Implementation Plan for a National Materials and Minerals Policy, Research and Development Program

December 1981

DRAFT

that the lead responsibility for executing this plan will be assigned to the Department of the Interior, supported by the Departments of Defense and Commerce. The Assistant Secretary for Energy and Minerals will act as Coordinating Group Chairman. Assistant Secretaries from the Departments of Defense and Commerce will serve as members on the three-member Coordinating Group. Representatives from the Department of Energy, State, and others listed in Section 7.6 will be asked to participate in Coordinating Group activities. An organization chart for the national program is shown in Figure 1.

To implement tne previously defined strategy, the National Materials and Minerals Program is divided into five major program areas:

1. National Management Overview
2. Policy and Legislative Recommendations
3. Materials and Minerals Characterization
4. Supply and Demand Analysis, and
5. Technical Investigations.

Accomplishment of these tasks will lead to the establishment of a consistent national materials policy that is supported by accurate data and a broad base of technological information concerning exploration, resources, production, materials properties, conservation, and stockpiling. The program areas are discussed in Section 8 of this document; the work breakdown structure is shown in Figure 2.

A preliminary milestone schedule, presented in Figure 3, outlines a six-year program. Detailed milestones and deliverables will be developed in the first year of the program. It is expected that the majority of the policy and legislative issues will be addressed in the early stages of the program. Research and development efforts may continue past the sixth year.

A preliminary budget of approximately $3.6 billion in constant dollars over six years is estimated (Table 3). It should be noted that the largest single budget item is for technical research and development investigations.

If the program is initiated, both the schedule and budget will receive further refinement during the first year, and annually thereafter.

This plan, adequately supported and funded, will result in an effective program, one which will enhance the industrial and economic security and independence of the United States.

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1. INTRODUCTION

It is widely recognized that the United States currently lacks domestic resources from which to produce, in the necessary quantities, certain materials and minerals that are essential to its national security, industrial base, and economic well-being. This situation and the lack of an implemented governmental policy have been addressed in various pieces of legislation either passed or being considered by the Congress.

This plan, developed by several agencies, defines the organization, strategy, and technological programs needed to address the essential materials problem and is designed to rapidly implement programs to resolve or alleviate these problems. The plan complies with the requirements of Public Law 96-479, the National Materials and Minerals Policy, Research and Development Act of 1980, and is structured to accommodate other legislative initiatives now pending.

2. DEFINITION

As used in this plan, "essential materials" means materials, including minerals, of current or potential use that will be needed to supply the industrial, military, and essential civilian needs of the United States in the production of goods and services. Included are those which are primarily imported or for which there is a prospect of shortages or uncertain supply. Also included are those materials which present technological opportunities for the development of new resources, production techniques, material technologies, and means of recycling and conservation. Food and fuels, used as such, are excluded.

3. STATEMENT OF PROBLEM

At present the United States imports more than 75% of its national needs of 14 materials. Such import reliance leaves the United States vulnerable to external forces that can have adverse effects on our economy and national security. For some materials, the United States nas no major deposits within its national boundaries, forcing the country to import materials to satisfy national needs. At the same time that the domestic demand for essential materials is increasing, foreign demand and competition for world-wide reserves and supplies are increasing.

The problem of increasing vulnerability caused by dwindling supplies and increasing import reliance is further compounded by the lack of a coherent and workable national materials and minerals program, despite the many previous attempts to formulate one. Also, our technological base for solving essential materials problems is diminishing because of foreign acquisition and lack of economic incentives. Because of these factors and market instabilities, United States industry alone is unable to insure an adequate and stable supply of the essential materials and minerals.

4. BACKGROUND

The need for a national materials policy, research, and development plan has long been recognized. Approximately 25 major studies and reports have endorsed the need for such a national policy. The major studies conducted provide certain general recommendations. These include efforts to:

(1) Establisn improved mechanisms for coordination of federal materials-related policies, programs, and decisions;

(2) Strengthen federally sponsored materials-related research and development (R&D) programs;

(3) More effectively use federal lands for resource production;

(4) Improve collection, analysis, processing, and dissemination of materials-related information; and

(5) Conduct comprehensive and long-range analyses of patterns of materials use.

While the need has been recognized, interest in the subject has been intermittent and, within the government, associated with international events which threatened our national security.

During the Arab oil embargo of 1973, concern about materials supplies grew. A number of Congressional hearings were held and Congress passed an act to establish a National Commission on Supplies and Shortages. When the Commission issued its final report in 1976, the perceived threat of materials supply interdiction was much reduced. Thus, like its predecessors, this report had no major effect on national policy.

The most recent resurgence of interest in the security of materials supplies was stimulated to a large extent by the actions of the U.S.S.R.

and Cuba in southern Africa. Many minerals essential to the United States are imported from Zaire, Zambia, Zimbabwe, and the Union of South Africa.

Congress has, over the years, passed legislation which was motivated by concern about materials supplies. These laws have not, however, resulted in a coherent set of interrelated policies, institutional structures, and programs. A summary of these laws and pending legislation is contained in Appendix A.

This plan outlines a program for developing a coordinated policy, organization, and a research and development effort to insure an adequate and stable supply of materials and minerals for the United States.

5. OBJECTIVE

The overall objective of this plan is to implement a program to ensure an adequate and stable supply of essential materials and minerals necessary to maintain national security, economic well-being, and industrial production.

Specific objectives of this implementation plan are:

(1) To bring about the development and implementation of a national minerals and materials policy for a secure and continued supply of essential minerals and materials;

(2) To encourage development of economically sound and stable domestic mining, minerals, and materials industries;

(3) To encourage the orderly development of domestic mineral and material resources;

(4) To improve on methods for exploration and development of public lands for minerals;

(5) To strengthen essential mineral data collection and analysis;

(6) To support research and development to provide for:

(a) Advanced science and technology for the exploration, discovery, and recovery of essential nonfuel materials.

(b) Enhanced methods and/or processes for more efficient production of essential materials,

(c) Development of technology for substitution, recycling, and conservation of essential minerals and materials,

(d) Improvement of methods for extraction, processing, use, recovery, and recycling of materials which encourage the conservation of materials, energy, and the environment,

(e) Improvement of understanding of current and new materials performance, processing, substitution, and adaptability in engineering designs;

(7) To provide for improved collection, analysis, and dissemination of scientific, technical, and economic material information.

6. STRATEGY

To accomplish the objectives, a well-coordinated, multifaceted plan is required which addresses a comprehensive range of foreign and domestic political, socioeconomic, and technological issues dealing with the material cycle.[a] The primary emphasis of the plan is technological.

Effective implementation of this plan requires the expeditious creation of a nationally recognized coordinating group and the continuing participation and cooperation of federal agencies, technical laboratories, state agencies, industry, and universities.

The near-term strategy of the program is to identify and rank, using existing data, essential materials. To ensure early results, work will be initiated on previously recognized and well-identified problems. Throughout the near-term, existing work on materials problems will be continued and integrated, supplemented, or consolidated.

