BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Learning To Look Ahead: The Need For A National Materials Policy And Planning Process

The United States needs an institutionalized planning and policy process to help assure the future availability of materials needed by American industry. Such a process can help the Nation prevent shocks or offset their severity to its economy from rapid changes in the price and supply of natural resources. Growing global competition for raw materials dictates that the formulation of this process receive immediate attention at the highest levels of Government.

In the future, the United States must strike a better balance between its materials problems and its pursuit of other important national goals, such as those for energy and the environment.

Only by concerted public-private effort can the Nation build contingency plans to deal with future disruptions from materials shortages, and surpluses.

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COMPTROLLER GENERAL OF THE UNITED STATES
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To the President of the Senate and the
Speaker of the House of Representatives

The General Accounting Office recently implemented a process which forces a continuing reassessment of events and trends which have captured the Nation's concern and interest. That process acts as an aid in focusing our own work efforts toward problems and issues that will require congressional action.

This continuing reassessment of critical national issues has resulted in a series of special GAO reports to the Congress. These reports have recently dealt with such issues as energy policy, land use, and the problem of reconciling our air and water pollution goals to other national needs. GAO believes that materials-related problems are beginning to emerge as issues that will present the Nation with difficult, and critical, choices in the near future. This is already evident with respect to some materials, such as steel. This report summarizes GAO's initial staff analysis of national materials problems and provides a framework for their examination.

The pursuit of our most important national goals dictates that we be concerned about materials, and that we make an effort to develop an enlightened materials policy. Materials availability and prices will affect our success in trying to reach a full-employment economy. They are essential to our goal of balanced economic growth. They can aid in our effort to reduce inflation. They affect our balance of trade. They will be crucial to our relations with emerging nations all over the world, and they have profound impacts on our environment. Ultimately, they will determine our success in attaining sustainable levels of production and consumption. Therefore, the organizing principle of this report is the concept of materials availability: what materials are available, from whom, and at what price? It should be noted that the term "price" can be expanded to include the concept of environmental and energy costs incurred in making certain materials available.

The chapters of this report, after the introduction, are structured according to our view of the factors that bear most significantly upon the question of materials availability.

--Information Systems. Since information systems provide knowledge about our materials resources, and trends concerning their use, this chapter discusses the information requirements attendant to materials policymaking. It provides a synopsis of recent GAO evaluations of existing information systems within Government. It also outlines the importance of information exchange between national governments and between the public and private sectors, as well as the need for better information about domestic industrial capacity.

--Access to Materials. Knowledge about our materials resources is not very valuable unless we have some idea about whether these resources are available for domestic or international use. This chapter on access issues addresses the physical, as well as some of the social, economic, and political factors which bear on the availability of the world's materials resources.

--Materials, Energy, and the Environment. We live in an era of changing standards. New standards of energy consumption, worker and consumer health and safety, and environmental protection will affect our ability to supply needed materials. Conversely, many of these same materials--such as copper, aluminum, and platinum--will be crucial to our success in saving energy and cleaning up the environment. Because of these interrelationships, this chapter points out that we cannot continue to treat materials as a subordinate problem to our goals for energy and the environment.

--Making Better Use of Our Materials Resources. This chapter contains a set of important public policy alternatives for future materials use. Conservation, substitution, and recycling offer us an opportunity to use our materials resources more efficiently. In addition to the possibilities of gaining a greater output from a given resource base, these practices may lead to energy, and other cost, savings as well.

--Planning and Administration of U.S. Materials Policies. Numerous commissions and studies have found fault with

recent Government actions in response to materials-related problems. Many of these studies recommended substantial improvements in the Government's ability to detect and understand emerging problems in materials supply and demand. Legislation toward that end has also been recently introduced in the Congress. This final chapter represents GAO's initial thinking about the current state of materials policy deliberations, and where we need to go from here. It is the beginning of what we hope will be an active dialogue leading to the enactment of a materials policy and planning process for the United States.

In its initial form, this report was prepared as a guide for our own efforts in the materials area, but it is our hope that it will prove helpful to others considering these issues, and thereby contribute to a greater understanding of our materials-related problems.

Comptroller General
of the United States

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CHAPTER 1

AN INTRODUCTION TO MATERIALS

This report contains the views of the General Accounting Office (GAO) on major materials issues which might be faced by the United States in the near future. These issues will also affect other nations, although perhaps in different ways. In writing this report, GAO has attempted to draw upon both its own experience and the best thinking of many individuals, organizations, and private enterprises that have spoken out on America's materials problems. The General Accounting Office has prepared this report to improve public awareness of the fact that materials affect America's national security, its economic performance, and the quality of its citizens' lives.

In recent years, there has been a growing concern over the price and supply of materials which are vital to American industry. The Comptroller General of the United States touched on some of these concerns in a keynote speech before a national conference on materials policy in July of 1978:

> "There is a need to reconcile international economic interdependence with growing worldwide competition for raw materials. There is a need to consider materials problems in conjunction with national energy and environmental goals, rather than as a subordinate problem. There is a need for less waste in processing raw materials and more complete recycling of fabricated materials. There is a need for more and better coordinated research."
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> "Legislation is needed to address many aspects of these problems. In fact, this approach has been tried in the past. In the 95th Congress, for example, some 150 bills were introduced which dealt with various materials issues. Many of those issues loomed so large as to understandably command individual legislative attention--stockpiling policy, for example, or decisions with respect to deep ocean mining, trade agreements, and solid waste disposal and recovery. However, to continue to treat our materials problems in isolation, without

some linkage to larger national goals, will tend to perpetuate ad hoc decisionmaking and leave the United States even more vulnerable to economic catastrophe from what might otherwise be manageable events."

* * * * *

"We often forget that time itself has become one of our most critical national resources. If we expect to solve the problems that will confront us in the 1980's and 1990's, we must begin by planning our strategy now. The national effort to provide jobs and reduce inflation in part requires that the materials cycle flow smoothly, and that the economy be protected from wild vacillations in materials prices. These conditions do not come about by accident; they require prudent yet comprehensive planning, and a cooperative relationship between Government and industry."

This chapter defines the range of materials issues with which GAO is concerned, and illustrates their importance to the national economy. It summarizes past efforts at defining a national materials policy, and concludes with GAO's view of the major concerns that will govern the adequacy of materials supplies in the future.

DEFINING MATERIALS

What are "materials"? As noted in a recent Congressional Research Service study: "The difficulty in defining this word is in determining what to exclude."

Definitions are important. They shape the dimensions of materials problems, the resources (money and labor) needed to deal with them, and suggest constraints upon policymakers in their search for alternatives. What follows is a sampling from a number of definitions that have been offered for materials:

"* * * materials comprise basically the nonenergy minerals, forest products, fibers, both natural and man-made, and those chemicals not already covered in the above categories. Excluded are food, energy sources, and drugs." 1/

1/Landsberg, Hans H., "Materials: Some Recent Trends and Issues," Science, February 1976, p. 637.

"* * * Materials include metals, ceramics, semiconductors, dialectrics, glasses, polymers, and natural substances like wood, fibers, sand, and stone. For our purposes, we exclude certain substances that in other contexts might be called "materials." Typical of these are food, drugs, water, and fuels. Materials as we define them have come increasingly to be classified by their function as well as by their nature; hence, biomedical materials, electronic materials, structural materials." 2/

We believe that natural substances such as wood, vegetable fibers, leather, and organic wastes should, properly, be included within the materials nomenclature. Food, drugs, and energy fuels, when used as such, are materials which pose a set of different problems. They are the subject of other national policies, and are normally dealt with separately. However, separate treatment should not imply exclusion; there are significant issues--concerning the interactions and trade-offs between materials, energy, and the environment--that demand attention. Therefore, GAO's working definition of materials is:

"* * * those substances used by Government and industry, because of their specific properties and performance, to make products, including minerals, metals, ceramics, polymers, together with renewable or recyclable substances such as food, fibers, scrap, and leather. Fuels, drugs, and foods are excluded when used as such."

THE IMPORTANCE OF MATERIALS TO THE ECONOMY

Unfortunately, there is a lack of reliable, quantitative indicators which could demonstrate the importance of materials to the American economy. It is not possible to account for materials, in a generic sense, as a portion of the Gross National Product (GNP), even though they represent one of the four basic factors of production--labor, land, capital, and materials.

2/Materials and Man's Needs, Committee on the Survey of Materials Science and Engineering, National Academy of Sciences, 1974, p. 2.

Even though it is difficult to measure the importance of materials in dollar terms, there is some data available which indicates their relative value. In 1977, for example, the value of extracted nonfuel mineral ores contributed $17 billion to the economy. The cost of materials is also an important factor in industrial investment. For example, the Bell System's investment in plant was valued at $100 billion (after depreciation) in 1977, with $10 billion more in new plant added each year. The cost of raw materials is an important part of that investment; wire and cable account for approximately 10 to 15 percent of the $100-billion investment, and raw materials represent 80 percent of the cost of the wire and cable.

Another set of figures, often overlooked, helps indicate the significance of materials in our economy; that is, the "value-added" worth of materials. For example, one estimate has placed the value of the American chemical industry at more than $100 billion. In terms of petrochemicals, it has been estimated that $4 billion of petrochemical precursors are annually converted into industrial products valued at $430 billion. It is estimated that the production of primary metals from nonfuel mineral ores contributed $170 billion to the U.S. economy in 1977. Timber provides another example. In 1976, the cost of timber products sent to primary manufacturers of lumber, paper, and allied products was $46 billion. But the combined value of goods shipped by these manufacturers was over $79 billion.

To some commentators, such figures suggest that the total value of materials in the economy may represent 20 percent of America's GNP. Others have even stated that without materials, there would be no GNP. In any event, there is a certain irony in the fact that attempts to quantify the worth of materials may actually lead to an understatement of their importance.

Materials are obviously, like food and energy, essential to our existence; they are intimately associated with perceptions about the quality of that existence as well. Therefore, using dollar figures to express their value to our society might, inadvertently, miss the point.

PAST STUDIES: INTERMITTENT CONCERN, BUT LITTLE ACTION

Expressions of formal governmental concern for a stable materials supply have been sporadic. Just a glance at the literature quickly shows that serious awareness of possible

supply problems typically develops during, or after, times of war. That pattern can be clearly traced from World War I through the Korean conflict. It shows a recognition of the necessity to obtain certain materials for a war effort; soon followed by spot shortages or tight supplies of those materials; which is followed by contingency planning after the war to prevent (or at least effectively deal with) a recurrence of similar situations in the future. Once the shortages are no longer visible, this effort has usually been followed by inattention born of the assumption that "the market will take care of things."

In the years since the Korean conflict, a number of studies have questioned the Nation's ability to meet its materials requirements. In 1952, the President's Materials Policy Commission--popularly known as the Paley Commission--predicted future problems with the availability of some materials. It predicted, for example, that the United States would be out of copper by the 1970s. Even though many of the Paley Commission's forecasts were inaccurate, one of its key themes remains valid today:

> "There must be, somewhere, a mechanism for looking at a problem as a whole, for keeping track of changing situations and the interrelation of policies and programs. This task must be performed by a Federal agency near the top of the administrative structure.
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> "Such an agency, at the level of the Executive Office of the President, should review all areas of the materials field and determine how they can be best related to each other. It should maintain, on a continuing basis, the kind of forward audit which has been this Commission's one-time function, but more detailed than has been possible here; collect and collate the facts and analyses of various agencies; and recommend appropriate action for the guidance of the President, the Congress, and the Executive agencies." 3/

3/The President's Materials Policy Commission, "Resources for Freedom," Washington, D.C. (U.S. Government Printing Office), 1952, Vols. 1 to 5. As quoted in Materials Policy Handbook, Washington, D.C. (Government Printing Office), 1977, p. 26.

