROWN,MILLED,GLAZED,POLISH.	4 442 000
044	CORN OR MAIZE--UNMILLED	24 452 012
047	CEREAL FLOURS, MEAL, AND GROATS, NEC.	849 028
048	PREPS OF CEREAL, FLOUR, STARCH, ETC	2 277 713
054	VEG,FRSH,ETC;DRIED LEGUM VEG;VEG PROD	10 300
055	VEG, ROOTS & TUBERS, PREP OR PRES, NEC.	1 058
099	FOOD PREPARATIONS, NEC.	11 536
111	BEVERAGES, NEC--NONALCOHOLIC.	4 118
112	BEVERAGES--ALCOHOLIC.	3 048
121	TOBACCO--UNMANUFACTURED	103 226
122	TOBACCO MANUFACTURES.	1 314
231	RUBBER, EXCL CMPDED, SEMIPROCD & MFRS	179 046
266	MANMADE FIBR & THEIR WASTE, EXC GLASS	10 160
273	STONE, SAND AND GRAVEL.	14 890
274	SULFUR AND UNROASTED IRON PYRITES	3 480
275	NAT ABRASIVES INCL INDUSTRIAL DIAMONDS.	16 335
279	CRUDE MINERALS, NEC	3 614
284	NONFERROUS METAL SCRAP.	2 055
332	PETROLEUM PRODUCTS.	365 590
421	VEGETABLE OILS--FIXED, SOFT, EXC HYDR	1 476 032
422	VEGETABLE OILS--FIXED, NEC.	5 546
431	FATTY ACIDS, WAXES, ETC, EXCL PET PROD.	53 403
512	ORGANIC CHEMICALS	1 192 403
513	INORG CHEM ELMNTS OXDS HYDROXDS ETC	275 475
514	INORGANIC CHEMICALS, NEC.	30 842
531	SYN ORG DYES ETC, LAKES AND TONERS.	1 570
533	PIGMENTS, PAINTS, VARNISHES ETC	7 457
541	MEDICINAL AND PHARMACEUTICAL PRODUCTS	482 879
551	ESSENTIAL OILS, PERFUME ETC MATERIALS	3 503
554	SOAPS, CLEANSERS, POLISHES ETC.	11 273
571	EXPLOSIVES AND PYROTECHNIC PRODUCTS	120 830
581	SYNTHETIC RESINS AND PLASTIC MATERIALS.	87 790
599	CHEMICAL PRODUCTS & MATERIALS, NEC.	120 117
611	LEATHER	10 223
621	RUBBER ARTICLES IN SPECIFIED FORMS.	5 273
629	RUBBER MANUFACTURES--FINISHED, NEC.	134 139
641	PAPER AND PAPERBOARD.	272 481
642	PAPER,PAPER PULP, & PAPERBOARD ART,NEC.	10 504
651	TEXTILE YARN AND THREAD	15 594
652	COTTON FABRIC, WOVEN EX SPEC OR NARROW.	80 258
653	TEXTILE FABRIC WOVEN EX COTTON, ETC	627 328
655	SPECIAL TEXT FABRIC AND PRODUCTS.	4 729
656	MADE-UP TEXT ARTICLES AND PRODUCTS.	61 991
662	CLAY AND REFRACTORY CONSTRUCTION MTLS	38 674
663	MINERAL MANUFACTURES, NEC	5 032
664	GLASS	8 874
665	GLASSWARE	4 218
673	IRON OR STEEL BARS, RODS, ANGLES, ETC	749
675	IRON OR STEEL HOOP AND STRIP.	658 174
678	IRON OR STEEL TUBES PIPES & FITTINGS.	387 016
682	COPPER & COPPER ALLOYS--NR & UNWR	2 575
691	STRUCTURES & PARTS--IR, ST, ALUM, ZINC.	46 616
692	METAL CONTAINERS FOR STORAGE & TRANS.	267 773
693	WIRE PRODS EXC INSULATED ELECTRIC	15 178
694	NAILS BOLTS & SIMILAR ARTS, IR ST COPP.	8 058
695	TOOLS FOR USE IN HAND OR IN MACHINES.	156 981
696	TABLE FLATWARE AND CUTLERY.	2 499
697	HOUSEHOLD EQUIPMENT OF BASE METALS.	1 361
698	MANUFACTURES OF BASE METAL, NEC	115 798
711	POWER GENERATING MACH EXC ELECT, & PTS.	1 164 073
712	AGRICULTURAL MACH & APPLIANCES, & PTS	1 788 098
714	OFFICE MACHINES AND PARTS	99 807
715	METALWORKING MACHINERY.	8 916
717	TEXTILE AND LEATHER MACHINERY, & PARTS.	80 819
718	MACHINES FOR SPECIAL INDUSTRIES, & PTS.	1 421 122
719	MACHINERY & APPL, & MACH PARTS, NEC	1 042 797
722	ELECTRIC POWER MACH, SWITCHGEAR, & PTS.	124 073
723	EQUIPMENT FOR DISTRIBUTING ELECTRICITY.	45 813
724	TELECOMMUNICATIONS APPARATUS, & PARTS	949 602
725	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS	16 866
726	ELECT MEDICAL & RADIOLOGICAL APPARATUS.	11 176
729	ELECT MACH & APPARATUS, & PTS, NEC.	91 539
731	RAILWAY VEHICLES AND PARTS.	14 211
732	ROAD MOTOR VEHICLES AND PARTS, NEC.	1 578 455
733	VEHICLES, EXC ROAD MOTOR VEH, & PARTS	265 395
734	AIRCRAFT AND SPACECRAFT, AND PARTS.	24 653
812	PLUMBING, ETC FIX, FIT, LAMPS AND PTS	27 935
821	FURNITURE	11 279
841	CLTHNG EX FUR, KNIT ELAS FAB, ART, ETC.	417 367
861	SCIENTIFIC, OPTICAL ETC APPARATUS	1 231 600
862	PHOTOGRAPHIC & MOTION PICTURE SUPPLIES.	93 018
863	MOVIE FILM--EXPOSED AND DEVELOPED	14 050
891	SOUND RECORDERS, MUSIC INSTRUMENTS ETC.	12 288
892	PRINTED MATTER.	20 910
893	ARTICLES OF ARTIFICIAL PLASTICS NEC	31 241
894	BABY CARRIAGES, TOYS, SPORTS GOODS ETC.	32 149
895	OFFICE & STATIONER SUPPLIES NEC	36 422
896	ARTWORKS, COLLECTORS PIECES & ANTIQUES.	5 547
899	MANUFACTURED ARTICLES NEC	32 332
931	SPEC TRANSACTIONS NOT CLASSED BY KIND	982 031
042.2	RICE--MILLED.	4 442 000
044.0	CORN OR MAIZE--UNMILLED	24 452 012
047.0	CEREAL FLOURS, MEAL, GROATS, EXC WHEAT.	849 028
048.1	BREAKFAST CEREALS--PREPARED	1 270 765
048.9	MALT EXTRACT, PREP OF FLOUR,STARCH,ETC.	1 006 948
231.2	RUBBER--SYNTHETIC,& RUBBER SUBSTITUTES.	179 046
332.9	PITCH, ASPHALT & OTH BYPROD EXC CHEM.	227 281
421.2	SOYBEAN OIL, EXCEPT HYDROGENATED.	1 475 308
512.0	ORGANIC CHEMICALS	1 192 403
513.2	CHEMICAL ELEMENTS, NEC.	248 297
541.6	GLYCOSIDES,GLANDS, ETC,VACCINES--BULK	157 200
541.8	MEDICINAL & PHARM PRODUCTS FOR RELIEF	182 832
641.3	KRAFT PAPER & PAPERBOARD IN ROLLS ETC	253 208
653.5	WOVEN FABRICS OF NONCELLULOSIC FIBERS	617 081
675.0	IRON OR STEEL HOOP AND STRIP.	658 174
678.2	IR & ST TUBES & PIPES--SEAMLESS	171 874
678.5	IRON OR STEEL TUBE AND PIPE FITTINGS.	145 349
692.3	COMPRESS GAS CYLINDERS--IR, ST, ALUM.	260 712
695.2	TOOLS, NEC, FOR HAND OR MACHINE USE	156 981
711.1	STEAM GENERATING POWER BOILERS & PARTS.	312 328
711.5	ENGINES--INT COM, EXC AIRCRAFT,& PARTS.	802 792
712.1	AGRI MACH FOR CULT, ETC SOIL, & PARTS	147 751
712.5	TRACTORS, EXCEPT ROAD AND INDUSTRIAL.	1 393 184
712.9	AGRI MACH & APPR NEC, & PTS & ATT, NEC.	137 269
718.4	CONSTRUCTION & MINING MACH, NEC & PTS	1 094 333
718.5	MINERAL WRKG & GLASS-WRKG MACH, & PTS	301 528
719.1	HEATING & COOLING MACH & EQUIP, & PTS	225 031
719.3	MECHANICAL HNDLNG MACH & EQUIP, & PTS	289 772
719.6	NONELECTRICAL MACHINES, NEC, AND PARTS.	134 913
719.8	MACHINERY & MECHANICAL APPLIANCES, NEC.	266 309
724.9	TELECOMMUNICATIONS EQUIPMENT, NEC	949 602
732.0	PASSENGER CARS, TRUCKS, ETC--ALL FUELS.	1 456 408
732.8	MOTOR VEHICLE & TRAC PTS & ACCESS, NEC.	122 047
733.3	TRAILERS & OTHER VEH & PTS--NOT MOTOR	265 395
841.8	CLOTHING ETC EXC NEW FOR RELIEF	411 520
861.9	MEASURING, CONTROL, ETC INSTRMNTS, NEC.	1 157 190
931.0	SPEC TRANSACTIONS NOT CLASSED BY KIND	982 031
---.-1	SUBGPS AVG UN $10,000 A MO BY ALL MOT	2 925 581
---	SPECIAL CATEGORY*	67 317