The long-term strategy is to develop a stable and continuing framework for dealing with materials issues. When established, the framework will provide for:

(1) National coordination, monitoring, consulting, and planning,

(2) Recommendations for foreign and domestic policy and legislation,

(3) Characterization and periodic reassessment of materials issues including supply and demand,

(4) Anticipation of new material requirements (usages, technologies, etc.,) to forestall the development of a supply problem,

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a. For each essential material, the components of the material cycle are: exploration--mining--ore processing--materials processing--use--recovery/recycle--disposal.

(5) Recommendations for the application of available technical solutions and sponsorship of necessary research and development,

(6) Facilitation of information exchange between government and private sectors.

7. ORGANIZATION

The administrative organization for implementing this plan is described in detail below, under appropriate subheadings. The overall organizational structure is shown in Figure 1. The proposed organizations responsible for program activities within the work scope are identified in Table 1, in Section 8.

7.1 Department of the Interior

It is assumed the Department of the Interior will, by executive order, be designated the lead agency for all matters of R&D and policy regarding essential materials. It is further assumed that the Secretary of the Interior will be responsible for initially establishing the Materials and Minerals Coordinating Group and maintaining a management overview of its activities. The Assistant Secretary for Energy and Minerals will be designated as the Chairman of the Coordinating Group.

7.2 Department of Defense

It is recognized that the Department of Defense has significant materials-related programs in progress. To assure the proper coordination of these programs and that defense needs are met, an Assistant Secretary from the Department of Defense will serve as a member of the Materials and Minerals Coordinating Group.

7.3 Department of Commerce

An Assistant Secretary from the Department of Commerce will serve as a member of the Materials and Minerals Coordinating Group.

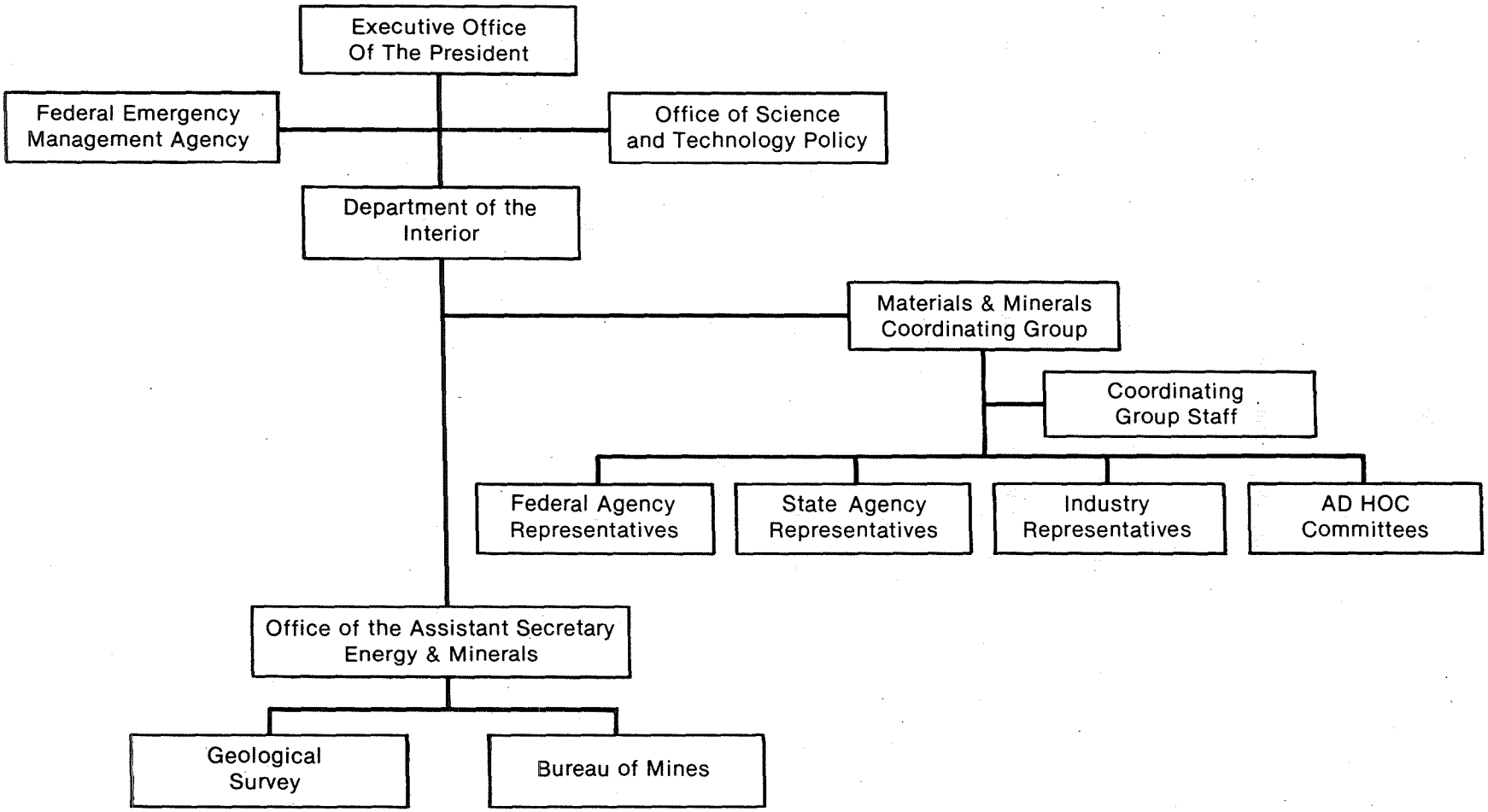


Figure 1 Organization Chart

7.4 Office of Management and Budget

The Office of Management and Budget will assist in the long-range planning and administration, and will be represented by participation in the Materials and Minerals Coordinating Group.

7.5 Other Federal Departments, Agencies, and Offices

It is anticipated that all other federal departments, agencies, and offices with essential-materials-related interests will be involved in an advisory capacity by providing members and information to the Coordinating Group and ad hoc committees. However, the Coordinating Group will direct the implementation of the plan by recommending programs and appropriate funding for specific departments. The departments, agencies, and offices, in turn, may carry out their assignments through internal resources, technical laboratories, government contractors, direct contracts, or subcontracts. The Federal Emergency Management Agency will retain its responsibilities, e.g., the management of defense stockpiles.

7.6 Materials and Minerals Coordinating Group

The Materials and Minerals Coordinating Group, to be established within the Secretary of the Interior's office, will be comprised of three members. The Chairman will be the Assistant Secretary for Energy and Minerals from the Department of the Interior. The additional members will be Assistant Secretaries from the Departments of Defense and Commerce, as designated by the Secretaries of their respective agencies. This Group could be integrated into an office within the executive office of the President if such an office is authorized by the President.

An Executive Director, appointed by the Group, will be chief administrator and program manager for the Coordinating Group Staff. The Director will be authorized to employ not more than twelve compensated employees to assist the Group.