Studies undertaken since then have expressed that same underlying concern for assuring materials availability. One means to this end was the Mining and Minerals Policy Act of 1970, which sought to stimulate development of a national minerals policy. Another example of this concern was the 1972 report of the National Materials Advisory Board (NMAB), which pointed out: "The maintenance of a healthy and moral industrial society depends on a continuing and varied flow of raw and refined materials, obtained and processed with due regard to environmental quality and for fundamental equity among people and nations." It should be noted that NMAB placed the same importance upon controlling materials consumption that it did upon increasing materials supplies.

In 1973, the National Commission on Materials Policy made 198 recommendations to improve the Nation's materials supply capability. Ironically, the issuance of this latter report coincided with the most serious shortages (or tight supplies) of materials since the Korean conflict. But neither the report nor the shortages led to any essential changes in the Government's approach to the problem of assuring a stabilized materials supply.

The Materials Shortages of 1973-1974--In 1970, the prices of some raw materials (as measured by the Department of Labor's spot market index covering 22 commodities) were actually lower than in 1950. However, from 1973 to 1974, tight supplies made the price of many materials--such as copper and fertilizer--soar to historic highs. The commodities boom not only fed worldwide inflation, but led to a spate of predictions that population growth and industrial development were finally pressing on the earth's limited resources.

Against this background, late in 1974, another Government commission, the National Commission on Supplies and Shortages (NCSS), was created to study the Nation's materials problems. In creating the NCSS, the majority and minority leaders of the U.S. Senate expressed what has now become a dominant concern:

> "What is needed most at this time and what we all agreed was of paramount importance

is to at long last implement the major recommendations of past studies--designing the appropriate instrumentality that can provide strategic economic information and assessments together with specific policy options that might be employed today to help mitigate or prevent the crisis, if any, perceived on down the road."

In its December 1976 report, the NCSS found that the 1973-1974 shortages had nothing to do with a basic scarcity of either domestic or foreign resources. The NCSS found the shortages to be a result of three events: (1) a slowdown in the rate of expansion of industrial capacity beginning in the late 1960s; (2) a sharp surge in demand, beginning in 1972, that occurred almost simultaneously in all major industrial countries; and, (3) a "shortage mentality" (manifested by such phenomena as double-ordering by purchasing agents) that was caused by, and which in turn compounded, the demand and capacity problems discussed above.

In a report which preceded the NCSS study, GAO found that the Government's response to the 1973-1974 shortages was ad hoc and crisis-oriented. This was illustrated by decision-making pursuant to one of the Government's major policy responses to the shortages, the imposition of export controls upon selected commodities. In our study, "U.S. Actions Needed to Cope with Commodity Shortages," (B-114824, 4/29/74), we found that, in imposing these controls, decisionmakers were hampered by the absence of reliable supply and demand estimates for numerous commodities. Effective action also depended upon close coordination between more than 20 departments, agencies, offices, and policy councils responsible for commodity policies. However, GAO found that, because of time pressures and poor coordination between these agencies, decisionmakers had to make choices on the basis of incomplete interagency analyses and without the benefit of well-thought-out policy options. After detailed analysis of decisions affecting six major U.S. commodities that were then in short supply, GAO expressed its belief that the U.S. Government lacks an adequate planning, policy analysis, and policy formulation system for basic materials issues, and that this hampers the Government's ability to deal with short-term problems and to anticipate the impact of foreseeable long-term trends.

The National Commission on Supplies and Shortages reaffirmed our findings, but concluded that the major requirement of the future--assuring adequate materials availability--could be met simply by better-coordinated Government tax, investment, and regulatory policies. These conclusions

follow rather directly from the Commission's premise that free market forces are basically sufficient to meet the needs of society.

GAO believes the Commission's approach and its conclusions--specifically its almost exclusive reliance upon traditional market mechanisms--minimizes the significance of developments which have been affecting materials markets since at least the early 1970s. These developments--which include a greater emphasis on environmental protection, the apparent inability of some industries to generate enough capital for plant expansion and modernization, the declining investment in research and development, and growing demands by developing countries for a greater share of the world's wealth--limit the utility of traditional free-market mechanisms and tend to stimulate governmental involvement in an increasingly interlocking international economy.

This criticism is not meant to imply that market mechanisms have lost all of their value, and that they should therefore be replaced. To the contrary, we believe that these mechanisms will remain a major element in any strategy employed to deal with materials problems in the future. What we are stressing, however, is that reliance on those mechanisms should be tempered by: (1) recognition of global developments during the past decade--alluded to in the preceding paragraph, and discussed further in the remaining pages of this chapter; (2) understanding how those developments have weakened and, in some instances, created imperfections in the normal working of free market mechanisms; and (3) the possibility that there may be inherent deficiencies in the generic structure of some materials industries.

TRADE WITH GOVERNMENT-SUBSIDIZED INDUSTRIES

Competition with Government-controlled or -subsidized industries is becoming increasingly characteristic of the international marketplace. This phenonmenon is, in turn, leading to greater Government involvement in materials markets to protect domestic economies.

People all over the world want to improve, or at least maintain, their standards of living and a growing proportion of the world's citizenry believes that a primary duty of Government is to help them attain that goal. Consequently, many nations have subsidized domestic industries to increase employment, to earn foreign currency, and to provide themselves with some measure of technological independence. National pride--as witnessed in widespread

foreign government ownership of air transportation and nuclear energy industries--may also play an important role in this emerging trend.

Government help can also take the form of outright grants or subsidies to financially-troubled industries. Governments can improve access to capital markets for their industries, and they can also help through enactment of "buy national" policies. More importantly, some Governments can exert an inordinate influence over materials markets through the control of raw materials resources.

Two present-day examples illustrate how Government may actually be forced to become involved in materials supply processes. During 1977 and 1978, developing-country exporters of copper tried to maintain production in the face of reduced demand by taking lower prices in order to sustain foreign exchange earnings. These actions depressed copper prices, reduced domestic production, and created widespread unemployment in the American copper industry. This, in turn, led to industry pressures in America for Government protection. Legislation was introduced into the Congress proposing the sale of tin from the Strategic and Critical Materials Stockpile to finance Government purchases of excess copper. But the proposed legislation itself provoked a flood of protests from developing-country producers of tin who feared that sales from the U.S. tin stockpile would drive down tin prices and severely damage their economies.

Steel provides another example. During 1978, the world steel market was plagued by overproduction. Domestic steelmakers in the United States accused foreign producers of "dumping" (exporting steel at prices below the market price in the producing country) their excess in the U.S. American steelmakers claim that, since 1975, Japanese steelmakers have sold steel in the United States at an average of $25-a-ton lower than home market prices (and at an average of $22-a-ton below actual production and shipping costs). Accordingly, these U.S. steelmakers have sought governmental protection from alleged unfair trade practices by requesting corrective measures such as import quotas and minimum prices for domestic steel sales.

The U.S. Government responded by implementing a "trigger price system," a reference system of pricing based upon the costs of production in Japan (presumably the world's most efficient steel producer) plus shipping charges to the United States. If foreign steel is imported below the trigger price, the Treasury Department is supposed to conduct a quick anti-dumping investigation which could culminate in the assessment of special duties upon that imported steel. In a somewhat un-

usual move, in September 1978, the United Steelworkers of America asked the Government to go even further and guarantee a $7.2 billion loan to the steel industry for modernization of existing plants in traditional domestic steelmaking areas.

There has been increasing governmental involvement in materials markets abroad as well. For example, in 1978 Belgian steelmakers were reportedly accepting Government control over their investment and capacity decisions in return for a $600 million infusion of cash into their financially-troubled industry. There has been Government intervention in the British and Spanish steel industries and, most recently, in France. In October 1978, the French Senate voted to take over the country's carbon steel industry which lost 5 billion francs ($1.1 billion) during 1977.

Another point to note is that both the number of Government-owned or -subsidized enterprises, and the breadth of their activities, is increasing. According to annual listings compiled by Fortune Magazine, Government ownership of companies among the top 100 foreign industrials has increased from 4 percent in 1960 to 16 percent in 1975. These companies are involved in such basic industrial activities as transportation, electricity, natural resources and energy, steel, computers, and shipbuilding.

These are just some of the developments that have fundamentally altered the economic "rules of the game" during the late 1960s and 1970s. They imply to us that we can no longer rely solely on traditional market mechanisms to resolve the political and social issues entailed in the management of globally-oriented systems of materials supply. American business will increasingly compete with foreign firms that have been created, or induced by their Governments, to serve ends other than profit optimization, and national interests will therefore increasingly affect the terms of trade. These developments suggest the need for better foresight and contingency planning, on the part of the U.S. Government, to avoid the consequences of poorly-conceived and hasty action during a genuine materials crisis. That subject will be addressed further in Chapter 6.

AN OVERVIEW OF MATERIALS ISSUES

In dealing with future materials issues, GAO believes that the dominant concern must be with assuring materials availability. However, that concept--materials availability--is complex, subtle, and therefore not always readily understood. To understand the idea of materials availability, it must be analyzed in terms of the many dimensions which affect it.

These dimensions include (1) the physical and economic scarcity of materials, (2) the industrial uses of these materials, which sometimes lead to the designation of the materials as "critical," (3) the information about the amount of materials--either in the form of reserves or resources--available for eventual use, (4) the accessibility or inaccessibility of materials supplies, and (5) psychological attributes such as those implied in the term "shortage mentality." These concepts are all interrelated. Materials availability also has to be considered within the context of time and space, for example, what may not be available domestically may be abundant elsewhere, and materials that may not be economical to extract and process today may be available through future changes in technology or market prices.

The following chapters of this report are structured to expose the many dimensions and interrelationships which shape our perceptions of materials availability. The chapters focus on

--materials information systems,

--access questions,

--interface issues,

--conservation of materials through resource recovery, recycling, and extended product lifespan, and

--planning and administration of materials policies.

Common to all of the chapters is an explicit recognition of the need for a continuing, and careful, examination of the relationships between the public and private sectors in attempting to satisfy the Nation's materials requirements. This public-private collaboration must be tailored to fit the substantial changes in circumstances occurring since the early 1970s, and to accommodate the changes forecast for the future.

CHAPTER 2

INFORMATION SYSTEMS

A reliable information system should be central to all materials planning and policymaking. Accurate, timely, and relevant data, responsive to questions of what materials are available, from whom, and at what price, is essential to the analysis of materials problems and the evaluation of appropriate governmental responses. Therefore, reliable data represents the first concern in responsible allocation of Government resources to foresee, understand, and either ameliorate or resolve, specific materials availability problems.

The National Commission on Materials Policy offered a broad assessment of problems it found with existing materials information systems:

> "Almost every aspect of policy work in this area is handicapped by inadequate, inaccurate, or inaccessible information. Available data are structured in ways that serve past needs and policy requirements but do not meet present nor prospective demands. Effective management and rational policymaking require sufficient, reliable, and usable data concerning both the constituent parts of the materials system and the interactions of the system itself."

To help the Congress discharge its oversight responsibilities in this area, the General Accounting Office has conducted a number of studies of existing, materials-related, Government information systems. This work indicates that the Government's materials information network is deficient in five major areas

- --the domestic data base for mineral resources and reserves,
- --the international data base for mineral resources and reserves,
- --information on the flow of materials through the American economy,
- --information regarding the measurement of industrial capacity, and
- --the role of Government information systems in directing materials research and development.

The first of GAO's studies focused on the mineral reserve and resource information systems in the Department of the Interior.