THAILAND

Imports of domestic merchandise from the United States, 1974

Total - $367,212,878

001	ANIMALS--LIVE	667 904
011	MEAT--FRESH, CHILLED, OR FROZEN	29 557
012	MEAT--DRIED, SALTED, OR SMOKED	8 840
013	MEAT--IN AIRTIGHT CONTAIN; MEAT PREPS	31 312
022	MILK AND CREAM	108 845
024	CHEESE AND CURD	18 904
025	EGGS--BIRDS , EXCEPT SEPARATE ALBUMIN	4 144
031	FISH & SHELLFISH--FRESH OR SIMPLY PREP.	2 450
041	WHEAT, INCL SPELT OR MESLIN--UNMILLED	7 294 554
042	RICE--ROUGH,BROWN,MILLED,GLAZED,POLISH.	14 388
044	CORN OR MAIZE--UNMILLED	35 008
045	CEREALS, NEC--UNMILLED	2 112
046	WHEAT FLOUR, MEAL, AND GROATS	868 757
047	CEREAL FLOURS, MEAL, AND GROATS, NEC.	508
048	PREPS OF CEREAL, FLOUR, STARCH, ETC	1 488 938
051	FRUITS--FRESH; NUTS, EXCEPT OIL NUTS,	222 207
052	FRUITS--DRIED, INCL ARTIFIC DEHYDRATED.	55 463
053	FRUITS & NUTS--PREP OR PRES, NEC.	272 941
054	VEG,FRSH,ETC;DRIED LEGUM VEG;VEG PROD	83 788
055	VEG, ROOTS & TUBERS, PREP OR PRES, NEC.	59 221
061	SUGAR, SIRUPS, MOLASSES, AND HONEY.	1 079 010
062	SUGAR CONFECTIONERY, NO COCOA, ETC.	313 209
071	COFFEE.	135 475
073	CHOC & FOOD PREPS CONT COCOA OR CHOC.	37 351
074	TEA AND MATE--CRUDE OR PREPARED	628
075	SPICES.	21 837
081	ANIMAL FEEDING-STUFF, EXCL UNML CEREAL.	3 472 236
091	MARGARINE, SHORTENING, PREP EDIBLE FAT.	36 610
099	FOOD PREPARATIONS, NEC.	2 063 744
111	BEVERAGES, NEC--NONALCOHOLIC.	5 314
112	BEVERAGES--ALCOHOLIC.	33 871
121	TOBACCO--UNMANUFACTURED	28 455 031
122	TOBACCO MANUFACTURES.	59 718
211	HIDES, SKINS, EXC FURSKINS--UNDRESSED	54 932
231	RUBBER, EXCL CMPDED, SEMIPROCD & MFRS	635 567
241	FUEL WOOD, WOOD CHARCOAL, & WOOD WASTE.	3 255
244	CORK--NATURAL, RAW AND WASTE.	800
251	PULPS, AND WASTE PAPER.	9 222 278
263	COTTON.	33 948 616
266	MANMADE FIBR & THEIR WASTE, EXC GLASS	4 192 713
267	TEXTILE FABRIC WASTE, INCLUDING RAGS.	12 665
273	STONE, SAND AND GRAVEL.	10 684
275	NAT ABRASIVES INCL INDUSTRIAL DIAMONDS.	46 441
276	CRUDE MINERALS, NEC	300 164
282	IRON AND STEEL SCRAP.	3 310 901
284	NONFERROUS METAL SCRAP.	297 823
291	ANIMAL MATERIALS, NEC--CRUDE.	10 417
292	VEGETABLE MATERIALS, NEC--CRUDE	365 582
321	COAL, COKE, AND BRIQUETS.	3 682
332	PETROLEUM PRODUCTS.	3 972 786
341	GAS--NATURAL AND MANUFACTURED	7 302
411	ANIMAL OILS AND FATS, NEC	380 964
421	VEGETABLE OILS--FIXED, SOFT, EXC HYDR	16 113
422	VEGETABLE OILS--FIXED, NEC.	18 834
431	FATTY ACIDS, WAXES, ETC, EXCL PET PROD.	153 155
512	ORGANIC CHEMICALS	9 622 107
513	INORG CHEM ELMNTS OXDS HYDROXDS ETC	1 241 619
514	INORGANIC CHEMICALS, NEC.	2 535 081
515	RADIOACTIVE & STABLE ISOTOPES & CPDS ETC	31 751
521	MIN TAR & OILS & CRUDE CHEMICALS ETC.	54 800
531	SYN ORG DYES ETC, LAKES AND TONERS,	437 381
532	DYEING & TANNING EXTRACTS & ART DATES	20 509
533	PIGMENTS, PAINTS, VARNISHES ETC	1 888 942
541	MEDICINAL AND PHARMACEUTICAL PRODUCTS	6 935 471
551	ESSENTIAL OILS, PERFUME ETC MATERIALS	936 485
553	PERFUMERY, COSMETICS, DENTIFRICES ETC	567 308
554	SOAPS, CLEANSERS, POLISHES ETC.	1 993 490
561	FERTLZRS--MFRD & FERTLZR MTRLS NEC.	19 633 723
571	EXPLOSIVES AND PYROTECHNIC PRODUCTS	340 029
581	SYNTHETIC RESINS AND PLASTIC MATERIALS.	6 260 199
599	CHEMICAL PRODUCTS & MATERIALS, NEC.	8 458 586
611	LEATHER	9 668
612	LEATHER MANUFACTURES, NEC	11 713
621	RUBBER ARTICLES IN SPECIFIED FORMS.	811 538
629	RUBBER MANUFACTURES--FINISHED, NEC.	819 014
632	WOOD MANUFACTURES, NEC.	54 257
633	CORK MFRS, & AGGLOMERATED CORK & MFRS	19 933
641	PAPER AND PAPERBOARD.	2 340 230
642	PAPER,PAPER PULP, & PAPERBOARD ART,NEC.	1 170 253
651	TEXTILE YARN AND THREAD	1 003 048
652	COTTON FABRIC, WOVEN EX SPEC OR NARROW.	2 655 744
653	TEXTILE FABRIC WOVEN EX COTTON, ETC	978 954
654	TULLE, LACE ETC AND OTHER SMALL WARES	40 461
655	SPECIAL TEXT FABRIC AND PRODUCTS.	530 876
656	MADE-UP TEXT ARTICLES AND PRODUCTS.	666 322
657	FLOOR COVERINGS, TAPESTRIES ETC	15 433
661	LIME CEMENT & FBR BLDG MTL NEC.	25 878
662	CLAY AND REFRACTORY CONSTRUCTION MTLS	316 187
663	MINERAL MANUFACTURES, NEC	652 098
664	GLASS	214 078
665	GLASSWARE	453 869
666	POTTERY	1 800
667	DIAMONDS & OTHER PRECIOUS STONES.	125 761