The Chairman of the Coordinating Group will solicit the support of other federal agencies, state agencies, industry representatives, and ad hoc committees in carrying out his duties. Representatives from the following federal agencies will be requested to participate in Coordinating Group meetings:

Central Intelligence Agency
Department of Commerce
Department of Defense
Department of Energy
Department of the Interior
Department of State
Department of the Treasury
Environmental Protection Agency
Federal Emergency Management Agency
National Academy of Science (Materials Advisory Board)
National Aeronautics and Space Administration
National Science Foundation
National Security Council
Office of Management and Budget
Office of Science and Technology Policy
Office of Technology Assessment

Representatives from state agencies, industry, and academia may be requested to participate in workshops held by the Coordinating Group or called upon to consult on specific R&D and/or policy issues. Ad hoc committees will be formed by the Coordinating Group to study specific R&D and policy issues.

The responsibilities and authority of the Coordinating Group and the Executive Director are listed in Appendix B.

7.7 Ad Hoc Committees

The ad hoc committees formed by the Coordinating Group will report to the Group. These committees shall consist of members from federal

agencies, state agencies, academia, industry, and technical laboratories.

The ad hoc committees will be responsible for advising the Coordinating Group on specific technical and policy issues and shall be assigned tasks as the Group deems necessary and appropriate.

As a minimum, ad hoc committees will be formed to analyze the following essential materials issues:

(1) Domestic policy
(2) Foreign policy
(3) Legislative recommendations
(4) Identification and ranking of essential materials
(5) Economic impacts
(6) Evaluation of R&D needs.

7.8 State Agencies

Appropriate state resource agencies will provide membership to the Coordinating Group and ad hoc committees. They will provide information on various materials, minerals, and related programs as appropriate, and may be commissioned through the various Departments of the federal government to execute a project or program on either a cost sharing or subcontractual basis.

7.9 Technical Laboratories for Science and Engineering

Technical laboratories, in addition to providing membership to the ad hoc committees, will be utilized as action agents on assigned programs.

7.10 Industry

Industry, individually and through professional associations, will be requested to provide both information and personnel to the Coordinating Group and the ad hoc committees, and will be eligible to compete for

projects of the National Materials and Mineral Program on a contract/ subcontract basis.

7.11 Academic Organizations

Knowledgeable academic personnel may be asked to serve on the ad hoc committees, and both private and public universities may be commissioned to execute projects of various programs on a subcontract basis.

8. WORK SCOPE

To implement the strategies defined in Section 6, the National Materials and Minerals Program is divided into five major program areas. The work breakdown structure for the overall program is shown in Figure 2. The major program areas are:

(1) National Management Overview
(2) Policy and Legislative Recommendations
(3) Materials and Minerals Characterization
(4) Supply and Demand Analysis, and
(5) Technical Investigations.

Table 1 identifies the proposed organization responsible for the accomplishment of each program activity identified in Figure 2.

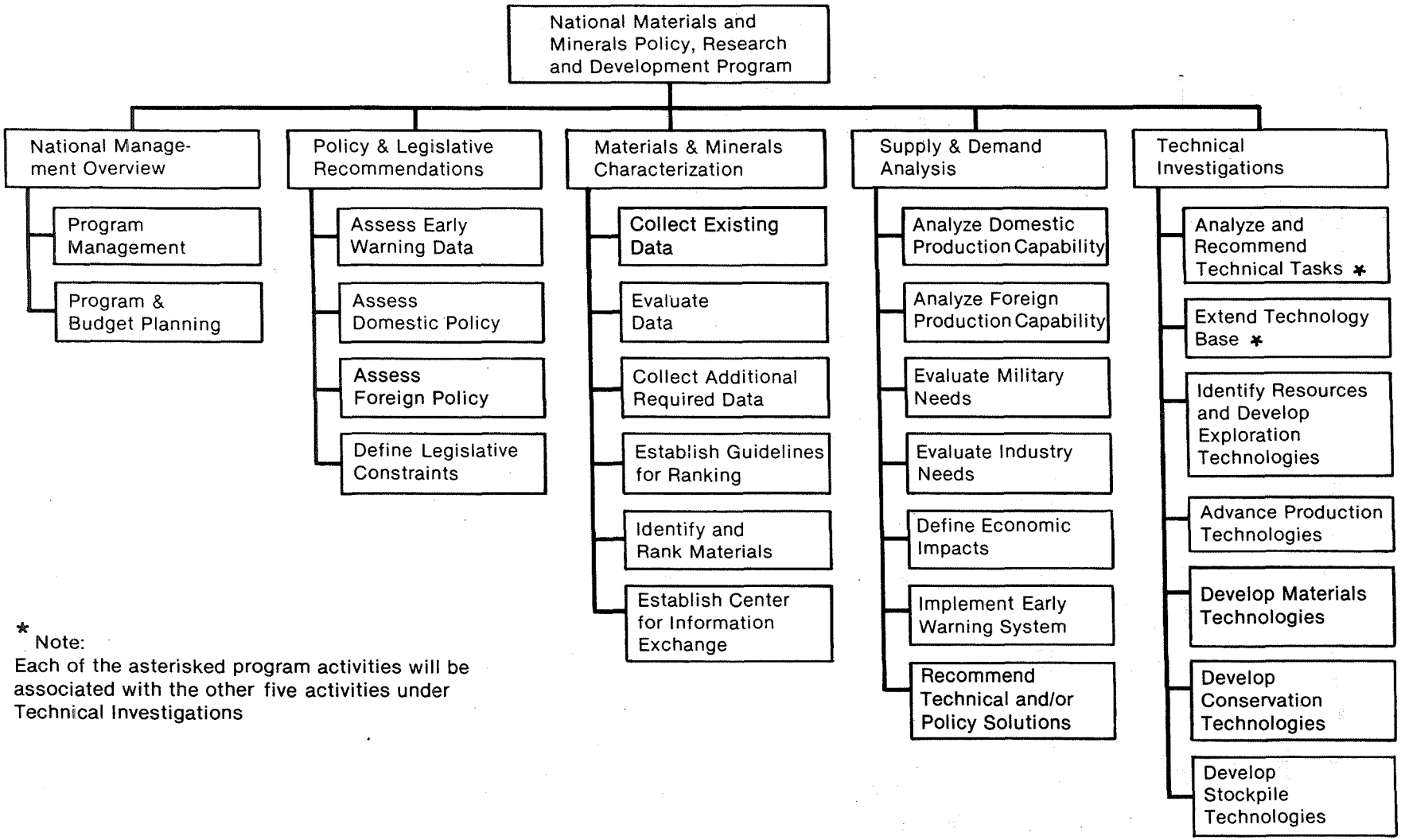
Descriptions of the objective and program activities of each major program area are contained in the following sections.

8.1 National Management Overview

8.1.1 Introduction

Numerous government and private sector organizations support materials and minerals research and development activities. The actions and needs of these entities must be coordinated to encourage cross-agency and public/private sector exchange of data and plans. Coordination would also aid in avoiding duplication of effort. While the need for coordination is acknowledged, it is also recognized that research and development is more effective if carried out in close relationship to the industry or government agency most concerned with the specific application. It is not the intent of this plan to modify that policy.