The Department of the Interior's Minerals Availability System (MAS) (EMD-78-16, 7/17/78)

The Minerals Availability System of the Department of the Interior is supposed to show how a variety of political, legal, environmental, and economic factors influence minerals supplies. The United States must have such information to make the best present and future use of its domestic mineral reserves and resources. The term "reserves" refers to mineral deposits that have been discovered and are economically recoverable. "Resources," on the other hand, refer to the total amount of minerals potentially available in the future. The latter includes deposits yet to be found, and those too low in grade to be economically worth extracting.

The Bureau of Mines acquires much of the mineral information for MAS through grants to private mineral consultants. GAO found this grant program to be poorly administered.

The deficiencies we found were, in part, caused by management problems within the Bureau of Mines parent agency, the Department of the Interior. For example, there was disagreement at key management levels about the purpose and relative priority of information collected for MAS. Furthermore, management control over the system is diluted because mid-level employees have been given responsibility for selecting the grantees. These choices significantly influence the kind of data collected in the system. As a result, the data collected often bore little relationship to program objectives set by high-level policymakers.

We believe MAS has tremendous potential for policy analysis once these problems are resolved. To realize this potential, MAS must be made more accessible to other Government agencies. GAO made a number of other recommendations to improve MAS. We recommended that the Director of the Bureau of Mines

--establish clear criteria for determining which deposits are significant and focus data requirements on these deposits;

--review existing MAS deposit files for accuracy and completeness;

--replace the program's numerous, small, unsolicited grant proposals for collecting mineral deposit data with phased, performance-oriented proposals;

--revise report requirements for MAS deposit files to emphasize short narrative summaries of essential deposit data;

--develop better reliability criteria for data to be used in the MAS file;

--reconcile existing differences between MAS and commodity specialists' data; and,

--develop specialized mineral data bases for specialized policy needs, utilizing existing or specially constructed data bases, rather than relying exclusively on grantee-supplied data.

In October of 1978, the Department of Interior notified us that it fully concurred with our findings, and that it had initiated actions to immediately implement each of the recommendations in our report.

The Department of the Interior's Computerized Resources Information Bank (CRIB) (EMD-78-17, 7/17/78)

While MAS provides information on mineral reserves, the Computerized Resources Information Bank (CRIB) provides information on the other part of the mineral puzzle--global mineral resources.

Like MAS, CRIB has an important role to play in formulating a national materials policy. This is because a materials policy relies heavily on estimates of potentially recoverable mineral resources. Without question, the accuracy and magnitude of these estimates have a tremendous influence on materials policy choices.

However, like MAS, we found much of CRIB's data to be incomplete, inconsistent, outdated, and generally unsuitable for the Geological Survey's use. And like MAS, this has prevented CRIB from serving as a mineral policy tool. We believe that CRIB, like MAS, is poorly administered. Serious deficiencies were found for such important commodities as bauxite, chromium, and platinum. For example, no effort has been made to update CRIB records on bauxite since 1973. Information on copper production is extremely limited in CRIB, and the system contains very little information on estimates of reserves and potential resources of this key industrial

material. With such deficiencies, it is difficult to imagine any policy relevance CRIB could have in estimating resources. And such estimates are crucial to materials policymaking.

GAO made a number of recommendations to help CRIB realize its full potential:

1. Rank identified mineral resources in accordance with their probable commercial significance within a fixed time frame;

2. Rank the most promising ore-forming environments for critically needed, but as yet undiscovered, mineral resources as a means of focusing mineral research efforts and land-use planning;

3. Assimilate new geoscience research technologies applicable to mineral discovery, into all mineral investigations;

4. Emphasize the use of aeromagnetic information and techniques, and area mapping overviews, in conducting all mineral investigations to facilitate the development of mineral occurrence models; and

5. Aggregate mineral resource data in the Computerized Resources Information Bank from all of the Geological Survey's programs, regardless of their primary focus, under specific significance and reliability criteria.

Again, in October of 1978, the Department of Interior notified us that it concurred with the findings in our report and that it has appointed a Task Force to implement our recommendations.

Because of the problems found in MAS and CRIB, we also reviewed a U.S. Geological Survey program to assess resources on Federal lands.

Interior's Programs for Assessing Mineral Resources on Federal Lands Need Improvements and Acceleration (EMD-78-83, 7/27/78)

Federal lands are believed to be rich in mineral resources. Therefore, assessments of these resources are important both to national materials policymaking and to the effectiveness of future land-use planning. For example, if Government-sponsored assessments reveal that a large amount of a needed resource is economically recoverable, the decision

might be made to expand domestic production. However, if only a small amount is recoverable, at great costs, policymakers might then choose to rely on foreign supplies and develop a domestic stockpile as insurance against supply interruptions.

Despite the importance of such assessments, we found that the Geological Survey will need 50 years or more to complete them. In the meantime, decisions could be made that would convert these lands into other uses, such as recreation and wilderness areas. Once these decisions are are made, lawsuits and protests from affected interests make it difficult, if not impossible, to resolve them. In view of such problems, GAO has recommended that the Geological Survey accelerate these programs to complete them in the shortest time possible--20 years or less. The Geological Survey agreed with that recommendation and is making revisions in its program plans and funding to implement it.

The Federal Government's ability to formulate effective materials policies is also dependent upon good information on materials research and development. However, our work has revealed that such information is not always available.

Management of Federal Materials Research Should Be Improved (EMD-78-41, 7/14/78)

Comprehensive information on materials research and development (R&D) serves a number of purposes in materials policymaking. Besides helping Federal managers identify and assign priority to existing research, such information can also be used to assess future R&D needs. Such efforts take on added significance at a time when R&D money is becoming extremely limited. Despite the advantages of consolidating such information, the Federal Government has not moved to establish such a data base.

GAO's report entitled, "Federal Materials Research and Development: Modern Institutions and Management," (OSP-76-9, 12/2/75), highlighted the need for a consolidation of materials R&D information. According to the report, the U.S. approach to materials R&D is highly fragmented. Available data suggests that there are at least 90 different Federal organizations engaged in materials R&D programs. One result of this situation is that collection of R&D data over the past 15 years has been sporadic, incomplete, and too fragmented for policymaking purposes.

Things had not substantially changed by 1978, so we issued another report on the need for a comprehensive data

base for materials R&D. This report, "Management of Federal Materials Research Should Be Improved," (EMD-78-41; 7/14/78), shows that adequate steps still have not been taken to develop a comprehensive materials R&D information system. Consequently, millions of dollars may be lost by unnecessary duplication, appropriation of funds to areas not related to national needs, and by the failure to coordinate Federal R&D with activities already being performed outside the Government.

We pointed out that these deficiencies were particularly troubling in view of the fact that, in 1976, the Office of Science and Technology Policy (OSTP) was specifically created by public law to help the President coordinate and direct Federal research programs. GAO believes OSTP would be more effective in this role if it took actions to:

--Determine the type of materials research and development data needed.

--Determine national materials research needs.

--Develop relevant budget recommendations for the Office of Management and Budget.

Our work in the materials information area has revealed other issues which we believe merit further study.

OTHER MAJOR ISSUES RELATED TO MATERIALS INFORMATION SYSTEMS

The current state of relations between the Government and American business is a significant factor in improving the Government's materials information network. Despite an emerging consensus on the need for concerted action by Government and business on the Nation's materials problems, meaningful cooperation is often blocked by industry fears of antitrust actions, by Government suspicion of businesses' motives and sensitivity to public concerns for impartiality in governmental processes, and by the perplexing problem of proprietary data.

Various chapters in this report point to fundamental changes that have occurred, domestically and worldwide, in our economic and social environment. In fact, in this time of economic transition, surely one major national objective must be to maintain a healthy economy. Attaining that goal will require new approaches in our treatment of materials-related issues, one of which must be a reorientation of traditional forms of public-private interface.

We also need to be concerned with matters such as the flow of materials through the economy, the factors affecting domestic industrial capacity, and with obtaining more reliable information on foreign mineral supplies. These are some of the issues that will have an important bearing on future discussions concerning a national materials policy.

Information on the flow of materials through the economy--Much attention has been given to the problem of potential shortages of "critical" materials. Concern on this subject was expressed by the National Commission on Supplies and Shortages, and in reports by the National Academy of Sciences, the Council of International Economic Policy, the Interior Department, and the Commerce Department. Still there is, as yet, no apparent consensus on the definition of "critical" materials. That term has traditionally been linked to the strategic needs of our national defense effort. However, there remains no well-developed methodology to address broader concerns about which materials are most critical to the U.S. industrial economy, and to the maintenance of socioeconomic stability.

It has long been held that the truest measure of criticality for any given material is the degree to which the United States is import-dependent for its supply. Now we know that this truism is no longer credible. In order to come to grips with the criticality issue, we must broaden our understanding of how materials are deployed throughout the economy.

As a case in point, in 1975, Canadian policymakers reportedly contemplated curtailing natural gas supplies to the United States in order to conserve them for domestic use. However, they did not understand the many indirect ways in which such a policy was counterproductive:

--Natural gas exports to the United States are combined with phosphates to produce fertilizer which, in turn, is used in U.S. crop production. Substantial amounts of these crops and fertilizers are exported back to Canada.

--Canadian natural gas is heavily used by the paper products industry in the American Northwest. Many of these products, particularly food containers and office supplies, are marketed in Canada.

--Many processes of copper smelting and fabrication in the United States depend directly and indirectly upon natural gas from Canada. These processes convert copper ore into a wide variety of products--such as

copper-related car and truck parts--which are used extensively in the maintenance of the Canadian transportation system.

--Tourism is one of the major industries in the Canadian province of British Columbia. A large fraction of the Pacific Northwest labor force, which spends part of its disposable income in this fashion, is employed by industries that are dependent upon Canadian natural gas.

This type of information could be beneficial in considering a number of other materials-related issues--such as trend forecasting in the steel industry, the effect of materials substitution in the automotive industry, the problems of trade with large centrally-planned economies, and impediments to capital formation in such basic domestic industries as mining and steel.

Measurement of industrial capacity--According to the NCSS, one of the key causes of the 1973-1974 shortages was the slowdown in the expansion rate of industrial capacity that took place beginning in the late 1960s.

These shortages were "solved" by a worldwide recession. Recovery has been uneven, and the basic problems which led to the shortages remain largely unchanged. For example, the aluminum industry is presently operating at capacity (about 97 percent), with no apparent plans for adding significant new capacity despite the fact that many forecasts point to potentially large increases in future aluminum usage. Thus, insufficient capacity could undoubtedly result in higher aluminum prices and increased imports.

The copper industry provides another example. The present glut of copper on the world market is projected to change to serious shortage by the mid-1980s. But investments in new copper mines virtually halted 2 years ago when copper prices became depressed.

Adequate industrial capacity is a critical element to a smoothly operating, noninflationary economy. Therefore, the Congress and Federal managers must know more about potential capacity problems in American industry. This includes the need for better information about industrial decisionmaking.

GAO believes special emphasis should be placed on (1) the effect of Government policies upon the availability and utilization of capital for capacity expansion, (2) the level of costs associated with such expansions, and (3)

future demand for material commodities. Such information will be critical to the development of a sound national materials policy.

Adequacy of foreign minerals data--During our studies of MAS and CRIB, we found foreign minerals data to be either totally excluded from these systems or grossly inconsistent with data elsewhere. For example, there were no deposit records for any of the four principal chromium-producing countries despite U.S. dependence on chromium imports and concern about reliability of supplies.

In many cases, America's ability to obtain such information is influenced by inadequate collection and analysis on the part of the producing countries. In other cases, the countries are concerned with the uses of such information and restrict its dissemination.

Thus far, the United States has tried to overcome this information deficiency by supporting projects that develop international minerals data. But in most cases, those efforts have been informal or indirect. The data generated is frequently subject to delays, restrictions on its use, or misunderstandings that minimize its usefulness.