671	PIG IRON ETC AND FERROALLOYS.	275 528
672	IRON OR STEEL PRIMARY FORMS	211 668
673	IRON OR STEEL BARS, RODS, ANGLES, ETC	144 051
674	IRON OR STEEL PLATES AND SHEETS	1 901 958
675	IRON OR STEEL HOOP AND STRIP.	113 719
676	IR & ST RAILS & RAILWAY TRACK MTL	3 678
677	IRON OR STEEL WIRE EXC INSULATED ELECT.	45 810
678	IRON OR STEEL TUBES PIPES & FITTINGS.	637 634
679	IR OR ST CASTINGS & FORGINGS--ROUGH	4 462
681	SILVER & PLATINUM--UNWR & PTLY WORKED	6 601
682	COPPER & COPPER ALLOYS--WR & UNWR	339 560
683	NICKEL & NICKEL ALLOYS--WR & UNWR	18 801
684	ALUMINUM & ALUMINUM ALLOYS--WR & UNWR	5 578 029
685	LEAD & LEAD ALLOYS--WR & UNWR	147 249
686	ZINC & ZINC ALLOYS--WR & UNWR	270 901
687	TIN & TIN ALLOYS--WR & UNWR	1 240
689	BASE METALS & ALLOYS, NEC--WR & UNWR.	33 680
691	STRUCTURES & PARTS--IR, ST, ALUM, ZINC.	846 581
692	METAL CONTAINERS FOR STORAGE & TRANS.	267 778
693	WIRE PRODS EXC INSULATED ELECTRIC	437 705
694	NAILS BOLTS & SIMILAR ARTS, IR ST COPP.	110 746
695	TOOLS FOR USE IN HAND OR IN MACHINES.	895 114
696	TABLE FLATWARE AND CUTLERY.	70 507
697	HOUSEHOLD EQUIPMENT OF BASE METALS.	189 343
698	MANUFACTURES OF BASE METAL, NEC	1 773 957
711	POWER GENERATING MACH EXC ELECT, & PTS.	13 470 903
712	AGRICULTURAL MACH & APPLIANCES, & PTS	5 735 567
714	OFFICE MACHINES AND PARTS	1 408 732
715	METALWORKING MACHINERY.	2 706 112
717	TEXTILE AND LEATHER MACHINERY, & PARTS.	8 362 291
718	MACHINES FOR SPECIAL INDUSTRIES, & PTS.	5 416 580
719	MACHINERY & APPL, & MACH PARTS, NEC	29 535 384
722	ELECTRIC POWER MACH, SWITCHGEAR, & PTS.	5 977 754
723	EQUIPMENT FOR DISTRIBUTING ELECTRICITY.	1 530 284
724	TELECOMMUNICATIONS APPARATUS, & PARTS	6 559 756
725	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS	683 589
726	ELECT MEDICAL & RADIOLOGICAL APPARATUS.	745 969
729	ELECT MACH & APPARATUS, & PTS, NEC.	5 892 280
731	RAILWAY VEHICLES AND PARTS.	11 176
732	ROAD MOTOR VEHICLES AND PARTS, NEC.	7 034 342
733	VEHICLES, EXC ROAD MOTOR VEH, & PARTS	142 283
734	AIRCRAFT AND SPACECRAFT, AND PARTS.	27 377 917
735	SHIPS, BOATS & FLOATING STRUCTURES.	415 053
812	PLUMBING, ETC FIX, FIT, LAMPS AND PTS	695 289
821	FURNITURE	120 869
831	TRAVEL GOODS, HANDBAGS ETC.	30 863
841	CLTHNG EX FUR, KNIT ELAS FAB, ANT, ETC.	809 991
851	FOOTWEAR--NEW, EXC MILITARY & ORTHOPED.	8 352
861	SCIENTIFIC, OPTICAL ETC APPARATUS	4 453 152
862	PHOTOGRAPHIC & MOTION PICTURE SUPPLIES.	2 496 152
863	MOVIE FILM--EXPOSED AND DEVELOPED	415 494
864	WATCHES AND CLOCKS, INCLUDING PARTS	48 881
891	SOUND RECORDERS, MUSIC INSTRUMENTS ETC.	857 801
892	PRINTED MATTER.	509 824
893	ARTICLES OF ARTIFICIAL PLASTICS NEC	1 300 793
894	BABY CARRIAGES, TOYS, SPORTS GOODS ETC.	1 915 042
895	OFFICE & STATIONER SUPPLIES NEC	844 075
896	ARTWORKS, COLLECTORS PIECES & ANTIQUES.	6 070
897	JEWELRY & RELATED ARTICLES.	54 070
899	MANUFACTURED ARTICLES NEC	1 455 814
931	SPEC TRANSACTIONS NOT CLASSED BY KIND	4 768 908
941	ANIMALS, NEC--INCL ZOO ANIMALS.	800
001.1	CATTLE--LIVE.	151 500
001.4	POULTRY--LIVE	510 054
041.0	WHEAT, INCL SPELT OR MESLIN--UNMILLED	7 294 554
046.0	WHEAT FLOUR, MEAL, GROATS	868 757
048.1	BREAKFAST CEREALS--PREPARED	211 442
048.8	MALT EXTRACT, PREP OF FLOUR,STARCH,ETC.	1 273 658
051.4	APPLES--FRESH	202 419
053.5	FRUIT & VEGETABLE JUICES--UNFERMENTED	235 452
061.9	SUGARS AND SIRUPS, N.E.C.	1 071 436
062.0	SUGAR CONFECTIONERY, NO COCOA, ETC.	313 209
071.3	COFFEE EXTRACTS,ESSENCES,CONCENTRATES	126 998
081.3	OILSEED CAKE, MEAL, RESIDUES.	2 679 712
081.9	FOOD WASTES & PREPARED ANIMAL FEED,NEC.	792 524
099.0	MUSTARD SAUCES, SEASONINGS, SOUPS, ETC.	126 685
099.1	FOOD PREPARATIONS, NEC.	1 934 089
121.0	TOBACCO--UNMANUFACTURED	28 455 031
231.1	RUBBER--NATURAL,& SIMILAR NATURAL GUM	177 395
231.2	RUBBER--SYNTHETIC,& RUBBER SUBSTITUTES.	458 192
251.1	PAPER--WASTE, AND OLD PAPER	1 595 837
251.6	WOODPULP--CHEMICAL, DISSOLVING GRADES	265 486
251.7	WOODPULP--SULPHATE.	5 592 952
251.8	WOODPULP--SULPHITE.	1 730 239
263.1	RAW COTTON, OTHER THAN LINTERS.	33 948 616
266.2	NONCELLULOSIC MANMADE FIBERS.	3 539 933
266.3	CELLULOSIC MANMADE FIBERS	609 788