Similarly, domestic and foreign policy, and legislative recommendations must be coordinated to meet a wide spectrum of national needs. Therefore, a National Management Overview activity is required to



* Note:
Each of the asterisked program activities will be associated with the other five activities under Technical Investigations

Figure 2 Work Breakdown Structure

TABLE 1. ORGANIZATION RESPONSIBILITIES

Materials and Minerals Coordinating Group

- Program Management
- Program and Budget Planning
- Assess Early Warning Data
- Assess Domestic Policy
- Assess Foreign Policy
- Define Legislative Constraints
- Recommend Technical and/or Policy Solutions

Federal Emergency Management Agency

- Develop Stockpile Technologies

Department of Defense

- Evaluate Military Needs
- Develop Materials Technologies[a]

Department of Commerce

- Evaluate Industry Needs
- Define Economic Impacts
- Establish Center for Information Exchange
- Implement Early Warning System

Office of Management and Budget

- Long range planning and administration

Department of The Interior

- Collect Existing Data
- Evaluate Data
- Collect Additional Required Data
- Establish Guidelines for Ranking
- Identify and Rank Materials
- Analyze and Recommend Technical Tasks
- Extend Technology Base
- Identify Resources and Develop Exploration Technologies
- Advance Production Technologies
- Develop Materials Technologies[b]
- Develop Conservation Technologies
- Analyze Domestic Production Capability
- Analyze Foreign Production Capability

a. Applicable to military needs.
b. Applicable to industrial needs.

coordinate, monitor, and plan a national policy and research and development effort for essential materials and minerals.

8.1.2 Objective

The objective of the National Management Overview program area is to provide the necessary framework for coordinating, monitoring, and planning the National Program.

8.1.3 Program Activities

8.1.3.1 Program Management. This program activity will provide the basis for the establishment of the Materials and Minerals Coordinating Group and Staff described in Section 7. This organization will carry out the responsibilities listed in Appendix B. Key tasks will be to review and monitor the various programs of the federal government. Consultation with industry and other private sector interests will be a continuing process. The various program activities will be coordinated in such a manner as to lead to the formulation of a coherent essential materials and minerals policy, and research and development program. As part of this program activity, a biennial report providing a domestic inventory of essential resources with projections on the prospective needs of government and industry will be issued.

8.1.3.2 Program and Budget Planning. A primary activity of the Management Overview area will be the yearly update of this implementation plan. Changes in the national and international essential materials situation, and results of R&D programs, will require this periodic reassessment of program objectives and specific activities. To insure program continuity and effective direction, a yearly update of the program plan is required.

In addition, the materials and minerals research and development authorization requests and budgets of all federal agencies and departments will be reviewed annually. The review will be conducted in cooperation with the Executive Office of the President. Recommendations will be made

to the Office of Management and Budget to provide the budgets required to conduct a viable national program.

8.2 Policy and Legislative Recommendations

8.2.1 Introduction

To promote effective and necessary legislation and policy decisions, careful assessment of current laws and policies must be completed. Data from other program areas will be integrated to assure that policies and legislation proposed are timely, necessary and effective. This program area will have the responsibility of analyzing existing legislation and policy in light of their original intent and the effect they have on essential materials supplies. Recommendations will be made based upon domestic and international requirements, political considerations, economic factors, trade agreements, and other factors relating to supplies. These assessments will be continually updated to assure the desired results.

8.2.2 Objective

The objectives of the Policy and Legislative Recommendations program area are to assess: data from the Early Warning System, domestic policy, foreign policy, and constraints imposed by current laws; and to recommend legislative action or policy decisions.

8.2.3 Program Activities

8.2.3.1 Assess Early Warning Data. After the establishment of an Early Warning System (see 8.4.3.6) which will continuously monitor the conditions of the worldwide markets and supplies of essential materials, the information from that system will be assessed and used to make policy recommendations. This assessment will assure that appropriate criteria are being used, that the data are received in a timely manner, that shortfalls in supply are being projected, and that legislative and policy organizations are alerted before critical shortages develop.

8.2.3.2 Assess Domestic Policy. All aspects of the essential materials problem are affected by policies and policy decisions of a variety of agencies, departments and organizations within the government. This program activity will review the policies of the governmental bodies which relate to exploration, mining, extraction, metallurgy, recycling, conservation, environmental concerns and disposal of essential materials. The effort will include careful analysis of the effects that current policies have on supply. Recommendations for suspension of policies which interfere with the program objectives or for new policies to improve th U.S. position will be made.

8.2.3.3 Assess Foreign Policy. The effects of U.S. foreign policy on essential materials supply will be analyzed with respect to material sources, stability of supplying countries, effect of other world powers on supplies, exchange programs, international trade and related factors. U.S. foreign policy changes or initiatives will be recommended in order to encourage cooperative R&D programs and long-range trade commitments with other nations, and assure U.S. supplies. Based on these assessments of foreign policy, stockpiling programs may be recommended to the Federal Emergency Management Agency.

8.2.3.4 Define Legislative Constraints. A large number of federal, state, and local laws and ordinances have direct and indirect bearing on the economics and legality of domestic production of essential materials. These include wilderness acts, environmental regulations, price control, plant siting restrictions, and many others. The existing acts will be reviewed and effects weighed against the original legislative intent. Recommendations will be made to consolidate current laws and propose either amendments or new legislation, at appropriate levels, to facilitate increased domestic production.

8.3 Materials and Minerals Characterization

8.3.1 Introduction

In order to effectively define and coordinate policy, research, analysis, and management tasks, the information which exists pertaining to all aspects of the essential materials must be collected, assimilated and then disseminated to the organizations responsible for decision making and management of the various program areas and program activities. This program area includes data collection, updating, evaluation and dissemination. Work in this area will also involve priority ranking of the essential materials, so as to establish the most important factors relating to essentiality. From these results, solutions to the most critical problems can be logically attained.

8.3.2 Objective

The objectives of the materials and minerals characterization program area are: to review and evaluate existing data on essential materials, collect new data if necessary, prioritize the materials and technical problem areas and establish a center for information exchange and dissemination.

8.3.3 Program Activities

8.3.3.1 Collect Existing Data. Existing data available in the Departments of Interior, Commerce, and Defense, other government agencies, industry and academia that pertain to essential materials will be reviewed. A preliminary list and ranking of essential materials will be developed. Based on this preliminary list, an inventory of available data for each material will be compiled. Data sources to be included are:

(1) geochemical and geophysical surveys, identified geographically, for each material;

(2) pertinent references concerning economic geology, both domestic and foreign, for each material;

(3) pertinent references concerning mining methods used to produce domestic resources of each material;

(4) pertinent references concerning pyrometallurgy and hydrometallurgy of each material;

(5) pertinent references concerning production and materials technologies;

(6) pertinent references concerning conservation and recycling techniques.

Results of the data inventory will be compiled in a bibliography for each material. This volume will contain a section for each discipline listed above.

8.3.3.2 Evaluate Data. The data collected for each material from the various agencies will be integrated and evaluated for completeness, consistency and compatibility, and will become the basic data set for use in the determination of the material ranking. These data may be stored in a computerized data bank. As new data become available, they will also be evaluated and incorporated into the data bank.

8.3.3.3 Collect Additional Required Data. If sufficient data are not available for specific essential materials, additional data may be collected. The exact scope of this activity will be determined on the basis of programmatic requirements.