Another way in which the United States has attempted to bridge the information gap is through minerals attachés and Agency for International Development (AID) programs. However, these programs tend to be sporadic operations and usually reflect the needs of the AID and the State Department. For these reasons, we believe much more needs to be done on the collection and review of international materials information.

SUMMARY

The need for good information about materials has never been more critical. As stated in chapter 1, the preeminent concern, with respect to materials issues in the future, will be with assuring materials availability. However, meaningful assessments of future materials availability might be precluded unless substantial improvements are made in the Government's materials information network.

Numerous studies have found that data being collected by Federal agencies is often incomplete, dated, and otherwise misleading. Sometimes the data collected is not disseminated outside the receiving agency, and sometimes it is too parochial to be of use to others. We have documented these and many other problems in specific reports on materials information systems of several Federal agencies. In the future, GAO

will continue to work toward improving the quality of information in these systems.

CHAPTER 3

ACCESS TO MATERIALS

Not too many years ago, the Club of Rome generated widespread fears regarding long-run resource scarcities. Its study, The Limits to Growth, argued that within 100 years, worldwide economic growth would be severely limited because the world's resources cannot accommodate current trends in income, population growth, and pollution. As shown in the next chapter, concerns over the geophysical limits of some resources are not unfounded. However, in recent years these fears have abated. As the National Commission on Supplies and Shortages observed, the constraints upon raw materials supplies now tend to be largely self-imposed:

> "For at least the next 25 years, and perhaps for many decades thereafter, the world is not likely to encounter any serious natural constraints on the availability of non-fuel minerals. The conclusion * * * takes into account the increased costs of extracting these minerals due to pollution regulations and higher energy costs.
>
> "The situation with regard to domestic reserves is less bright. While the resources exist that would allow the United States to become virtually self-sufficient in most basic minerals, self-sufficiency would have such a high social and economic cost as to render the option extremely unattractive. This implies that the United States is likely to become increasingly dependent on foreign sources for certain key materials."

This chapter is about the issues--both international and domestic--that affect access to raw materials.

INTERNATIONAL ISSUES AFFECTING ACCESS TO MATERIALS

The United States materials network links domestic producers, brokers, processors, and consumers with a global marketing system comprised of both developed and developing countries.

Perhaps one of the most remarkable features of the 1973-1974 shortage situation was that it was caused, in part, by increased worldwide competition for raw materials. It was a poignant illustration of diminished U.S. control over foreign sources of supply, and the decline of U.S. hegemony in the international economy.

This situation coincides with a long-run trend in which the United States is becoming increasingly import-dependent for the raw materials needed to sustain its large industrial economy. For example, the United States now depends on foreign sources, in whole or in part, for approximately 22 of the 74 nonenergy mineral commodities considered by the Department of Interior to be most essential to our economy. The Department of Interior has predicted that by 1985, the United States will depend on imports for as much as half of its basic supplies of raw materials. One implication of all this is that the deficit in the Nation's mineral balance of trade could approach $100 billion by the year 2000.

This increasing import dependency has also led to concerns that raw materials might be used as political weapons to advance the interests of foreign suppliers. Most experts, however, believe that an OPEC-like embargo is extremely unlikely for most raw materials. They claim the geographically dispersed nature of most raw materials prevents cartel formation. But perhaps an even more important impediment to such actions is the fact that there are close substitutes for most materials.

It can be argued that certain benefits accrue from importing raw materials. By importing raw materials, we enable some countries to earn the foreign exchange they need in order to purchase American manufactured goods and agricultural commodities. Undoubtedly, we import many raw materials because they are cheaper than what it would cost to produce them, if available, domestically. In fact, a policy of domestic self-sufficiency for many raw materials could add significantly to the inflationary pressures now faced by the United States.

Nonetheless, dependence upon foreign sources for supplies of key materials can present problems. For example, when fighting broke out in Zaire during 1978, supplies of cobalt became scarce and prices soared. For strategic reasons, it is not very desirable to rely upon the Soviet Union to supply chromium, and supplies from South Africa, the world's other major producer, are continually in doubt due to that country's political problems. There is the continued problem of expropriation of investments that have

been made in materials-producing countries; the resulting uncertainties threaten the investments needed to assure long-term materials supply. In addition, some industrialized countries--such as France, Germany, and Japan--have negotiated agreements with mineral-rich nations to assure access to raw materials in return for technical assistance. The United States, however, has been reluctant to enter into comparable joint ventures, and may be increasingly unable to obtain access to these materials as a result.

GAO believes that these and a number of other related issues deserve close study in the future. Accordingly, the following lines of inquiry will, over a long period, guide GAO's work in the international materials area:

--How much is the United States increasing its dependence on foreign sources of materials as a result of economic competition? How do existing Government policies affect this dependence?

--What are the consequences to the United States of increasing competition with other developed countries, which are more dependent on foreign sources than the U.S. for materials necessary to maintain satisfactory economic performance? What U.S. policies affect our competitive position and how might they be coordinated and improved?

--What are the consequences to the United States from the shift of materials processing and refining activities to foreign sites? What policies might increase or impede this shift?

--What are the implications of developing national economic stockpiles and international buffer stocks? How might pertinent U.S policies be coordinated and improved?

--How do World Bank and other U.S.-supported international financial institutions affect investments by the private sector in materials development?

The shift to overseas processing of mineral resources--In recent years, there has been a growing tendency for American mining companies to shift their industrial processing operations to locations outside the continental United States. We have identified this trend in the aluminum, copper, zinc, and ferrous alloy industries. This trend, offshore processing and refining of raw materials, will most likely increase for a

variety of reasons, including

--growing competition for investment in foreign mineral resources,

--producer-country efforts to increase the value derived from their raw materials resources by greater involvement in resource production and beneficiation processes,

--private-sector decisions reflecting competitive cost and profit-maximizing efforts, and

--the growing costs of health, safety, and environmental regulations.

We believe that capital formation problems and high unit labor costs may have also contributed to the shift toward overseas processing.

These shifts raise a number of important questions for the United States:

(1) Do such shifts reduce or increase U.S. vulnerability to supply disruptions, and what are the possible trade-offs to the economy from such shifts--such as energy savings?

(2) What role do existing U.S. policies play in these shifts?

(3) What role do international financial institutions play in promoting these processing shifts?

(4) How does foreign competition affect the processing shift of U.S.-owned industries overseas?

(5) If these shifts adversely affect America's trade position, would they not also undermine its commitments to foreign aid and international security?

GAO is concerned that particular shifts may be the result of intended or unintended side-effects from public policy. Accordingly, our International Division has initiated a study of several issues associated with process shift. We expect to report our findings to the Congress during 1979.

Constraints to deep ocean mining--An important international issue currently receiving legislative attention is deep ocean mining. Extensive deposits of mineral-bearing nodules have been identified on the deep seabed and commercial development now seems feasible. This advance seems to promise relief from import dependence for some metals--mainly manganese and cobalt--as well as providing additional reserves of nickel to replace land sources of high grade ore, which are currently being depleted. However, exploitation of ocean resources raises a number of complex questions: does the absence of an international agreement imply the assertion of national sovereignty over international waters? If ocean resources are exploited by private companies, how will the public interest (domestic and international) be protected? Does the U.S. Government have an ocean policy and an appropriate organization to carry it out?

In response to congressional interest in these issues, GAO testified and issued a report to the Congress on the administrative, equity, and foreign policy problems surrounding deep ocean mining. Our January 1978 testimony before the House Subcommittee on International Economic Policy and Trade, and the Subcommittee on International Organizations, highlighted the need for (1) defining the Government's role in this area, (2) coordinating deep ocean mining with overall U.S. foreign policy objectives, and (3) resolving how the benefits of deep ocean mining should be equitably distributed.

Untimely initiatives in this area could result in serious international economic dislocations. For example, studies by the World Bank and Johns Hopkins University have concluded that extra supplies of minerals from the deep seabed could cause declines in the prices of manganese, cobalt, and nickel. Although such a decline might benefit consumers, countries which export these commodities would face lost markets and reduced foreign exchange earnings.

Increasing international competition for materials and the role of international commodity agreements--As stated earlier, the United States no longer dominates global economics to the extent that it did following the Second World War. Japan and West Germany are now the third and fourth largest economies in the world.

Few developed countries now feel comfortable relying solely on market forces to assure access to needed minerals and materials. Some European countries, and Japan, have created special incentives for overseas investments in minerals resources. European and Japanese businesses also

seem more willing to accept producer-country restrictions on their direct investments. They seem to regard the payment of premium prices for materials, and requests for technology transfers, as less important than supply interruptions of vital materials needed for manufacturing exports.

Furthermore, these governments appear to consider government-to-government supply and investment agreements with producing countries more favorably than the United States. Such agreements tend to assure supplies while minimizing dependence on U.S.-controlled multinational mining corporations.

International commodity agreements are designed to stabilize materials prices and assure their supply. These agreements reduce producer risks that result from unexpected price movements, thereby providing incentives to production and assuring adequate capacity. They also tend to produce a more stable market structure that helps reduce speculation.

However, these agreements have sometimes stirred controversy within the United States because they clash, in principle, with our traditional advocacy of an international economic system based upon "free trade." Also, artificially-set prices tend to be inflationary and create the spectre of officially-sanctioned cartels in key commodities.

We believe there is a need to examine this issue further. The notion of cooperative management of the world's resources need not necessarily imply a violation of the principles of free trade. In their absence, many nations are likely to resort to forms of national stockpiling to assure supplies of needed materials. Stockpiling presents additional, and perhaps more serious, problems in terms of access to materials.

Stockpiling--The critical issues surrounding the concept of stockpiling concern its objectives. For example, if the stockpile objectives are only to prevent physical interruptions in supplies due to foreign actions, it requires very different capabilities than if the objectives are to maintain a price level for imported minerals.

For many years, the United States has maintained strategic stockpiles of critical industrial materials as part of its defense effort. These activities have been carried out as part of the Strategic and Critical Materials Stockpiling Act of 1946, which requires the United States to acquire and retain materials that would be of critical importance to industry and the military during a national emergency.

Recently, GAO has undertaken several studies to determine whether the Nation is meeting its stockpile objectives. In a report entitled, "The Strategic and Critical Materials Stockpile Will Be Deficient for Many Years" (EMD-78-82, 7/27/78), we found that it will take 15 to 20 years to achieve goals set for the stockpile in 1976.

The problems stem mainly from policies which govern the buying and selling of materials for the stockpile. For example, to generate revenues for stockpile purchases, the Government must auction off materials currently in the stockpile. This sometimes results in disposing of some needed commodities to meet revised goals set for others. Another problem is that there are no provisions to assess changing industrial requirements for some materials. As a result some materials, acquired for the stockpile 20 years ago, are no longer suitable for use.

We made a number of recommendations which generally pointed out the need for more flexible stockpiling policies, and initiated another study to assess alternatives to traditional stockpiling methods. A report on the latter study will be sent to the Congress in 1979.

We believe some other key issues in this area for future study are:

(1) How does U.S. involvement in commodity agreements creating international buffer stockpiles relate to U.S. interests supporting a limited national economic stockpile?

(2) Would Government objectives in creating an economic stockpile be consistent with other policies pertaining to national security, economic health, and quality of life considerations?

(3) What options have been developed to fund the sale or purchase of materials for national security stockpiles and what is their rationale?

Encouraging development of foreign mineral supplies by financial institutions--In recent years, the role and capital base of Government-supported, international, financial institutions have been greatly expanded. The World Bank has expanded compensatory financing facilities and increased membership subscriptions to help finance debts incurred by producer countries resulting from depressed raw material exports.

What has now emerged as an important issue is the political-institutional structure of rescheduling the global debt resulting from energy price increases, and the attendant implications for foreign minerals production and trade. International financial institutions will most likely play a key role in rescheduling that debt.