Thailand - Imports from the United States (Continued)

276.2	CLAY & OTHER REFRACTORY MINERALS NEC. .	210 076
282.0	IRON AND STEEL SCRAP.	3 310 901
284.0	NONFERROUS METAL SCRAP.	297 823
292.5	SEEDS,FRUIT,SPORES, NEC, FOR PLANTING .	253 309
332.5	LUBRICATING OILS AND GREASES.	3 013 055
332.6	PETROLEUM JELLY AND MINERAL WAXES . . .	348 266
332.9	PITCH, ASPHALT & OTH BYPROD EXC CHEM. .	611 465
411.3	ANIMAL FATS & OIL,NEC INCL WOOL GREASE.	370 244
512.0	ORGANIC CHEMICALS	9 622 107
513.2	CHEMICAL ELEMENTS, NEC.	531 645
513.5	OXIDES--METALLIC,PGMT & NONPGMT GRADES.	296 429
513.6	AMMONIA,INORGANIC BASES,HYDROXIDES,ETC.	306 702
514.6	SODIUM AND POTASSIUM COMPOUNDS, NEC . .	1 401 946
514.7	INORGANIC CHEMICALS, NEC EXC MED CHEM .	1 117 767
531.0	SYN ORGANIC DYESTUFFS,NAT INDIGO,ETC. .	437 381
533.2	PRINTING INKS	248 772
533.3	PREPARED PAINTS,ENAMELS,LACQUERS,ETC. .	1 606 810
541.3	ANTIBIOTICS--BULK	215 373
541.6	GLYCOSIDES,GLANDS, ETC,VACCINES--BULK .	166 913
541.7	MED & PHARM PREP,CMPNDS,MIXTURES,ETC. .	4 256 462
541.8	MEDICINAL & PHARM PRODUCTS FOR RELIEF .	1 646 604
541.9	PHARMACEUTAL GOODS & PREPARATIONS,NEC .	512 764
551.1	ESSENTIAL OILS AND RESINOIDS.	164 204
551.2	SYN PERFUME & FLAVOR MTL & CONCEN, ETC.	772 281
553.0	COSMETICS & OTH TOILET PREPARATION,NEC.	567 308
554.1	SOAPS	173 123
554.2	SURFACE ACTIVE AGENTS,DETERGENTS,ETC. .	1 658 760
554.3	SCOURING CLEANSERS,SHOE POLISHES,ETC. .	161 607
561.1	NITROGENOUS FERTILIZERS, NEC, EX NATRL.	366 456
561.9	FERTILIZERS, N.E.C.	19 238 145
571.4	SHOTGUN SHELLS,HUNT & SPORT AMMO & PTS.	306 547
581.1	CONDENSATION,POLYCONDENSATION,ETC,PROD.	1 004 199
581.2	POLYMERIZATION,COPOLY, PROD--UNFINSHD .	3 298 902
581.3	VULCANIZED FIB & CELLULOSIC PLAST MTRL.	1 132 734
581.9	HARDENED PROTEINS,MODI NAT RESINS,ETC .	824 364
599.2	INSECTICIDES,FUNGICIDES,& SIMILAR PROD.	2 902 380
599.5	ALBUMINOIDAL SUBSTANCES,STARCHES,ETC. .	184 766
599.7	ARTIFICIAL WAXES,PREP ADDITIVES,ETC . .	3 790 678
599.9	CHEM PROD, NEC INCL REAGENTS ETC. . . .	1 548 890
621.0	RBR IN VARIOUS FORMS--UNVULCANIZED,ETC.	811 538
629.1	RBR TIRES & TUBES FOR VEHICLES & PLANE.	306 822
629.3	HYGIENIC & PHARM ART--UNHARDENED RBR. .	199 319
629.4	RBR BELTS & BELTING--TRANSMISSION, ETC.	154 534
629.9	ARTICLES OF RUBBER, NEC	158 339
641.1	STANDARD NEWSPRINT PAPER.	740 150
641.2	PRINTING AND WRITING PAPER, NEC	314 435
641.3	KRAFT PAPER & PAPERBOARD IN ROLLS ETC .	166 951
641.5	PAPER AND PAPERBOARD, MACHINE-MADE,ETC.	254 508
641.9	PAPER & PAPERBOARD--COATED,IMPREG,ETC .	832 842
642.1	PAPER BAGS,PAPERBOARD BOXES,CONTAINERS.	174 091
642.9	ART OF PAPER PULP,PAPER,OR PAPERBOARD .	985 058
651.6	YARN & THREAD ETC OF NONCELLULOSIC FIB.	631 146
651.7	YARN & THREAD ETC OF CELLULOSIC FIBER .	334 542
652.2	COTTON FABRICS--WOVEN, BLEACHED,FINSHD.	2 626 906
653.5	WOVEN FABRICS OF NONCELLULOSIC FIBERS .	623 782
653.6	WOVEN FABRICS OF CELLULOSIC FIBERS. . .	302 730
655.4	COATED OR IMPREGNATED TEXT FAB & PROD .	345 762
656.9	MADE-UP ARTICLES OF TEXTILE MTL, NEC. .	658 920
662.3	BRICKS & OTHER REFRACTORY CONST MTLS. .	316 187
663.2	CLOTHS, PAPERS,ART OF COATED ABRASIVE .	356 529
663.5	ASBESTOS MFRS AND FRICTION MATERIALS. .	125 967
664.9	GLASS, NEC.	148 157
665.1	CONTAINERS AND CLOSURES OF GLASS. . . .	129 659
665.8	GLASS ARTICLES, NEC	233 876
671.2	PIG IRON, INCLUDING CAST IRON	275 000
672.5	IR & ST BLOOMS, BILLETS, SLABS, ETC.. .	211 668
674.4	IRON & STEEL PLATES & SHEETS--UNCOATED.	802 777
674.7	TIN PLATE AND TIN COATED SHEET.	1 007 909
678.3	IR & ST TUBES & PIPES--WELDED, ETC. . .	274 239
678.5	IRON OR STEEL TUBE AND PIPE FITTINGS. .	288 351
682.2	COPPER AND COPPER ALLOYS--WROUGHT . . .	252 033
684.0	ALUMINUM & ALUM AL--UNWR, & BARS, ETC .	3 933 710
684.2	ALUMINUM & ALUM ALLOYS--WROUGHT, NEC. .	1 644 319
685.1	LEAD AND LEAD ALLOYS--UNWROUGHT	147 249
686.1	ZINC AND ZINC ALLOYS--UNWROUGHT	246 901
691.1	FINSHD STRUC PTS & STRUCTURES--IR & ST.	835 284
693.1	WIRE CABLE--UNINS, IR, ST, COPP, ALUM .	138 648
693.3	WIRE GAUZE, ETC--IR, ST, COPP, ALUM . .	299 037
695.2	TOOLS, NEC, FOR HAND OR MACHINE USE . .	886 867
697.2	DOMESTIC UTENSILS, ETC, OF BASE METALS.	179 701
698.1	HARDWARE OF BASE METALS, INCL LOCKS . .	810 703