8.3.3.4 Establish Guidelines for Ranking. Objective means of evaluating the overall national and international importance of each material will be developed so that the most productive lines of research can be identified and appropriate priorities assigned. Factors to be considered include:

(1) importance to defense
(2) importance to industry and commerce
(3) extent to which the material can be replaced
(4) extent of domestic requirements by usage
(5) dependence on foreign imports
(6) political stability of foreign import sources.

8.3.3.5 Identify and Rank Materials. The previously collected and evaluated data will be utilized to identify and rank essential materials in accordance with the guidelines. A report will be issued that summarizes the work accomplished in the Materials and Minerals Characterization program area. The report will include an overview and evaluation of the data, criteria for establishing the ranking guidelines, and the ranking process itself. Annual updates of this report will be published.

8.3.3.6 Establish Center for Information Exchange. The Essential Materials Information Center will be established to act as a repository for materials data. It will be the clearinghouse for the collection, compilation, and dissemination of data to interested parties (governmental, academic, and private). Information gathered from all program areas will be assembled for use by program managers for the effective guidance of the program.

8.4 Supply and Demand Analysis

8.4.1 Introduction

A system to provide government and industry with the mechanism required to make long-range assessments of materials supply and demand is necessary. To implement an effective early warning system, detailed reviews of domestic and foreign production capability will be required. Data from existing programs and computer files will be used to the maximum extent practicable and updated as necessary to prepare a comprehensive supply analysis. Military and industrial needs will be assessed and integrated with the Early Warning System. Based on these analyses and

detailed reviews of specific essential materials issues, recommendations will be made for policy and/or technical program action.

8.4.2 Objectives

The objectives of the Supply and Demand Analysis program area are: to analyze domestic and foreign production capability, to evaluate industry and military needs, to define economic impacts, to implement an early warning system, and to recommend technical and or policy approaches to possible solutions.

8.4.3 Program Activities

8.4.3.1 Analyze Domestic Production Capability. Once the list of essential materials has been established, the current domestic availability of each must be determined as accurately as possible in the context of geologic, technical, economic, and legal/political parameters.

Production capabilities will be analyzed from the standpoint of known reserves as well as the physical plant capacity of existing ore processing and other facilities. Detailed, reliable data will be gathered, analyzed and stored. A computer data system will be used to permit analysis, retrieval, and periodic update of the data. The Bureau of Mines "Minerals Availability System" and similar data sources will be used and fully integrated into this analysis. Once established, the domestic production computer data bank will be updated on a yearly basis. Reports that summarize significant changes in production capability will be issued on an as-required basis.

8.4.3.2 Analyze Foreign Production Capability. An analysis similar to the domestic production capability activity will be conducted for the foreign sector. The results will be compiled in the same manner: updated on a yearly basis, and significant changes in foreign production capability reported. An additional report will assess the opportunities for the United States to promote cooperative multilateral and bilateral agreements

for materials development in foreign nations. The purpose of these agreements will be to increase the reliability of materials supplies to the United States.

8.4.3.3 Evaluate Military Needs. Availability data for specified materials from the domestic and foreign production capability activities will be integrated with demand data in an econometric model to determine whether production capacity is adequate to meet military needs.

Imbalances of supply and demand shall be examined, and annual availability curves constructed for each critical material. Analyses shall then be made to describe in detail the nature and magnitudes of the imbalances and the principal causes.

A separate report will assess the availability and adequacy of supply of technically trained personnel necessary for the proper conduct of defense-related materials programs.

In addition, a report will be issued that assesses the Defense Production Act of 1950 and the Strategic and Critical Materials Stockpiling Act. This report will be periodically updated to reflect the status of the national stockpile.

This program activity will be performed in conjunction with the evaluation of industry needs. The Department of Defense is responsible for this program activity and will accomplish it in coordination with other cognizant agencies.

8.4.3.4 Evaluate Industry Needs. An evaluation similar to the Military Needs activity will be conducted for the industrial sector; the results will be compiled in the same manner and updated on a yearly basis.

A separate report will assess the availability and adequacy of supply of technically trained personnel for industry-related materials programs. The Department of Commerce will be responsible for this program activity

and will accomplish it in conjunction with the evaluation of military needs and in coordination with other cognizant agencies.

8.4.3.5 Define Economic Impacts. The economic implications of essential materials will be evaluated. This evaluation will include analyses of broad generic implications to the overall national economy and specific price and supply/demand considerations for a particular material. Along with the national economic analyses, international analyses will be performed to measure balance of payments, competition, optimum resource allocation, and comparative advantages. The Department of Commerce will be responsible for this activity.

8.4.3.6 Implement Early Warning System. An Early Warning System covering essential materials and minerals will be established. The system will alert the government of any potential supply and demand imbalance that would significantly impact the national security of the United States and its economic and social well-being. The types of likely supply interruptions and the effects of drastic price increases and depletion of inventories will be highlighted in the comprehensive supply, demand, and economic analyses conducted for all selected essential materials. These analyses will be integrated into the Early Warning System. Key outputs of the system will be: Quarterly Summary Reports on essential materials issues and Special Bulletin Reports that will alert government and industry to significant changes in the status quo. The Early Warning System will be closely coordinated with the Essential Materials Information Center.

8.4.3.7 Recommend Technical and/or Policy Solutions. Essential materials problems can be resolved by technical or policy actions or a combination thereof. For each identified essential material an analysis will be performed to determine the specific reasons that the material is not found or produced domestically in sufficient quantities to meet projected needs. A full range of possible technical and/or policy solutions will be reviewed. A report that recommends specific technical and/or policy actions that should be implemented to mitigate supply shortages will be issued and updated as needed.

8.5 Technical Investigations

8.5.1 Introduction

Advances in science and technology, resulting from investment in R&D, can help alleviate future U.S. essential materials supply/demand problems directly, by increasing mineral supplies through mineral exploration, mining, processing, and recovery; and indirectly, by aiding conservation of essential materials through advances in minerals and materials processing, design, durability, performance, substitution and recycling.

Short-term efforts that utilize existing technologies will be aimed at alleviating identified near-term criticalities. However, to provide the nation with a long-range assessment and solution capability, and to allow for dynamics in the materials usage and changing technologies, this program area must be considered long-term.

8.5.2 Objectives

The objectives of this program area are to conduct material-specific technical investigations in R&D areas and thereby alleviate essential materials problems by advancing the state of the art. A broad range of solutions will be investigated to permit extension of the technology base, identification of new resources, development of exploration technologies, advancement of production techniques, and improvement in materials, conservation, and stockpile technologies.

8.5.3 Program Activities

8.5.3.1 Analyze and Recommend Technical Tasks. The technical solutions recommended as a result of the Supply and Demand Analysis will be generic in nature. In this analysis, each essential material will be reviewed, and detailed work plans prepared for R&D programs. The main R&D areas perceived as providing solutions are:

(1) Resource Identification and Exploration Technology Development
(2) Production Technologies
(3) Materials Technologies
(4) Conservation Technologies
(5) Stockpile Technologies

A flowchart, shown in Appendix C, will be used to assist in the design of a work plan. The work plan shall include recommendations for each material with respect to:

(1) Specific projects aimed at reducing the need for a particular material and developing satisfactory alternative materials. Existing technologies, where suitable, will be utilized. Research and development activities which are deemed necessary will be recommended.