There are still a number of questions about what role those international banking and financial institutions should play in materials production and trade. The growing need for increasing mineral production and refining capacity to minimize future economic shortages is widely recognized. Conversely, the political and social effects in producing countries of excessive capacity during periods of economic recession are also recognized as major impediments to forecasting market force adjustments.

But what needs to be studied further are the implications of public versus private debt financing in minerals-producing countries. Specifically, with respect to public debt financing, there is a need to evaluate whether the activities of financial institutions supported by the Government might be inimical to U.S. interests (i.e., U.S. financing of industrial projects that may compete with domestic U.S. industries).

DOMESTIC ISSUES AFFECTING ACCESS TO MATERIALS

The problems of access to materials do not evolve solely from international constraints. Federal lands have traditionally been an important source of minerals and other materials. These holdings constitute over 33 percent of the Nation's lands and remain the foremost unexplored and undeveloped areas in the country.

More than 90 percent of these Federal lands are found in our Western States. Hidden beneath these lands may be significant deposits of such minerals as: copper, lead, uranium, gold, silver, coal, oil, and iron. In 1965, Federal lands in 11 Western States accounted for 90 percent of the Nation's domestic production of copper, 100 percent of the nickel, molybdenum, and potash, and about half of the Nation's domestic production of lead.

At one time, 90 percent of all Federal lands were available for mineral exploration and development. However, beginning with the passage of the Wilderness Act of 1964, which created 9.1 million acres of federally-protected wilderness area, successively more and more public land throughout

the United States has been declared off-limits to mining. In the past decade, numerous withdrawals have been carried out, under a variety of authorities, and as a result, two-thirds of all Federal lands now have moderate to prohibitive restrictions on mineral exploration and development.

The need for mining law reform--Two laws have provided principal control of the use of public lands which are open to mining: the General Mining Law of 1872 and the Mineral Leasing Act of 1920, as amended. The earlier measure was established to promote development of mineral resources in the United States and to encourage the settlement of the West. That law essentially provided for ownership of the land once a claim was filed and a valuable deposit identified. This is referred to as the "claim patent" system. The leasing law changed the system from ownership to leasing for certain kinds of mineral deposits such as oil, gas, coal, phosphate, and sodium.

The 1872 law has been the target of criticism for many years, often for (1) the absence of environmental standards, (2) the use of mining claims for purposes other than mining, (3) a perceived inadequacy in the share of mineral wealth returned to State and Federal Governments, and (4) a lack of incentives to mine lands once they have been leased or claimed.

Recognizing these concerns, the Congress enacted the Federal Land Policy and Management Act of 1976. This law did not specifically repeal the 1872 and 1920 mining laws, but definitely affected them. It contains several policy statements applicable to both materials and land-use issues:

--Public lands should be periodically and systematically inventoried to plan present and future uses.

--Lands previously classified by executive action or statute should be reviewed.

--Federal lands must be managed according to the concepts of multiple use and sustained yield, unless otherwise specified by law.

--The Secretary of Interior must consider the views of the general public when establishing rules and regulations.

--Fair market value must be received for use of the lands.

--The lands must be managed in a manner which recognizes the Nation's need for minerals, food, timber, and fiber.

Efforts to reform existing mining laws are polarized between those who wish to repeal the 1872 law in its entirety and replace it with a all-leasing system, and those who maintain that retention of the 1872 law is critical to the future availability of mineral supplies. If adopted for hardrock minerals, an all-leasing system could theoretically assure a fair market value return for development of public minerals, and would parallel the system created for disposition of federally-controlled energy resources (e.g. oil, gas, coal, etc.).

There are, however, substantial complications to implementing an all-leasing system for hardrock minerals. The key complications are:

--Hardrock minerals are found in irregular occurrences, of unknown extent, and would not always lend themselves to a leasing system.

--Small mining firms play an important role in exploration, but their activities would be curtailed under a leasing system.

The problems posed by the irregular geologic structure of hardrock mineral deposits combined with the absence of adequate deposit data are significant. While an all-leasing system could be the means for securing fair market value return, when adequate data becomes available for hardrock mineral deposits, it would not encourage up-front exploration by the private sector to establish this information base. A system combining the time-tested incentive features of the claim-patent system with provisions to assure a fair market-value return on extracted minerals might be a more preferable approach. Such an approach would assure orderly and timely mineral development, and provide for protection of the environment. It would also protect the structure of the mining industry, assuring continued opportunities for the Nation's small mining firms. A GAO report entitled, "Mining Law Reform and Balanced Resource Management," (EMD-78-93, 2/27/79), was sent to the Congress early in 1979.

GAO believes that future attention must also be given to issues such as these:

(1) What efforts have been made to assure that valuable minerals have not been unnecessarily locked up in land withdrawals?

(2) How is the mineral potential of Indian lands determined, and how effective have past surveys been?

(3) How is the mineral potential of privately owned land determined, and what are its implications on Government policy?

(4) How effective are surveys of federally-owned land that is withdrawn, or proposed for withdrawal, from mineral development?

(5) What is the effect of recent land-use, environmental, and water purity legislation on the development of mineral reserves in the United States?

(6) What are the transportation problems associated with developing domestic mineral resources and what will be the effect on highways, port facilities, and railways?

(7) How effective are taxation measures encouraging new domestic mining activity, and how necessary are they for maintaining current mining operations and minerals reserves?

SUMMARY

For the immediate future, access problems will impose the primary constraints upon the availability of most materials. As this chapter points out, some access problems evolve from the realities of international politics, while others are the result of simple economics. And some access problems--principally those arising from domestic policies--are self-imposed.

The access issue, in essence, is the problem of circumventing artificial impediments to materials supplies. This chapter has discussed some of the efforts toward that end--such as stockpiling, buffer stocks, commodity agreements, and deep seabed mining.

But much more needs to be done. There is abundant evidence that the United States has not made the transition--culturally, socially, psychologically, or politically--from an era of relative materials abundance, to an era of intense competition for the world's resources. This competition, in addition to some of the developments mentioned in this chapter, may seriously threaten industry's future access to raw materials. In keeping with that concern, GAO will give access issues prominent treatment in its work in the materials area.

CHAPTER 4

MATERIALS, ENERGY, AND THE ENVIRONMENT: INTERFACE ISSUES

Materials, energy, and the environment. As the title to this chapter suggests, they are all interrelated. The Nation must use energy to mine and process raw materials for its industry. Environmental pollution is often ascribed to materials mismanagement. And materials themselves--such as copper, aluminum, platinum and silicon--may determine the Nation's ultimate success in meeting its energy and environmental goals.

This chapter is about those interrelationships.

THE INTERFACE BETWEEN MATERIALS AND ENERGY

What we commonly refer to as "minerals" are actually the elements and other substances which are found in the earth's crust. As might be expected, some minerals--those formed from more abundant elements--are more plentiful than others. These would include such minerals as silicon, aluminum, iron, and magnesium. Examples of "geochemically scarce" minerals would include cobalt, lead, platinum, silver, tin, and zinc. It is important to note that these special metals are heavily used in industrial technologies.

To make minerals available for industrial use, their ores must first be mined and then processed. Both activities require substantial inputs of energy.

Increasing the energy efficiency of minerals extraction and processing--According to a recent Conference Board study, the industrial sector of the economy uses about 40 percent of all fuels and electricity consumed in the United States. From 25 to 50 percent of that industrial consumption is used in the extraction and processing of mineral materials. Table 1 illustrates the significant amounts of energy required to process some materials.

TABLE 1

Energy Used in Processing Virgin and Recycled Materials

Material	Energy Needed to Process Virgin Ore (BTU/Pound)	Energy Needed to Process Recycled Material (BTU/Pound)
Steel	8,300	7,500 (40% scrap) 4,400 (100% scrap)
Aluminum	134,700	5,000
Aluminum Ingot	108,000	2,200 - 3,400
Copper	25,900	1,400 - 2,900
Glass Containers	7,800	7,200
Plastics (polyethylene)	49,500	1,350
Newsprint	11,400	8,800

Source: Adapted from Dennis Hayes, "Repairs, Reuse, Recycling--First Step Toward a Sustainable Society," Worldwatch Paper 23, Worldwatch Institute, Washington, D.C., September, 1978.

As mineral ores are depleted, their average grade tends to decline. This means that larger volumes of ore must be mined to recover a constant supply of a mineral. And that, in turn, requires more energy. The National Academy of Sciences pointed out the possible implications of this trend in a 1978 report entitled, "Review of National Mineral Resource Issues and Problems":

> "The fact that increasingly lower grade ores are being mined puts mining and processing on a collision course with increasing energy costs and needs. Thirty to forty years ago the average grade of copper mined in the United States was 1.1 percent; today it is only 0.65 percent. Continuous decline remains evident, and a grade near 0.20 percent copper by the year 2000 seems a reasonable extrapolation. When the average copper ore grades reach 0.20 percent we must be prepared to use roughly three times as much energy to recover one ton of copper in the form of concentrate as is employed today, and we must also find room for disposal of three times as much overburden and tailings--close to two billion tons per year."

Therefore, considering mining alone, energy may become a more limiting factor than geophysical occurrences in determining the availability of some materials. Technological breakthroughs can temporarily offset this trend toward increased energy usage in mineral mining and manufacturing. However, in view of the numerous and persistent expressions of concern regarding the adequacy of current research and development activities in the United States, and specifically in the American minerals industry, we would caution against placing disproportionate reliance upon R&D as the answer to these problems. The need to produce increasing tonnages of materials from lower grade, and more deeply-buried, ore bodies will be one of the most crucial issues facing the mining industry in the years to come.

This problem is compounded by other factors. First of all, some minerals require more energy to process than others. For example, some minerals--such as bentonite, graphite, and gypsum--may be separated from their ores by basic techniques like crushing and grinding. Most minerals, however, require further processing--ranging from simple flotation techniques, to extensive treatment with chemicals and heat--to be separated from their ore. Most of these must then be smelted and refined into metal. Each of these steps requires additional investments of energy.

The harsh economics of increasing energy costs have not been lost on American industry, and many companies have attached a high priority to developing processes which reduce energy consumption. For example, it is reported that the Dow Chemical Company's "War on BTU's" reduced that company's energy use by 15 percent in five years, saving the equivalent of 10 million barrels of oil a year. This translated into savings of approximately $150 million for Dow in 1977. Union Carbide also reported that it used 15 percent less conversion energy, in absolute terms, in 1977 than it did during 1973, and that these savings accounted for nearly 11 percent of its operating profits. And Amex Nickel, Inc. has reportedly developed a new acid leach process which it claims will reduce the energy required to extract nickel from lateritic ores by 40 percent, when compared to conventional pyrometallurgical processes.

A number of suggestions have been made to further increase the energy efficiency of U.S. industry. They include Government support of research into new industrial processing technologies; improved product design and engineering to improve durability and encourage materials conservation; and measures to encourage the growth of secondary metal production. The latter alternative would encourage conservation

of "virgin" materials by producing more products from recycled scrap.

To provide information for future policy choices in this area, GAO has initiated a study of energy consumption in selected mineral processing industries. This study will also examine current and future trends in

--grades of basic mineral ores,

--mineral processing technologies,

--power sources, and

--patterns of mineral usage.

Upon completion of this work, we will report our findings to the Congress.

Energy efficiency standards and changing patterns of materials usage--New technologies and new regulatory requirements are also acting to change traditional patterns of materials use. For example, as part of their strategy to meet Government-mandated mileage standards, automobile manufacturers are using lighter and stronger materials to reduce the curb weight of new vehicles. This translates into increasing use of aluminum and plastics as substitutes for iron and steel. There is also a trend toward using less materials in car production by reducing the overall size of the vehicles themselves. Such changes may lead to some disruptions in a number of individual materials markets.