698.8	CHAINS--COPPER, & MISC BA MET ARTICLES.	476 609
698.9	ARTICLES OF BASE METALS, NEC.	399 870
711.1	STEAM GENERATING POWER BOILERS & PARTS.	1 165 958
711.3	STEAM ENGINES, TURBINES, AND PARTS. . .	1 843 320
711.4	ENGINES AND JET,GAS TURBINES--A/C, ETC.	1 579 553
711.5	ENGINES--INT COM, EXC AIRCRAFT,& PARTS.	8 801 209
712.2	AGRI MACH FOR HARVESTING, ETC, & PARTS.	328 447
712.5	TRACTORS, EXCEPT ROAD AND INDUSTRIAL. .	4 975 109
712.9	AGRI MACH & APPR NEC, & PTS & ATT, NEC.	390 851
714.2	ELECTRONIC COMPUTERS EXC PUN CARD TYPE.	461 316
714.3	STATISTICAL MACH, NEC, INCL AUXIL MACH.	354 678
714.9	OFFICE MACHINES, NEC, & OFC MACH PARTS.	551 456
715.1	MACHINE TOOLS FOR WORKING METAL	815 566
715.2	METALWRKNG MACH, EXC MACH TOOLS, & PTS.	1 890 546
717.1	TEXTILE MACH, ETC EXC DOM WASHING MACH.	8 167 672
717.3	SEWING MACHINES AND PARTS	193 999
718.1	PULP & PAPER PROCESSING MACHINES & PTS.	492 954
718.2	PRINTING & BOOKBINDING MACHINES, & PTS.	408 874
718.3	FOOD PROCESSING MACH, EXC DOM, & PARTS.	1 069 695
718.4	CONSTRUCTION & MINING MACH, NEC & PTS .	3 052 924
718.5	MINERAL WRKG & GLASS-WRKG MACH, & PTS .	391 933
719.1	HEATING & COOLING MACH & EQUIP, & PTS .	11 289 669
719.2	PUMPS, CENTRIFUGES, ETC, AND PARTS. . .	6 685 108
719.3	MECHANICAL HNDLNG MACH & EQUIP, & PTS .	3 843 603
719.5	POWERED TOOLS, NEC, & ACCESS, & PARTS .	691 913
719.6	NONELECTRICAL MACHINES, NEC, AND PARTS.	1 636 428
719.7	BEARINGS--BALL, ROLLER, ETC, AND PARTS.	935 052
719.8	MACHINERY & MECHANICAL APPLIANCES, NEC.	2 923 645
719.9	PARTS & ACCESSORIES FOR MACHINERY, NEC.	1 515 645
722.1	ELECTRIC POWER MACHINERY AND PARTS. . .	3 815 881
722.2	ELECT APPR FOR MAKING ETC ELECT CIRCTS.	2 161 873
723.1	WIRE AND CABLE--INSULATED	1 462 075
724.9	TELECOMMUNICATIONS EQUIPMENT, NEC . . .	6 549 914
725.0	ELECTRIC HOUSEHOLD EQUIP & APPL & PTS .	683 589
726.1	ELECTRO-MEDICAL APPR & PTS, EXC X-RAY .	501 065
726.2	X-RAY & RADIOLOGICAL APPARATUS, & PTS .	244 895
729.1	BATTERIES, AND PARTS NEC.	549 493
729.2	ELECTRIC LAMPS, AND PARTS, NEC.	192 812
729.3	ELECTRON TUBES, ETC, NEC, AND PARTS . .	679 628
729.4	ELECT IGNITION, ETC EQUIP--INT COM ENG.	1 159 623
729.5	ELECT MEASURING & CONTROLLING APPR,NEC.	1 674 511
729.6	ELECTRO-MECHANICAL HAND TOOLS & PARTS .	154 658
729.9	ELECTRICAL MACH & APPR, NEC, & PARTS. .	1 481 855
732.0	PASSENGER CARS, TRUCKS, ETC--ALL FUELS.	3 270 553
732.8	MOTOR VEHICLE & TRAC PTS & ACCESS, NEC.	3 750 893
733.3	TRAILERS & OTHER VEH & PTS--NOT MOTOR .	142 283
734.1	AIRCRAFT--HEAVIER THAN AIR.	24 680 182
734.9	AIRCRAFT, NEC, & AIRCRAFT PTS & ACCESS.	2 697 735
735.5	SHIPS & BOATS EXC MILTY, INCL SPEC PUR.	410 154
812.1	CENTRAL HEATING APPARATUS AND PARTS . .	142 330
812.2	SANITARY & PLUMBING FIX & FIT--CERAMIC.	205 627
812.3	SANITARY, ETC FIX & FIT--IRON OR STEEL.	218 435
812.4	LIGHTING FIX & FIT, LAMPS, ETC, & PTS .	327 897
821.0	FURNITURE	120 869
841.1	CLOTHING--TEXT FAB, NOT KNIT OR CROCH .	364 337
861.4	CAMERAS--STILL, & FLASH APPR, AND PTS .	142 121
861.5	CAMERAS, ETC--MOTION PICTURE, & PARTS .	245 479
861.6	PHOTO & MOTION PICTURE EQUIP & PTS,NEC.	545 983
861.7	MEDICAL INST ETC EXC ELECTRO-MEDICAL. .	1 035 239
861.9	MEASURING, CONTROL, ETC INSTRMNTS, NEC.	2 247 979
862.3	PREPARED PHOTOGRAPHIC CHEMICALS	256 868
862.4	PHOTO FILM, PLATES, ETC EXC DEV MP FLM.	2 239 284
863.0	MOTION PICTURE FILM--EXPOSED & DEVELOP.	415 494
891.1	PHONOGRAPHS,TAPE RECORDERS,& SMLR MACH.	432 006
891.2	PHONOGRAPH RECORDS & OTH SOUND MEDIA. .	386 919
892.1	MAPS,CHARTS,BOOKS,PAMPHLETS,GLOBES ETC.	306 907
892.9	CALENDARS, CATALOGS, PRINT MATTER NEC .	152 859
893.0	ARTICLES,NEC--FINSHD, ARTIFICIAL PLAST.	1 300 793
894.2	CHILDREN'S TOYS, CHRISTMAS DECORAT,ETC.	324 125
894.3	NONMILITARY ARMS & PTS EXC PISTOLS ETC.	975 868
894.4	FISH & HUNT EQUIP, SPORTS EQUIP, ETC. .	609 762
895.2	PENS,PENCILS,HLDRS,POINTS,CRAYONS,CHALK.	646 695
895.9	INKS & OFFICE STATIONERY SUPPLIES NEC .	182 148
899.1	ART & MFRS OF CARVING OR MOLDING MTL. .	672 441
899.3	CANDLES,TAPERS,MATCHES,SMOKERS ART . .	414 940
899.5	POWDER PUFFS,BUTTONS,& SMALLWARES NEC .	135 754
931.0	SPEC TRANSACTIONS NOT CLASSED BY KIND .	4 768 908
---.-	SUBGPS AVG UN $10,000 A MO BY ALL MOT .	5 298 345
---.-	SPECIAL CATEGORY*	31 767 006