(2) Proposed schedules for the recommended projects, indicating milestones and project durations.

(3) The responsible agencies/organizations to coordinate each of the recommended program activities.

(4) A projected total, as well as annual, program cost for that material investigation.

In cases where investigations of more than one technical area appear feasible, recommendations for each technical approach will be formulated. Priorities will be assigned by the Coordinating Group and recommendations for funding and execution will be made.

8.5.3.2 Extend Technology Base. Scientific investigations with broad applicability will be conducted in several areas including materials science, chemical science, engineering science, biological processes, geotechnical engineering, and computer technology.

a. Materials Science

Optimum solution of materials technology development will demand greater understanding of several fundamental aspects of materials science. Significant research areas include:

(1) alloy theory--the development of methodologies for understanding the role of alloying elements;

(2) alloy development--the development of fundamental quantified concepts of alloy design for application to computerized alloy design;

(3) rapidly solidified alloy technology;

(4) surface science--quantifying the difference between surface and bulk behavior of materials and identifying their effects on bonding mechanisms and material/environmental interactions;

(5) solid/wave (acoustic, UT, eddy current, etc.) interactions as a result of material structure and temperature;

(6) deformation processes (particularly superplasticity);

(7) composite toughness; and

(8) heat source and metal interactions--for optimization of welding technology and process metallurgy.

b. Chemical Science

Design of wet chemical processes for the recovery and reduction of essential elements from ores and waste streams requires basic chemical research in catalysis, ion exchange, and membrane chemistry. High temperature extractive processes require

chemical research in slags, electrowinning, and plasmas to advance the state of the art and to promote economical recovery and refinement with minimal material loss.

c. Engineering Sciences

In engineering sciences, the disciplines requiring fundamental research include fracture mechanics, electronics and instrumentation, and high temperature processes. Fracture mechanics advances are required for more effective design and extended-life analyses, particularly with composite and other materials with directional properties. Advances in instrumentation are required for more precise process control and nondestructive evaluation. Greater knowledge of high temperature processes such as plasma arc deposition and thermal properties can be applied to development of extractive pyrometallurgy processes and protective coatings for hard-facing, corrosion resistance, etc.

d. Biological Processes

Extending the technology base in biological processes useful to essential minerals recovery requires research in the mechanisms by which biological processes act and in improving the properties of organisms. Biological sorption to recover essential metals from solution and the chemistry of enzyme reactions with essential minerals require basic work. Selection, screening, and isolation of useful organisms requires extensive field and lab work. Amplification of the useful properties of organisms by adaptation, mutant genesis, and genetic engineering is basic to developing a broadened hydrobiological technology for essential minerals.

e. Geotechnical Engineering

Significant geotechnical research should be conducted relative to:

(1) predicting and/or determining porosity, permeability and fluid flow, in situ,

(2) development of better methods for determining shallow and deep in situ stresses,

(3) improvement in the ability to map fracture patterns, particularly major fractures and faults, at depth,

(4) improvement in the understanding of rock fragmentation processes for increasing the effectiveness of drilling the excavation systems,

(5) increasing the understanding of the relationship of laboratory-measured quantities to in situ conditions,

(6) providing the thermal-physical and thermal-mechanical properties of rock, including fractured rock, and

(7) measuring and modeling subterrestrial fluid flows.

f. Computer Technology

Areas where basic computer technology capability needs to be advanced on a broad basis include:

(1) alloy design, where the effect of changing a given alloy composition on mechanical properties, corrosion, etc., presents a multivariable problem;

(2) component design (another multivariable problem where it is necessary to optimize material properties, recyclability, mechanical design, inspectability, and economics);

(3) signal processing (i.e., the collection and evaluation of real-time signals resulting from various process control and advanced nondestructive evaluation techniques), and

(4) automation (utilizing computer technology to optimize real-time process automation and control).

8.5.3.3 Identify Resources and Develop Exploration Technologies. This program activity will consist of investigations to provide estimates of domestic resources of each essential material. From these investigations a more accurate inventory of both known reserves and potential resources will evolve. Although geologic deposits are of primary interest, less conventional or less extensive sources must also be considered.

Investigations will be conducted in systematic fashion to ensure that no geologic environment favorable for deposits has been overlooked. In addition, resource analysis will focus on identifying geologic environments favorable for currently subeconomic or uneconomic deposits of critical materials, which have received little or no attention from industry in the past. Nongeologic sources (slag piles, coal ash, fly ash, etc.) will also be included in this assessment, with a view to their exploitation.

Resource analysis will utilize data from the earlier characterization of materials and minerals, as well as new data obtained in geologic field investigations. Unevaluated or insufficiently evaluated terrane in the United States will be examined to delineate favorable geologic environments. Geologic characteristics of known deposits worldwide will be compiled and applied in the evaluations. Potential resource estimates will subsequently be made for favorable environments, utilizing a standardized analogy with environments that host known deposits. (See Appendix D for a more detailed work breakdown and schedule for this activity.)

Finally, resource analysis will include investigations to formulate new or modified occurrence models, which could lead to identification of additional geologic environments potentially favorable for deposits.

Where a search is instituted for additional or new supplies of critical materials, new exploration instruments or methods may be needed to detect deposits of essential materials in geologic environments different from those enclosing known deposits or in subsurface environments either deeply buried or masked by surficial deposits. Where voluminous data exist in national geoscience data files that may contain subtle indications of environments considered to be favorable for the deposition of essential materials, new data handling and evaluation techniques may be required to maximize the usefulness of the data. Where location of additional domestic essential materials resources is selected as an appropriate task, program efforts may involve any of the following: research and development programs that could result in improvements in analytical methods; exploration instruments, techniques and/or methods; new technology based on heretofore unexploited physical characteristics of the mineral deposits containing the critical materials; or advancement in data evaluation techniques.

8.5.3.4 Advance Production Technologies. Adequate resources of essential materials may be known to exist but may be uneconomical to produce in a free-trade environment. Such a condition could exist where the grade is too low; where mining costs due to excessive depths, size of deposits, geographic location, environmental constraints, or land owership may be prohibitively high; or where domestic demand is not sufficient to support an industrial extractive complex. Wherever appropriate, research and development programs in advanced mining, milling, refining, and/or advanced extractive ore dressing processes will be undertaken to elevate such deposits to economically feasible or competitive status by reducing constraint costs.

Solution or in situ mining is a method that can promote the economic mining of low grade ores, since there is no need to physically remove overburden or non ore-bearing rock. Solution mining is presently limited

to permeable ore deposits. Uranium, copper, and molybdenum are currently solution mined. Further advances in solution mining require research in the fields of geology, geochemistry, hydrology, and biohydrometallurgy. Advanced methods of rock fracturing will be required to make impermeable ore bodies permeable.