The changes fostered by energy efficiency standards could have some unintended side effects. For example, in the housing industry, the increased demand for cellulosic insulation at the end of 1976 very nearly depleted supplies of boric acid. And some analysts have suggested that there may be up to 20,000 jobs lost if steel in automobiles were reduced by 700 pounds per vehicle.

Finally, the new energy technologies themselves will require substantial new supplies of certain materials. For example, the development of photovoltaic cells for solar energy using current technology could account for 25 percent of the copper consumption by 1985. This application will also require massive quantities of silver, but it is now uncertain as to whether adequate supplies will be available at any reasonable price.

GAO has initiated several studies to examine these issues. One study, expected to be completed early in 1979,

will look at the potential impact of automotive fuel efficiency standards upon individual materials industries--such as iron, steel, aluminum, and plastic--and upon the national economy. A key issue to be addressed is whether the effects of materials substitutions in automobiles can be sufficiently projected to allow a smooth market adjustment to altered conditions of materials demand and supply. We will be initiating further studies to assess the impact of rising energy costs upon materials availability and use.

THE INTERFACE BETWEEN MATERIALS POLICY AND POLICIES TO PROTECT THE ENVIRONMENT AND WORKER HEALTH AND SAFETY

Perhaps the issue having the greatest contemporary significance for materials policy, is the controversy that surrounds Government regulations to protect the environment and worker health and safety. The controversy centers not on the need for regulations, but on their relative costs. For example, the Department of Commerce estimates that U.S. business will increase spending for air pollution control by 30 percent in 1978; total expenditures were expected to rise from $4.5 billion in 1977 to $5.9 billion in 1978. Total spending for solid waste pollution was expected to reach $1.1 billion, an increase of 64 percent from 1977. Total spending for pollution control was $35 billion in 1976--nearly twice the amount spent in 1972. It should be clear that these expenditures are now large enough to affect the national economy.

Our purpose in citing this issue is not to imply that the regulations in question lack merit. To the contrary, as we pointed out in a recent report to the Congress entitled, "16 Air and Water Pollution Issues Facing the Nation" (CED-78-148A; 10/11/78):

> "We believe that the goals of the clean air and water acts, except for the goal to eliminate the discharge of pollutants into waterways, are basically sound. However, regulatory adjustments are needed to resolve major issues that have emerged, and to continue progress in achieving air and water quality goals in the most cost-effective, efficient, and equitable manner consistent with other national priorities--particularly energy issues."
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> "We feel compelled to bring to the attention of the Congress the need for coordination of

policies and programs and to stress that a number of recent energy policies exist which have superseded earlier environmental actions to a great extent. In brief, the Nation is facing a number of issues that should be considered as a whole rather than separately, as is currently being done."

We believe it will become increasingly important to recognize that many national policies--addressing issues such as the environment, energy, and worker health and safety--while not necessarily in conflict, often involve tradeoffs that must be stated and explicitly dealt with in future Federal decisionmaking. As one editorial posed the problem:

"Congress generally treats environmental legislation as, essentially, a moral issue. That, in our judgment, is the correct view of it. Pollution affects people's health and comfort. It affects aesthetic values and the pleasure that people are able to take in their surroundings. But to say that is not a license to ignore the costs, which have been rising steadily."

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"This country, in its high-flying way, might try to avoid the choice. It would not be uncharacteristic of Americans to keep pressing Congress for more environmental protections in the style of the 1970s, while pressing President Carter for faster economic growth at the rate of the early 1960s. In fact, something very much like that is going on right now. The warning that the statisticians are offering, in their intricate arithmetical way, is that the two purposes don't fit together." 4/

In the near future, GAO will be examining the regulatory process to determine its impact upon the materials industries and upon materials availability. In that context, GAO will specifically address the question of whether the Federal regulatory process is inducing a shift of American industries to overseas locations.

Are we exporting hazardous materials?--Although many commentators have criticized environmental and worker

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4/Washington Post, 4/5/78, p. A14.

health-safety regulations for the competitive burden they place on U.S. industry, serious attention has not been given to the fact that, as a result, we might be "exporting hazardous factories" to developing nations. The material, asbestos, presents a case in point.

It has been estimated that there are nearly 400,000 people in the United States today who have worked with asbestos and who will someday develop cancer as a result. The United States started regulating exposure to asbestos in June 1972 and, according to a recent study 5/, imports from Taiwan, Mexico, and Brazil since that time have increased over 400 percent. Apparently, none of these nations has specific health-exposure standards for asbestos. Furthermore, the United States appears to be indirectly subsidizing this phenomenon because some of the asbestos textiles from these nations enter the country duty free.

Legislation was introduced during the 95th Congress that would have imposed a $0.10/per pound "environmental equalization tariff" on imports not meeting U.S environmental standards. The concept underlying such legislation might be helpful in dealing with this problem. However, we believe the issue deserves much further study, especially considering the range and industrial importance of some of the hazardous products now regulated by Government--such as benzene, vinyl chloride, exposure to arsenic during copper refining, and coke oven emissions from steelmaking.

Critical trends affecting the chemical industry--Many of the products now labeled as "hazardous" by the Government are chemicals. In fact, more than 250,000 chemicals are now candidates for regulation. Yet chemicals are increasingly being used to cut industrial costs and to develop new or substitute products. For example, the petroleum industry uses over 100 different chemicals to extract and process oil into finished products. Laminated wood trusses, bonded by chemical-based adhesives, have proven to be valuable replacements for steel in many applications.

An important source of many of these chemicals are the distillates made from petroleum and natural gas. In fact, as noted in chapter 1, these "petrochemicals"--benzene, ethylene, toluene, and others--represent a $430 billion industry in the United States today. They are used to make a variety of products--including nitrogen fertilizers, synthetic detergents,

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5/Castleman, Barry "The Export of Hazardous Factories to Developing Nations," March 7, 1978. (unpublished paper)

synthetic rubber, plastics, photographic chemicals, pesticides, and preservatives.

Products made from petrochemicals have a number of advantages over products made from nonsynthetic materials. For example, tires made of synthetic fibers generally have twice the life of natural rubber tires. Similarly, products made from plastics are noncorrosive, more durable, and lighter than materials derived from some mineral ores.

Although increased use of petrochemicals might appear a logical solution to many of the Nation's materials problems, it may also entail significant disadvantages. Probably the major disadvantage of using petrochemical feedstocks is the resulting diversion of oil and natural gas from more basic energy needs. Also, as alluded to earlier, there are environmental and worker health-safety issues associated with the use of some petrochemical substances.

GAO has initiated a study of critical trends that may affect the petrochemical industry. This study will examine the future growth of the petrochemical industry, factors affecting competition with other products, and the trade-off issues associated with using oil and natural gas for energy or as petrochemical feedstocks. This study will culminate in a report to the Congress during 1979, and will most likely lead to further work by GAO in this area.

SUMMARY

This chapter has highlighted one of the key problems confronting policymakers in the materials area: decisions, and attendant policy actions, designed to enhance supplies of needed materials often involve trade-offs with other Government policies to

--protect the environment

--enhance worker health and safety,

--conserve energy, and vice versa.

Understanding the major interface points between these Government policies is essential if we are to avoid the appearance of a Government working at cross purposes.

Not only are the economic consequences of these policy decisions significant, but the very viability of policy goals in each of these areas is threatened if decisionmakers fail to grasp--and make allowances for--the interplay between materials, energy, the environment, and the Nation's industrial health.

CHAPTER 5

MAKING BETTER USE OF OUR MATERIALS RESOURCES

As chapters 3 and 4 point out, even though there is no immediate threat of physical depletion for most materials, economic scarcity has become a real possibility. In many respects, this is due to the changing nature of energy supplies and the significant increases in their costs.

Our current economic and social structure was built upon a foundation of cheap energy and relatively abundant resources. However, a period of growing global changes has significantly altered that framework. Whereas oil once cost $2 a barrel, we are now approaching an era in which it will cost $20. That energy cost will become even more significant in the future, because, in December of 1978, OPEC sharply increased the price of oil and indicated that it may peg future oil price hikes to increases in the price of other raw materials. This built-in cost escalation could make it enormously expensive to extract, process, fabricate, and dispose of minerals and other materials resources.

This energy barrier to economic growth comes at a time when materials use--and "waste"--are growing at a significant rate. In 1976, worldwide mineral use was reported to be 3.75 metric tons per person (15 metric tons in the United States), and increasing at a rate of 7 percent annually. These trends underscore the fact that we have been living through a period of rapid consumption of our materials resources. For example, global consumption of iron ore and petroleum roughly tripled from 1950 to 1966, and the United States increased its consumption of copper by almost 70 percent and nearly tripled its consumption of aluminum between 1960 and 1977. The vast majority of these minerals are used once and then disposed of.

The convergence of these trends--the increasing cost of energy, the rapid "consumption" of materials, the tremendous cost of obtaining and disposing of them, and the generation of large volumes of waste material--clearly suggests the need for a more conservative attitude toward the use of our materials resources.

RESOURCE RECOVERY AND RECYCLING

Recently, increased attention has been given to the opportunities available from resource recovery. Congress took steps in this direction when it passed the Resource

Conservation and Recovery Act of 1976. The objectives of that act are to preserve the environment through better waste management and improved recovery of usable materials in industrial wastes. Though the Government has taken steps under the act to control pollution, relatively little has been done to recover materials from industrial wastes.

In most mineral extraction processes, mining companies dig huge amounts of rock, extract the minerals of interest, and dispose of the remaining materials. Many times these discarded materials contain valuable minerals. In the mining and processing of phosphate ores for example, only 60 percent of the phosphorus is recovered.

Improved phosphate recovery is one of the research projects now sponsored by the Bureau of Mines. The Bureau spends $2 million annually on research into recovering and recycling mineral constituents in wastes. According to the Bureau, the prospects of recovering significant quantities of some metals and minerals are promising. Current projects include: the recovery of aluminum, carbon, and fluoride from the black muds generated in the production of aluminum; reclaiming waste zinc from superalloy casting molds; processing gallium and germanium from fly ash; and producing chromium from leather tanning wastes.

The costs associated with removing minerals from consumer wastes, and the ability of the marketplace to absorb the recycled materials, have constrained the Nation's recycling efforts. For most recycled materials, additional processing steps are needed to remove contamination from other substances not found in virgin ore. This results in added costs that make the recovered materials noncompetitive with imports and virgin domestic mineral ores. Also, recycling centers often are not contiguous to waste treatment facilities and landfills. And, in other cases, product design--as with many consumer appliances such as refrigerators--makes separation of recyclable materials difficult.

In addition to the technical problems just mentioned, the uncertainties surrounding this country's commitment to recycling have precluded investments in the requisite plants, equipment, and facilities. Recycled materials must be cost competitive with virgin materials. Even though recycling costs can be readily determined, the future value of virgin materials is highly speculative. As a result, recycling is viewed by many as a risky venture. Recycled materials must also overcome the traditional aesthetic preference of many Americans for "new" goods.

GAO has initiated studies into the opportunities and problems associated with the recovery and recycling of materials. Several reports on this subject will be sent to the Congress in 1979.

CONSERVATION

Materials conservation is another way of making more materials available. By making materials last longer, and by lessening our material needs through better design, conservation can result in permanent, or at least long-term, materials savings.

Extending the functional life of products is one way conservation can help the Nation stretch limited supplies of scarce materials, or reduce its import dependencies. One means of achieving this end would be to control corrosion. In 1975, corrosion cost the United States an estimated $70 billion or 4.2 percent of the estimated Gross National Product. Of this total, about 15 percent or $10 billion was avoidable. About 17 percent of our present demand for metallic ores has been attributed to metallic corrosion, one-eighth of which was avoidable. Using these statistics, the National Bureau of Standards has concluded that our demand for raw materials could have been reduced by 2.1 percent, if we had made greater efforts to control corrosion.