Thailand's Imports by Major Commodity Categories, 1972-1973

(in millions of dollars)

	1972			1973*			Variation
	No	%	Value	No	%	Value	1972/1973
Boilers, mechanical equipment and parts thereof	1	15.3	236	1	14.0	293	-23.9
Fuel Oil	2	10.3	159	2	11.0	229	+44.3
Iron and steel and articles made of steel	3	10.2	158	3	10.6	221	-40.2
Land vehicles and parts thereof	4	9.1	140	4	9.7	203	+45.4
Electrical machinery and accessories	5	5.9	91	5	6.1	129	-41.1
Cotton	7	3.2	49	6	3.9	80	+65.2
Organic and inorganic chemicals	6	3.3	51	7	3.8	80	+57.2
Artificial resin and plastic materials	8	2.9	45	8	3.5	73	+61.2
Man-made fibres (continuous)	11	2.1	32	9	2.2	47	+46.7
Pharmaceutical products	9	2.3	36	10	1.9	41	+12.2
Fertilizers	10	2.1	33	11	1.9	40	+24.1
Paper and cardboard	15	1.7	27	12	1.9	40	+49.0
Miscellaneous chemical products	14	1.9	30	13	1.9	39	+31.5
Tanning and dyeing extracts	13	1.9	30	14	1.8	38	+29.2
Dairy products, eggs and natural honey	16	1.6	24	15	1.2	26	+7.5
Man-made fibres (discontinuous)	18	1.2	18	16	1.2	25	+37.8
Aluminum and articles thereof	19	1.0	15	17	1.1	23	+57.8
Optical and photographic supplies	17	1.3	20	18	1.1	22	+9.3
Materials used in paper production	20	0.9	15	19	1.0	21	+57.1
Tobacco (including tobacco leaves)	12	1.9	30	20	0.9	19	+34.2
Total		80.0	1,237		80.9	1,689	+36.3
Total		100.0	1,484		100.0	2,090	+35.4

Source: Customs Department, Royal Thai Government
*preliminary figures

APPENDIX III

PRODUCTION OF MINERAL COMMODITIES

Bolivia
Ghana
Guatemala
Philippines
Tanzania
Thailand

Bolivia: Approximate Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity [1]	1971	1972	1973 [p]
METALS [2]			
Antimony:			
Mine output, metal content	11,878	13,338	14,852
Metal [3]	--	NA	19
Bismuth:			
Mine output, metal content	682	587	646
Metal [3]	--	439	499
Cadmium, mine output, metal content [4]	[r] 82	139	169
Copper, mine output, metal content	7,512	8,307	8,154
Gold, mine output, metal content [5] ....troy ounces	22,193	20,145	35,949
Iron ore, gross weight	[e] 5,970	[e] 52,000	[e] 1,591
Lead:			
Mine output, metal content	20,600	20,504	20,985
Metal, including alloys	18	[e] 30	50
Manganese ore, gross weight	713	93	641
Silver, mine output, metal content ....thousand troy ounces	5,369	5,581	5,707
Tin:			
Mine output, metal content [6] ....long tons	20,533	30,986	29,827
Metal, including alloys [7] ....do	7,116	6,405	[e] 7,700
Tungsten, mine output, metal content	2,090	2,247	1,934
Zinc, mine output, metal content	45,077	42,068	50,989
NONMETALS			
Cement, hydraulic ....thousand tons	206	151	166
Fluorspar [3]	--	17	--
Gypsum, crude [3]	2,000	2,308	900
Stone:			
Calcite [3]	63	32	105
Quartz [3]	750	--	--
Sulfur, elemental [3]	10,487	18,214	56,392
MINERAL FUELS AND RELATED MATERIALS			
Gas, natural:			
Gross production ....million cubic feet	[r] 82,461	120,965	151,199
Marketable production [8] ....do	1,427	36,917	57,857
Natural gas liquids:			
Natural gasoline ....thousand 42-gallon barrels	46	67	76
Liquefied petroleum gas ....do	48	51	48
Petroleum:			
Crude ....thousand 42-gallon barrels	[r] 13,446	15,967	17,266
Refinery products:			
Gasoline ....do	[r] 2,170	2,107	2,266
Jet fuel ....do	115	129	148
Kerosine ....do	845	923	990
Fuel oil, distillate and residual ....do	[r] 1,640	1,847	1,890
Lubricants ....do	[r] 47	59	58
Other:			
Liquefied petroleum gas ....do	[r] 47	70	94
Unspecified ....do	[r] 5	([8])	3
Refinery fuel and losses ....do	[r] 64	59	67
Total ....do	[r] 4,933	5,194	5,516