Many ores of essential minerals in North America are low grade or have complex chemistries and are not amenable to economic extraction by conventional techniques. Advancement in conventional techniques could assist in extraction of such minerals. Work in flotation chemistry and magnetic fluid separation needs to be continued and expanded to aid in this effort.

Biohydrometallurgical extraction is presently used for significant fractions of copper and uranium production. This technology should be applied to essential minerals. Research in the areas of extraction chemistry, organism selection, genetic engineering, and enzyme chemistry needs expansion. Research on novel pyrometallurgical techniques such as plasma arc reduction of ores should be expanded. Advanced electrowinning and membrane chemistry could be important in separation of essential metals and should be pursued.

8.5.3.5 Develop Materials Technologies. For many current applications of essential elements, it is technically feasible to develop materials with lower or no essential element content with properties equivalent to those of the currently used materials. This can be accomplished by development of:

(1) new metallic and nonmetallic materials based on nonessential elements and

(2) treatments (coating, surface modification, etc.) to existing materials to achieve the desired properties.

Alloy development will be pursued utilizing techniques based on more readily available (domestic) alloying elements (e.g., Fe-Al-Mn alloy

system, Mo/Ni-rich stainless steels, and alloys strengthened by intermetallic compounds). Efforts directed toward a fundamental understanding of alloying concepts and mechanisms, for application to future alloy development work, will be continued. Rapid solidification technology offers the potential of improved new alloys of high strength and oxidation resistance. Powder metallurgy techniques offer the potential of synthesizing new alloys by minimizing or preventing extensive segregation which results when such alloys are produced by conventional casting techniques. Current efforts toward the application of computers to alloy design will be expanded. A data bank will be developed on existing alloys and alloy substitution.

Surface treatments which allow the use of base metals containing low quantities of essential materials while retaining high resistance to wear, corrosion, and oxidation provide one means of significantly reducing essential element dependence. Ion implantation to produce surface alloys and coatings needs additional developmental work. Fine-grain or amorphous surface structures may be produced by rapid solidification technology (laser glazing). Surface chromium diffusion, and chemical vapor deposition and electroplating used in conjunction with laser glazing, can reduce alloy dependence. A fundamental understanding of surface/environment interactions is critical to the ability to evaluate environmental degradation and develop the most effective solutions.

Use of composite materials can result in weight savings and extended lifetimes in many applications. Organic composites, substituted for metals in low-temperature applications, save weight and permit down-sizing of support structures and propulsion systems, with associated reduction of essential materials usage. Metal/metal, metal/ceramic, and graphite/graphite composites have potential for high-temperature applications.

Ceramics offer a potential replacement for essential materials in both bulk and surface coating forms. Brittle mechanical behavior limits the application of ceramics in many areas. The development of enhanced durability ceramics for superalloy replacement needs emphasis. Research

and developmental work on spinels, fosterite, and dolomite, as potential replacements for chromium-dependent refractories, will be expanded.

The development of new material systems (alloys, composites, ceramics) will require the evaluation and development of new joining processes. Development work will be initiated on processes for joining of sections with treated surfaces and protective coatings, seeking processes which do not dilute or affect the surface characteristics of the coatings. Current work on nonweld bonding systems will be continued.

Fracture toughness is a very important consideration, both for the selection of alloys for any given application and for determining the suitability of a structural component for continued use. Fracture toughness studies of new alloys must be conducted and the effects of weld joints and thermal exposures on fracture toughness determined as part of the assessment of the alloy properties. Commensurate with fracture toughness testing is the use of fracture mechanics techniques to quantify environmental effects (stress-corrosion, hydrogen embrittlement, liquid-metal embrittlement, fatigue, and corrosion fatigue) on structural reliability.

Alternative alloys to those containing essential metals will require extensive testing to establish a data base permitting their use where applicable and certify their compliance with code requirements, e.g., the ASME Boiler and Pressure Vessel Code. Some tests are extremely long term, especially creep and corrosion testing. New alloys that could replace conventional alloys must be tested.

8.5.3.6 Develop Conservation Technologies. The reduction in essential materials demand which can be realized by the application of conservation measures is highly significant. Additional work to achieve reduction in process-generated scrap, improved design, extended lifetimes, and development of recyling technology is needed.

Process technology is the melting, refining, and alloying of metals. Some portion of the alloying elements added to molten metal is often lost

by oxidation and volatilization and to slag. Slag chemistry requires extensive research, and improvements in plasma melting, electroslag refining and other methods of arc melting are needed. Research into melting methods that would permit the use of contaminated scrap is required.

Material losses during primary metal-working operations must be reduced. Several complementary approaches need to be explored:

(1) In-process detection of defects to permit early removal and minimize scrap losses,

(2) Improved metal-working equipment (rod and bar mills),

(3) Ingot process changes (continuous casting, near-net-shape casting) to reduce need for breakdown.

The replacement of fabrication operations that generate large amounts of scrap with material-conservative operations is needed. Processes that need further development to meet that goal include chipless machining, investment and slush casting, hot isostatic processing, and zero-draft and isothermal forging. Also, a better understanding of superplasticity is needed to assist in development of these metal-working techniques.

Development and optimization of mechanical or automated weld processes will permit the use of narrow-gap weld designs, thereby allowing significant savings in filler metals during welding. The development of high-energy-beam autogenous weld processes will allow another order-of-magnitude improvement. Improved weld processes resulting in a decrease in weld repair frequency and subsequent component rejection will provide a measurable reduction in essential materials usage. Substitution of welded components for machined and mechanically fastened components offers the potential savings of significant amounts of material. Current developmental work in these areas will be continued and expanded.

The development and implementation of advanced nondestructive examination techniques will reduce in-process waste, improve product

reliability, extend useful lifetimes, and reduce the need for excess material bulk associated with design conservatism. Nondestructive techniques capable of use at high temperature need to be developed so that defects can be detected during hot working, corrective process adjustments applied, and the subject material repaired in a timely fashion if possible. Improved sensitivity for detecting, locating, and sizing defects will decrease design conservatism and thus promote the design of lighter structures and extend useful structural lifetimes. Similar benefits will be realized by the development of nondestructive techniques for determining material strength and toughness.

There is a need to develop advanced engineering design techniques and practices, possibly computer-assisted, which promote material conservation. Such techniques, used in concert with nondestructive examination and fracture mechanics, will help to optimize strength-to-weight ratios, extend useful lifetimes, and minimize design conservatism. For this purpose, a comprehensive and precise national data bank of material properties needs to be established.

Recycling is very important to the conservation of essential materials. New refining processes will be identified for reclaiming scarce alloying elements from superalloy scrap and for minimizing introduction of impurities from service-related contamination. New process technologies, and improved alloy selection and design criteria, are needed to reduce the buildup of residuals resulting from extensive recycling. Techniques for recovery of essential materials from process effluent streams need further development.