Another way to attain greater conservation of materials is through laws or incentives which discourage wasteful practices. According to EPA, national returnable-bottle legislation would reduce roadside beverage-container litter by 60 to 70 percent by 1980, and would save 500,000 tons of aluminum, 1.5 million tons of steel, and 5.2 million tons of glass each year. It would also save the energy-equivalent of 45.6 million barrels of oil annually.

A GAO report entitled, "Potential Effects of a National Mandatory Deposit on Beverage Containers," (PAD-78-19; 12/7/77), expressed similar sentiments. We estimated that beverage container litter could be reduced by as much as 80 percent if mandatory deposit legislation were to be implemented, and that energy use in the beverage industry could be reduced by as much as 30 to 40 percent.

Design standards that reduce materials use in many consumer products can also facilitate conservation. The downsizing of automobiles to meet fuel efficiency standards is a good example of this phenomenon. By reducing the size and weight of automobiles, larger quantities of materials are saved without significantly affecting the automobile's functions and performance.

These examples are just some of the conservation options available. There are additional options that should be explored by policymakers. One such option is substitution.

SUBSTITUTION

There are ready and obvious substitutes for a great number of materials--synthetic rubber has replaced natural rubber in many applications, aluminum has been substituted for iron and steel, glass fibers can replace copper wire in some electrical applications, and plastic has displaced many traditional uses of wood and metals.

However, substitution is by no means a panacea for the Nation's materials problems. Workable economic substitution often requires development of new technologies which, in turn, requires a substantial investment in research and development.

However, national materials research efforts are fragmented, without focus, and suffer from lack of coordination. As mentioned in chapter 2, GAO has found that Government efforts are scattered among 23 agencies with 90 sponsoring subdivisions, each with its own unique needs and parochial reasons for research. Furthermore, the nature and extent of private efforts are poorly understood. So is the understanding of how and why materials R&D is undertaken in the private sector, or how Federal efforts--especially at Government-financed laboratories--could be made more useful in the private sector.

Without some commitment to improve the management and coordination of Federal R&D, it will be extremely difficult to align current materials research with the goals of national materials policies. Striking a proper balance in that policy will also require considerable improvement in the Government's knowledge of materials research undertaken in the private sector. To meet both concerns, GAO has repeatedly advocated the need for

--an unclassified materials R&D information system within the Smithsonian Science Information Exchange (SSIE),

--mandatory reporting of all Federal materials R&D to the SSIE, and

--improved collection of data on private sector materials R&D by the SSIE and inclusion of that data within the basic information system.

Related to the problem of research and development is the length of time which is often required to test, re-tool, and implement new processes. Large-scale industry replacement of one metal by another could require 5 to 10 years. If new technology is involved, the time frame is much longer--perhaps 20 or more years. If several metals should become relatively scarce at about the same time, the problems with substitution become compounded. In fact, when highly specific chemical and physical properties are required by production processes, substitution may not even be feasible.

In view of the foregoing, a warning issued by the National Academy of Sciences seems entirely appropriate:

> "We cannot emphasize too strongly that the discovery and development of new and improved materials as possible substitutes for existing ones takes time and that the process is generally driven by clearly-perceived functional objectives rather than by ill-placed optimism that "something will turn up when the crunch comes."

In a related context, we should also remember that there are some nonrenewable resources for which there are no known substitutes. Phosphates and helium are perhaps the best known substances in this category. GAO issued a report entitled, "Unique Helium Resources Are Wasting: A New Conservation Policy Is Needed," (EMD-78-98; 3/7/79), and a report on phosphates will be issued in FY 1979. Using these two materials as examples, we will show the need for new and better ways to manage the Nation's nonrenewable resources.

WOOD: THE MAJOR RENEWABLE MATERIAL

As indicated in chapter 1, wood is by far the most important renewable material in the economy. However, a series of studies conducted by the U.S. Forest Service and others, as early as 1969, indicated that softwood sawtimber and some hardwoods might become "economically scarce" by the end of this century. The implications of this forecast are serious. Lumber prices, which historically have risen faster than the general price level, would probably rise sharply; in fact, one recent study projects a sixfold increase in the real price of wood over the next several decades. What all this implies is that an important basic material, wood, will probably cost more and be used less.

Nearly all of the recent studies done on this issue have concluded that the potential timber shortfall could be offset by increasing the supply of timber harvested from Federal land. However, such a policy would place

the burden upon the Federal Government to resolve a situation which is largely the result of declining production on industry lands. The environmental effects from such a policy are uncertain, and the changes in harvest schedules or multiple use practices of national forests implied by such a policy may not be in accord with the National Forest Management Act of 1976.

Another possible alternative might be to increase timber harvests from noncommercial, private landholders. This could avert some of the problems noted above. In fact, one of the aforementioned reports did trace part of the projected timber shortfall to declining production from private lands, and suggested that high yield forestry practices on these lands could help avert the projected shortage. However, additional supplies from these sources may be dependent upon Federal subsidies, tax credits, or similar inducements to stimulate investments in high yield forestry.

These and other observations are contained in a 1978 GAO report, "Projected Timber Scarcities in the Pacific Northwest: A Critique of 11 Studies" (EMD-79-5; 12/10/78). As a result of our work in this area, we have identified other trends that may have future significance:

--The prospects for exporting timber in the future may increase. Timber has never been a major U.S. export, but balance-of-payments problems, increasing demands from other countries, and the possibility of making good profits from growing and exporting trees, all point toward increased activity in this area. One company, Weyerhaeuser, already plans to greatly increase timber exports.

These new sources of demand are different from the traditional demand for construction materials and paper, and could cause significant changes in the way the wood processing industry operates. There are also some fundamental changes occurring with respect to timber supply:

--Timber production has historically been unprofitable unless it was viewed as part of an integrated growing and processing operation. But growing trees appears to be becoming profitable in and of itself. This economic breakthrough could substantially affect the traditional supply roles of private and Government timber owners, and favor the larger timber companies.

--Timber supply has always come, in part, from virgin or "old growth" forests. Part of the industry has

always depended on having an outside source of supply for timber and on paying less for raw materials than it would cost to grow them. Old-growth timber from private ownership will soon disappear, however, and public-growth timber will be constrained by multiple use and sustained yield policies. The industry will face some substantial supply adjustments as a consequence.

In summary, these demand and supply trends all point to possibly significant changes in the traditional operation of wood industries and the wood marketplace. GAO believes that the possibility of such change clearly suggests the importance of the following basic policy questions:

What are the possibilities of increasing the availability of wood materials through

--increasing supplies of softwood sawtimber from the public lands and from private nonindustrial landholdings?

--extending wood utilization through the development of new products and processes capable of using currently unused portions of U.S. timber stocks?

--encouraging the timber self-sufficiency of wood-processing firms and enhancing the profitability of timber growing?

What are the advantages and disadvantages of

--substituting wood materials for nonwood materials within the domestic economy?

--attempting to increase timber exports from the U.S.?

What implications would supply and market enhancement policies have on

--the structure, conduct, and performance of the private timber and wood processing industries?

--the U.S. Forest Service?

--the competitive position of the different timber producing and processing regions within the U.S.?

SUMMARY

It is clear that most decisions about recovery, recycling, conservation, or substitution of materials are based almost entirely upon considerations of current costs.

One consequence of this is that the Nation often finds itself reacting to change rather than anticipating it and developing measures to offset its effects. As this chapter has pointed out, substitution requires years, not days or months, to take effect. And the need for conservation of materials often does not become apparent until they have already become scarce. Although the resulting price movements do in fact perform a rationing, or allocating, function for the remaining materials, it is often done at some cost to the economic fabric of society.

The question that increasingly comes to the fore seems to be whether we, as a society, can do a better job of anticipating future events and respond with planned actions to soften, or offset, their effects. The American economy, based upon market-pricing mechanisms, has been resilient and highly effective in responding to change in the past. But we face a new era in which these traditional methods may no longer suffice. Consequently, there appears to be a growing need for Government-led efforts to improve the forecasting ability of the Nation's materials managers and users. That is the subject of the next chapter.

CHAPTER 6

PLANNING AND ADMINISTRATION OF U.S. MATERIALS POLICIES

The preceding chapters have addressed a variety of materials-related trends and issues. Chapter 1, for example, made reference to several trends which may force a change in the way our Government approaches materials-related problems. One such trend is the increasing incidence of governmental involvement in materials supply processes, involvement which is often undertaken in response to the actions of other governments.

While not a trend per se, there is also a growing awareness of economic trade-offs arising from regulation. As pointed out in chapter 4, policies designed to promote the Nation's energy posture may not be in total concert with policies designed to protect its environment. And the Nation's reluctance to develop a policy process which consciously and consistently seeks to reconcile its need for materials with its energy and environmental goals, could very well jeopardize its future economic and industrial health.

This chapter addresses the need for such a process.

THE NEED FOR BETTER FORESIGHT

Even though materials are central to America's industrial health and economic welfare, the Federal Government has never given materials availability the serious, sustained attention it deserves.

This is true even today, despite abundant evidence of a resurgence of the conditions that created the materials shortages of the early 1970s. Nothing was ever done to remedy the 1973-1974 shortage situation; it was largely "solved" by a worldwide recession. Global economic recovery from that recession has been slow and uneven. But the pace of recovery has begun to quicken, simultaneously, in all the major industrialized nations. This trend could lead to the same synchronized demand pressures that fostered the 1973-1974 shortage situation. Furthermore, there has been very little expansion since that time of production capacity in many vital industries. Current investment plans indicate a continuation of this trend into the near future.

For example, in early 1978, aluminum inventories were short and the aluminum industry was operating at 97 percent capacity. But, in spite of projections of a possible doubling of demand for aluminum in some uses by the mid-1980s, total domestic production of aluminum is expected to grow by less than 2 percent annually through 1982.

Better foresight, as implied above, entails improvements in the Government's ability to detect trends and events which may impact upon the future availability of materials. It also implies the need for a procedure to deal with unintended side-effects that sometimes arise from the pursuit of other national policies. As the following comments by an official of the Standard Oil Company suggest, this issue is beginning to take on significant dimensions:

> "* * * [we have] been having problems getting the necessary authorizations to construct a pipeline from Long Beach, California to Midland, Texas. This pipeline would transport Alaskan North Slope oil to Midwest refineries. We started working on this project early in 1974.
>
> Now it is January 1978--4 years later--and we still don't have the necessary authorizations to get on with it. For this project alone we need approval on nearly 700 permit applications." 6/

In a similar context, an executive of the Union Carbide Corporation offered these thoughts:

> "Rather than solving differences we have institutionalized them by setting up separate departments to handle each problem area. Not unnaturally, each tries to bolster its position by cultivating constituencies--in the Administration, in Congress and among the electorate--to support specific positions.
>
> "What we seem to have at present is a regulatory approach that seeks to force new technologies but fails to encourage them; that acknowledges the relationship between energy and environmental goals, but fails to address it; and that gives each piece of the interrelated action to separate and independent agencies, but provides no real mechanism to solve differences between them." 7/

6/Vital Speeches of the Day, March 15, 1978, p. 349.

7/American Metal Market - Metal Working News, May 19, 1978, p. 46.