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] In addition to the commodities listed, salt and a variety of construction materials such as clays, stone, and sand and gravel are produced, but information is inadequate to make reliable estimates of output levels.

[2] Unless otherwise specified, data shown represent the sum of production by COMIBOL and exports by medium and small mines.

[3] Total national exports.

[4] Contained in zinc concentrates produced by COMIBOL.

[5] Sum of placer production, COMIBOL production (in ores and concentrates of other metals) and medium and small mines' exports (in ores and concentrates of other metals).

[6] Total of COMIBOL output, COMIBOL purchases from lessees operating in COMIBOL mines, sales to ENAF by medium and small mines, and exports by medium and small mines.

[7] Production by ENAF, Pero, and Metabol smelters.

[8] Less than ½ unit.

Ghana: Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity [1]	1971	1972	1973 p
METALS			
Aluminum:			
Bauxite, gross weight	329,608	340,321	309,908
Metal, smelter production, primary	111,125	144,070	150,707
Gold ... thousand troy ounces	698	724	723
Manganese ore and concentrate, gross weight	598,562	498,340	818,211
NONMETALS			
Cement	531	415	e 450
Diamond: e			
Gem ... thousand carats	256	266	270
Industrial ... do	2,306	2,393	2,430
Total ... do	2,562	2,659	2,700
Salt	47,261	e 50,000	e 50,000
MINERAL FUELS AND RELATED MATERIALS			
Petroleum refinery products:			
Gasoline ... thousand 42-gallon barrels	1,684	1,669	1,726
Jet fuel ... do	166	279	199
Kerosine ... do	601	689	735
Distillate fuel oil ... do	1,985	1,919	1,956
Residual fuel oil ... do	2,165	2,459	2,039
Other ... do	69	55	60
Refinery fuel and losses ... do	347	385	367
Total ... do	7,017	7,455	7,082

e Estimate. p Preliminary.

[1] In addition to the commodities listed, a variety of crude construction materials (clays, sand, gravel, and stone) is produced, but production data are not reported and available general information is inadequate for the formulation of reliable estimates of output levels.

Guatemala: Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity	1971	1972	1973 p
Antimony, mine output, metal content	1,771	1,177	1,745
Cadmium (contained in zinc concentrates)	1	(2)	2
Cement ... thousand tons	227	264	310
Feldspar e	2,500	2,000	2,000
Gypsum e	7,900	r 8,000	8,000
Lead:			
Mine output, metal content	e 500	138	102
Metal, including secondary	90	22	65
Lime e	22,000	r 23,000	23,000
Mica	--	r e 2,400	e 2,500
Petroleum refinery products:			
Gasoline ... thousand 42-gallon barrels	1,512	1,629	1,781
Kerosine and jet fuel ... do	670	734	759
Distillate fuel oil ... do	r 1,567	1,787	2,007
Residual fuel oil ... do	r 1,775	1,903	2,074
Liquefied petroleum gas ... do	114	126	111
Other ... do	--	4	2
Refinery fuel and losses ... do	NA	227	261
Quartz	NA	e 18,000	e 18,000
Stone, sand and gravel, crushed and broken:			
Limestone ... thousand tons	NA	e 600	e 600
Other (volcanic ash)	NA	e 54,000	e 55,000
Tungsten, concentrate (W content)	40	8	158
Zinc, mine output, metal content	506	308	280

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e Estimate.

p Preliminary.

r Revised.

2 Less than 1/2 unit.

Philippines: Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity	1971	1972	1973 p
METALS			
Cadmium mine output, metal content ... kilograms	9,843	7,983	--
Chromium, chromite, gross weight:			
Metallurgical grade	88,790	81,370	95,659
Refractory grade	340,804	268,230	484,609
Total	429,594	349,600	580,268
Copper mine output, metal content	197,573	213,695	187,400
Gold ... troy ounces	637,048	606,730	572,319
Iron and steel:			
Iron ore and concentrate ... thousand tons	2,331	2,205	2,255
Ferroalloys	1,484	1,819	NA
Lead mine output, metal content	e 20	--	--
Manganese ore and concentrate, gross weight	5,133	2,491	3,973
Mercury mine output, metal content ... 76-pound flasks	5,020	3,341	2,160
Molybdenum mine output, metal content	4	--	--
Nickel mine output, metal content	222	334	399
Platinum-group metals:			
Palladium ... troy ounces	1,756	4,810	4,205
Platinum ... do	703	2,712	2,464
Silver mine output, metal content ... thousand troy ounces	1,940	1,848	1,892
Zinc mine output, metal content	3,875	4,603	5,371
NONMETALS			
Asbestos	e 1,200	--	--
Barite	--	--	3,261
Cement, hydraulic ... thousand tons	3,117	2,903	4,059
Clays:			
Bentonite	133	61	e 70
White	14,384	11,655	e 13,000
Rock	4,436	4,202	e 4,700
Other	289,768	280,482	256,345
Diatomite	e 50	--	--
Feldspar	39,358	46,061	24,998
Fertilizer materials:			
Crude phosphatic:			
Guano	1,135	2,012	10
Phosphate rock	4,729	2,618	12,228
Manufactured:			
Nitrogenous [1]	48,000	54,000	e 60,000
Mixed and unspecified	55,864	56,975	56,896
Gypsum and anhydrite, crude [2]	42,796	84,882	101,782
Lime	222,580	282,665	150,740
Perlite	415	435	825
Pyrite and pyrrhotite (including cupreous):			
Gross weight	238,334	255,785	125,738
Sulfur content	110,944	118,787	e 58,000
Salt, marine	235,000	219,500	220,000
Sand and gravel:			
Sand, glass ... thousand tons	498	412	504
Sand and gravel n.e.s. [3] ... thousand cubic meters	4,628	5,598	5,691
Stone:			
Coral, crushed ... do	335	334	e 370
Dolomite	11,488	8,871	10,455
Limestone ... thousand tons	3,948	4,015	4,534
Marble (dimension), unfinished	3,700	e 11,000	9,053
Tuff	59,206	49,387	35,667
Cobbles and boulders n.e.s. ... thousand cubic meters	215	216	612
Sulfur, elemental	39	10	--
Talc	1,317	1,007	1,634
MINERAL FUELS AND RELATED MATERIALS			
Coal, all grades	40,024	38,900	39,004
Petroleum refinery products:			
Gasoline ... thousand 42-gallon barrels	15,771	16,004	NA
Jet fuel ... do	2,116	2,589	
Kerosine ... do	3,382	3,601	
Distillate fuel oil ... do	14,946	13,663	
Residual fuel oil ... do	24,528	21,562	
Other ... do	2,421	2,549	
Refinery fuel and losses ... do	3,949	4,153	
Total ... do	67,113	64,121	NA