While better coordination of some policies is needed, it should not be viewed as a panacea for materials problems. As Leonard Fischman of Resources for the Future has stressed:

> "What is frequently overlooked, in all the emphasis on a "coordinated materials policy," is that its achievement would not necessarily be an unmixed blessing. A coordinated materials policy may well be inconsistent in many ways with coordinated tax policy, a coordinated foreign policy, a coordinated forest policy, a coordinated regional development policy, a coordinated environmental policy, or what have you. Any one federal decision is likely to be multifaceted, impacting on the public welfare and the mix of individual welfares in many direct and indirect ways. It is not at all clear that consistency of federal decisions with regard to their impact on materials costs and supplies will lead to consistent results in terms of optimization of either the general or particular welfares. What is important is only that the way in which any kind of decision impacts on welfare by way of an impact on materials not be inadvertently overlooked or slighted and that one such decision not inadvertently detract from another such decision." [emphasis in the original] 8/

Within this context, we believe it will become important to develop a greater symmetry between materials issues and our goals for energy and the environment, a marked departure from our current habit of viewing materials as a subordinate problem.

CURRENT EFFORTS TOWARD A MATERIALS POLICY PROCESS

The President's Nonfuel Minerals Policy Study

In December 1977, after congressional pressure, and at President Carter's direction, a Cabinet-level committee was formed to review U.S. policies relating to nonfuel minerals and materials. That committee selected 9 broad problem areas to be analyzed within the context of one,

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8/Fischman, Leonard L., "Materials Information Systems for Federal Policy Making," as quoted in Government and the Nation's Resources, The National Commission on Supplies and Shortages, Washington, D.C., 1976, pp. 110-111.

or more, mineral industries 9/. The 9 problem areas selected for analysis were:

--Major Mineral Supply Problems;

--Availability of Foreign Minerals to the United States and its Allies;

--Relationship of Environmental Quality, Health, and Safety Standards, and the Price and Availability of Minerals;

--Mineral Resource Potential of Federal Lands;

--Financing, Capital Formation, and Tax Policies;

--Competitiveness of the U.S. Minerals Industry;

--Conservation, Substitution, and Recycling;

--Adequacy of Mineral-Related Research and Development (R&D); and

--Adequacy of Existing Government Capabilities to Support Federal Policymaking.

The Administration's study has two basic objectives. The first, as previously mentioned, is to identify current and anticipated problems with respect to nonfuel minerals, and appropriate policy options that can be used to deal with them. The latter is to include an assessment of how existing Government policies affect nonfuel minerals.

The second objective of the President's study is of even greater potential importance. That objective is to develop, test, and begin implementation of, a policy and planning process which can be used by Federal decisionmakers to assess minerals-related problems in the future. This objective seems to indicate an acknowledgment that one-time policy studies are no longer a sufficient response to the Nation's recurring materials problems.

GAO believes that it is time to establish an institutionalized planning process for the materials area. The essence of that process must entail some form of continuous monitoring and reporting to assure that future materials issues receive sustained attention at the highest levels of Government. The

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9/Aluminum, asbestos, chromium, cobalt, copper, iron (ore or scrap), lead, manganese, nickel, phosphate, silver, and zinc.

goal of such a process should focus on assuring future materials availability and the avoidance, or at least minimization, of short-term shocks to the economy from rapid changes in materials supply and demand. Long range analyses of materials supplies and industrial requirements, together with contingency plans to deal with shortages--and surpluses--can help minimize such shocks. Primary emphasis, in the long run, should therefore be given to maximizing the surety of supply flows, minimizing price instability, and achieving a sustainable level of materials production and consumption.

GAO is working to assist the Congress in developing this type of policy planning process for the materials area.

Recent GAO initiatives

During the 95th Congress, GAO became actively involved in efforts to develop a materials policy and planning process. This began with testimony before the House Committee on Science and Technology, and continued with detailed comments on several pieces of materials-related legislation. Two bills--H.R. 10859 and H.R. 11203--were particularly noteworthy because they represented a step toward a materials policy process.

H.R. 10859 contained an effective statement of goals for materials policy. However, GAO pointed out that the bulk of that measure concerned itself with the problem of institutional structure. While early attention should be given to that matter, GAO believes that what is first needed is consensus-building as to what should constitute an appropriate planning process for materials policy. Resolution of that question should, in turn, provide specific insights as to what new or modified institutional arrangements are in fact needed.

H.R. 11203 would take the initial steps to address precisely this point. It would require the President to identify national materials goals over time periods of 5, 25, and 50 years, and report to the Congress every 4 years on the plans made to attain them. What is important about this legislation is not the specific timeframes, but rather the recognition of the need to exercise maximum foresight in formulating national materials policies. We strongly endorse this principle, and we believe that it is basic to establishing an effective, institutionalized planning process for materials.

There are several matters to be considered in determining the proper scope of the planning and analytical effort attendant to a policy process for materials. Some of those interested in this problem have suggested that a viable materials policy and planning process would have to cover all materials. GAO believes such coverage would be unnecessary and self-defeating. An analytical effort directed at all materials would be so exhaustive as to risk virtual burial of priority matters requiring attention and decisions.

There are several alternatives which should be considered in setting the boundaries of the planning and analytical effort

--concentration on "critical" materials commodities, though it is to be explicitly noted that, as yet, no Government-wide consensus has been achieved as to (1) which materials are most critical and (2) a common methodology for determining criticality;

--concentration, industry-by-industry, on production and consumption of materials;

--concentration on early detection of major trends and events which can affect the future health of basic domestic industries;

--some combination of the foregoing.

There seems to be a growing consensus that the policy and planning process should be organized to address short-term needs against the background of mid- and long-term goals. Properly conceived, long-term goals provide a reference point, and stability, for materials actions to be taken at specified intervals in the immediate future. In other words, proper attention to such goal-setting helps Federal agencies to focus more clearly on appropriate short-term programs and provides corresponding signals to the private sector. When circumstances force changes in those near-term actions, these long-run--and sometimes mid-term--goals provide a basis for assessing alternative policies. Therefore, long-run goals should be based on various scenarios for the future with emphasis on keeping as many options open as possible.

Regardless of the length of time chosen for the short-term planning cycle, it is of vital importance that short-term materials programs, and planning, be subject to continuous monitoring and annual review. This is necessary because of the volatile nature of most materials markets.

The efficacy of the entire process rests upon its ability to detect emerging trends or changes in the conditions of materials demand, supply, or availability, and to anticipate the effects of these trends, or changes, upon long-run materials goals.

At this point in the discussion, it is important to note that research and development will provide a critical linkage between short-range materials programs and planning, and long-range materials goals. For example, research and development should complement short-range materials programs, and both of these should be designed to improve the Government's ability to anticipate, offset, and respond to foreseeable trends in materials during the next 25 to 50 years.

The goals and objectives themselves are obviously the most important parts of this process. From our experience there tends to be a rather broad consensus with respect to national goals for materials, such as the need to assure their long-term availability. That consensus breaks down, however, once objectives are elicited to obtain those goals, and even more so when specific courses of action are proposed in pursuit of both those goals and objectives. In the coming months, GAO will be working with the Congress, private industry, professional societies, and others in an attempt to better define the Nation's materials goals and objectives, and to increase our understanding of the tradeoffs that arise from the pursuit of specific materials policies.

Whatever the form of policy analysis eventually brought to bear on the materials planning process, we believe it should always encompass at least five basic considerations:

--One, adequacy of materials information systems. This examination must include evaluation of the reliability of information systems within the Federal Government, as well as information coordination between the public and private sectors and, as appropriate, between national governments.

--Two, availability and accessibility of the materials under consideration, including analysis of the full range of political and social factors that can tend to restrict their supply and consumption.

--Three, examination of the principal interface issues between production and consumption of specific materials, and the energy and environmental ramifications of significantly different levels of materials consumption.

--Four, examination of materials commodities supply, lifespan, opportunities for renewal, and requirements for substitutes research and development. The latter may be prompted by a range of considerations, from rising energy costs to prospective resource depletion.

--Five, development of specific institutional arrangements required to execute materials plans and policies. The range of considerations here must be comparable to the foregoing recommendations for the information system component of analysis.

With regard to this last point, it is worth reiterating that agreement should be obtained on a planning process to formulate materials policy before attempting to fix institutional responsibility for implementing it. At a minimum, the choice and location of the organizational structure eventually chosen to administer this function must reflect interest in, and continuing concern for, materials policy at the highest levels of Government.

On a concluding note, serious consideration must also be given to establishing some means for greater public-private collaboration in the formulation of national materials plans and policies. Concern for protection of America's industrial infrastructure, balanced by a recognition that Government itself increasingly structures the environment in which materials industries must operate, should lead both sectors to recognize the need for mutual assistance.

In the fall of 1978, GAO started discussions with individual members of the National Materials Advisory Board, an arm of the National Academy of Sciences, to obtain the best thoughts of private industry and academia about how to better define--and obtain agreement on--the type of planning and analytical effort needed to formulate a policy and planning process for materials.

To be sure, there will sometimes be many impediments--such as proprietary data issues--to this type of collaboration between Government and the private sector. But the need for such an effort is increasingly referred to in many areas of governmental endeavor, and GAO believes that materials issues provide a relevant and justifiable basis for this experiment.

APPENDIX I

REPORTS BY GAO ON

MATERIALS-RELATED ISSUES

Report	Date	Report Number
U.S. Actions Needed to Cope with Commodity Shortages	4/29/74	ID-74-37
Modernization of 1872 Mining Law Needed To Encourage Domestic Mineral Production, Protect the Environment, and Improve Public Land Management	7/25/74	RED-74-246
Stockpile Objectives of Strategic and Critical Materials Should Be Reconsidered Because of Shortages	3/11/75	LCD-74-440
Federal Materials Research and Development: Modernizing Institutions and Management	12/2/75	OSP-76-9
U.S. Dependence on Imports of Five Critical Minerals: Implications and Policy Alternatives	1/29/76	ID-75-82
Impact of Shortages of Processed Materials on Programs of Vital National Interest	4/2/76	PSAD-76-93
Policies and Programs Being Developed to Expand Procurement of Products Containing Recycled Materials	5/18/76	PSAD-76-139

Acreage Limitation on Mineral Leases Are Not Effective	6/24/76	RED-76-117
Need to Develop a National Nonfuel Minerals Policy	7/2/76	RED-76-86
The Fifth International Tin Agreement--Issues and Possible Implications	8/30/76	ID-76-64
Deep Ocean Mining Environmental Study--Information and Issues	9/21/76	PSAD-76-135
How to Improve U.S. Forest Service Reports on Forest Resources	2/23/77	PAD-77-29
Implementation of Economic Sanctions Against Rhodesia	4/20/77	ID-77-27
Letter Report to Assistant to the President for National Security Affairs, Concerning the Early Results of our Review of the Strategic and Critical Materials Stockpile	9/9/77	EMD-77-68
Additional Precious Metals Can Be Recovered (to the Secretary of Defense and the Administrator of General Services)	12/28/77	LCD-77-228
Timber Harvest Levels for National Forests--How Good Are They?	1/24/78	CED-78-15
Deep Ocean Mining--Actions Needed to Make It Happen	6/28/78	PSAD-77-127
Management of Federal Materials Research Should Be Improved	7/14/78	EMD-78-41

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The Department of the Interior's Computerized Resources Information Bank	7/17/78	EMD-78-17
The Department of the Interior's Minerals Availability System	7/17/78	EMD-78-16
Strategic and Critical Materials Stockpile Will Be Deficient for Many Years	7/27/78	EMD-78-82
Interior's Programs for Assessing Mineral Resources on Federal Lands Need Improvements and Acceleration	7/27/78	EMD-78-83
16 Air and Water Pollution Issues Facing the Nation	10/11/78	CED-78-148 (A,B,& C)
Projected Timber Scarcities on the Pacific Northwest: A Critique of 11 Studies	12/12/78	EMD-79-5
Mining Law Reform and Balanced Resource Management	2/27/79	EMD-78-93
Learning to Look Ahead: The Need for a National Materials Policy and Planning Process		EMD-79-30
Unique Helium Resources Are Wasting: A New Conservation Policy Is Needed	3/07/79	EMD-78-98

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