e Estimate. NA Not available. p Preliminary.
[1] Data are for year ending June 30 of that stated.
[2] Including synthetic.
[3] Including unspecified earths.

Tanzania: Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity	1971	1972	1973 p
METALS			
Gold, refined ..... troy ounces..	167	213	56
Silver, refined ..... do....	36	45	4
Tin, mine output, metal content ..... long tons..	136	51	23
Tungsten, mine output, metal content	7	4	1
NONMETALS			
Cement, hydraulic	179,300	236,956	314,002
Clays, kaolin	830	1,460	870
Diamond:			
Gem e [1] ..... carats..	418,595	r 326,023	250,730
Industrial e [1] ..... do....	418,595	r 326,022	250,729
Total ..... do....	837,190	652,045	501,459
Gem stones, precious and semiprecious, except diamond:			
Amethyst ..... kilograms..	69	80	NA
Aquamarine ..... do....	2	3	NA
Beryl (gem only) ..... do....	35	100	NA
Chrysoprase and opal ..... do....	5	31	NA
Corundum (gem only) ..... do....	33	(2)	NA
Garnet ..... do....	33	104	NA
Ruby and sapphire ..... do....	11	20	NA
Tourmaline ..... do....	2	9	NA
Zircon ..... do....	(2)	3	NA
Zoisite (tanzanite) ..... do....	16	60	NA
Gypsum and anhydrite, crude	17,691	14,121	12,872
Lime (quicklime and hydrated lime)	5,203	1,862	5,988
Magnesite, crude	982	58	109
Meerschaum	8	30	14
Mica:			
Sheet	37	18	32
Scrap e	13	13	13
Salt, all types	37,278	32,467	38,392
Stone, sand and gravel:			
Ornamental stones:			
Art stone	(2)	5	2
Amethystine quartz	r (2)	30	186
Glass sand	r 2,244	1,489	15,233
Vermiculite	29	--	--
MINERAL FUELS AND RELATED MATERIALS			
Coal, bituminous	2,798	3,464	1,994
Petroleum refinery products:			
Gasoline, motor ..... thousand 42-gallon barrels..	1,041	1,128	974
Jet fuel ..... do....	444	459	445
Kerosine ..... do....	121	148	148
Distillate fuel oil ..... do....	875	1,299	1,289
Residual fuel oil ..... do....	2,379	2,501	2,394
Other ..... do....	54	58	76
Refinery fuel and losses ..... do....	609	369	337
Total ..... do....	5,523	5,962	5,663

e Estimate. p Preliminary. r Revised. NA Not available.

[1] Estimates based on reported total diamond output and best available information on ratio of gem to industrial stones in total output.

[2] Less than ½ unit.

[3] Revised to none.

Thailand: Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity [1]	1971	1972	1973 [p]
METALS			
Antimony:			
Ore:			
Gross weight	5,397	11,172	8,033
Metal content	2,294	4,748	3,414
Metal	[r] 225	202	199
Chromite, gross weight	1,000	--	--
Columbite-tantalite concentrates, gross weight	42	14	24
Copper, mine output, metal content	NA	[e] 6	1
Iron and steel:			
Iron ore, 55% iron, gross weight	[r] 41,591	27,818	36,309
Pig iron	[r] 13,560	11,918	14,063
Crude steel	119,994	181,943	[e] 190,000
Steel billets	51,931	100,800	[e] 102,000
Lead, mine output, metal content	[r] 1,473	1,819	3,704
Manganese ore:			
Battery grade and chemical grade 75% MnO_2	[r] 4,597	5,437	11,368
Metallurgical grade 46% to 50% MnO_2	[r] 10,735	14,415	24,950
Total	[r] 15,332	19,852	36,318
Monazite, gross weight	112	171	318
Tin:			
Mine output, metal content ..... long tons	21,346	22,072	20,591
Metal ..... do	[r] 21,427	21,929	22,565
Tungsten concentrate:			
Gross weight	[r] 4,864	6,485	5,048
Metal content	[r] 2,507	3,343	2,602
Zinc, mine output, metal content [e]	900	700	1,500
Zircon, gross weight	1,526	366	402
NONMETALS			
Asbestos	NA	22	83
Barite	63,539	97,091	111,930
Cement, hydraulic ..... thousand tons	[r] 2,771	3,378	3,745
Clays, [illegible]	10,133	16,290	16,995
Feldspar	NA	1,500	4,510
Fertilizer materials, crude, phosphatic	--	--	810
Fluorspar, 80% to 85% CaF_2	[r] 427,498	395,070	[2] 398,005
Gypsum	167,903	89,805	236,265
Salt [e] ..... thousand tons	160	160	160
Sand, silica	27,440	48,080	51,450
Stone:			
Marl (used for cement) ..... thousand tons	490	372	246
Quartz, not further described	NA	2,248	13,837
Talc and related materials:			
Pyrophyllite	50	1,550	9,550
Talc	NA	75	75
MINERAL FUELS AND RELATED MATERIALS			
Coal, lignite ..... thousand tons	445	345	361
Petroleum:			
Crude ..... thousand 42-gallon barrels	95	[r] [e] 47	[e] 45
Refinery products:			
Gasoline ..... do	12,521	8,160	9,008
Jet fuel ..... do	3,237	4,937	4,283
Kerosine ..... do	1,139	1,804	1,515
Distillate fuel oil ..... do	11,972	13,474	13,753
Residual fuel oil ..... do	11,488	15,753	19,470
Naphtha ..... do	219	2,072	2,466
Liquefied petroleum gas ..... do	1,100	1,903	2,539
Asphalt ..... do	713	854	7,742
Other ..... do	2,816	6,620	5,727

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] In addition to the commodities listed, Thailand produces other varieties of crude construction materials (clays, sand, gravel, and stone, etc.) but output is not reported and available information is inadequate to make reliable estimates of output levels.

[2] Includes 56,000 tons of subgrade ore that was not marketed for consumption.