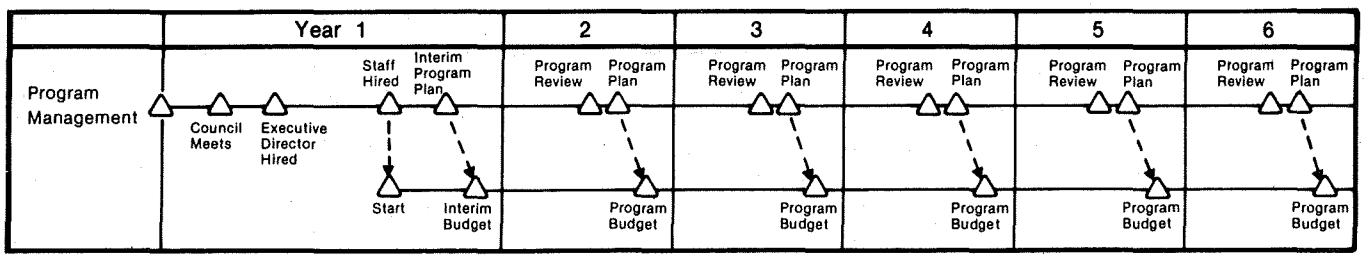
8.5.3.7 Develop Stockpile Technologies. Many of the materials currently in the national stockpile must be reprocessed to be useable. They may require conversion from the ore to the primary metal or alloy. Some may require refining for upgrade. Special refining and reprocessing techniques may be needed. The required process development activities will be addressed by this program.

9. SCHEDULE

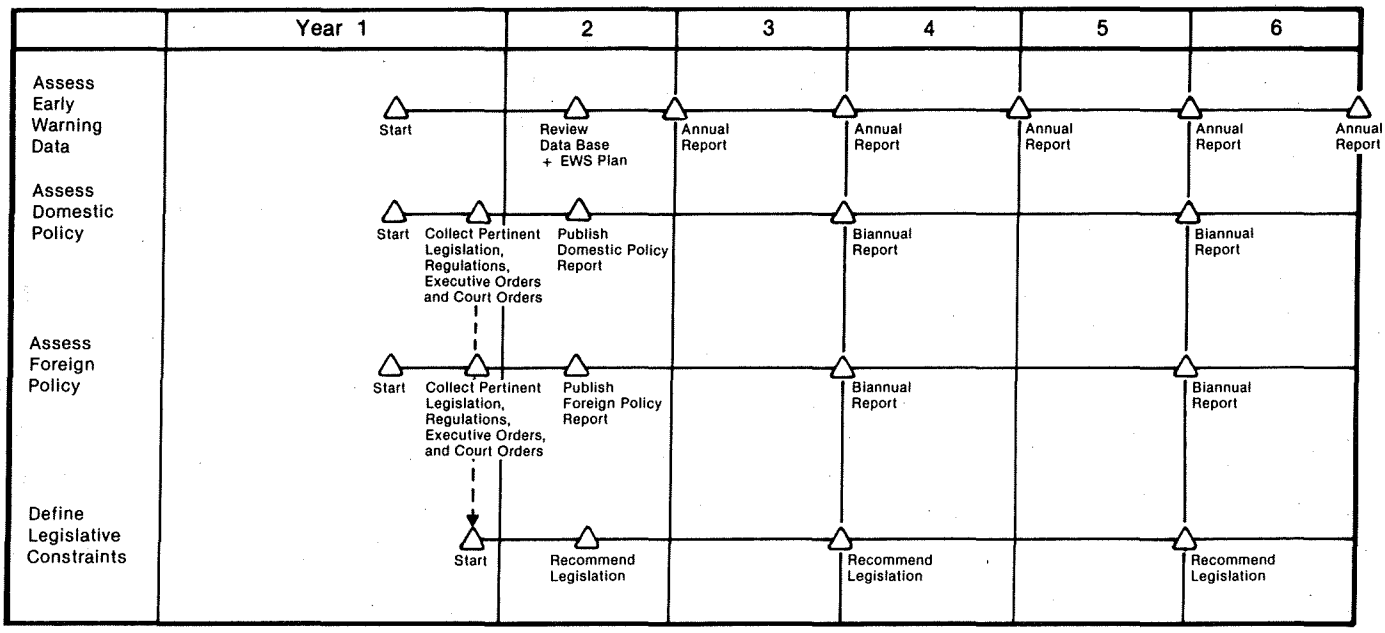
Figure 3 presents a preliminary schedule for the program. The majority of the policy and legislative mechanisms will be established in the initial activities of the program. It is expected that the research and development activities will extend beyond the sixth year.

Figure 3
Milestone Schedule

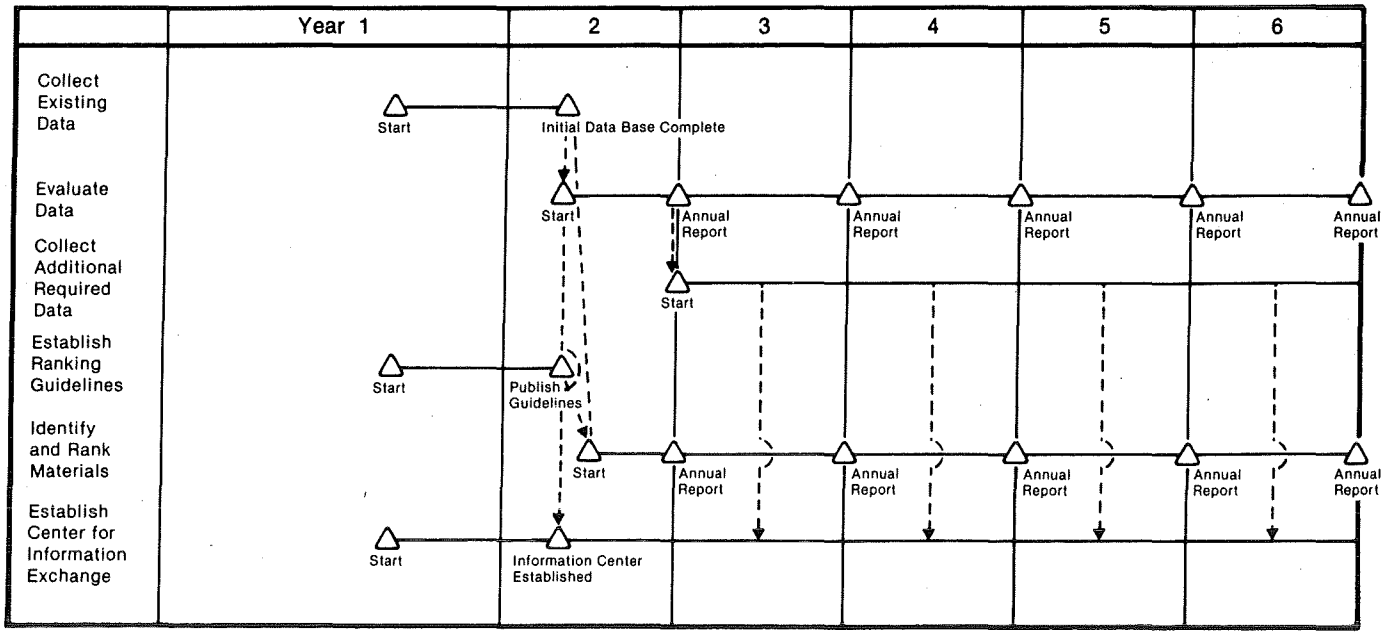
National Management Overview



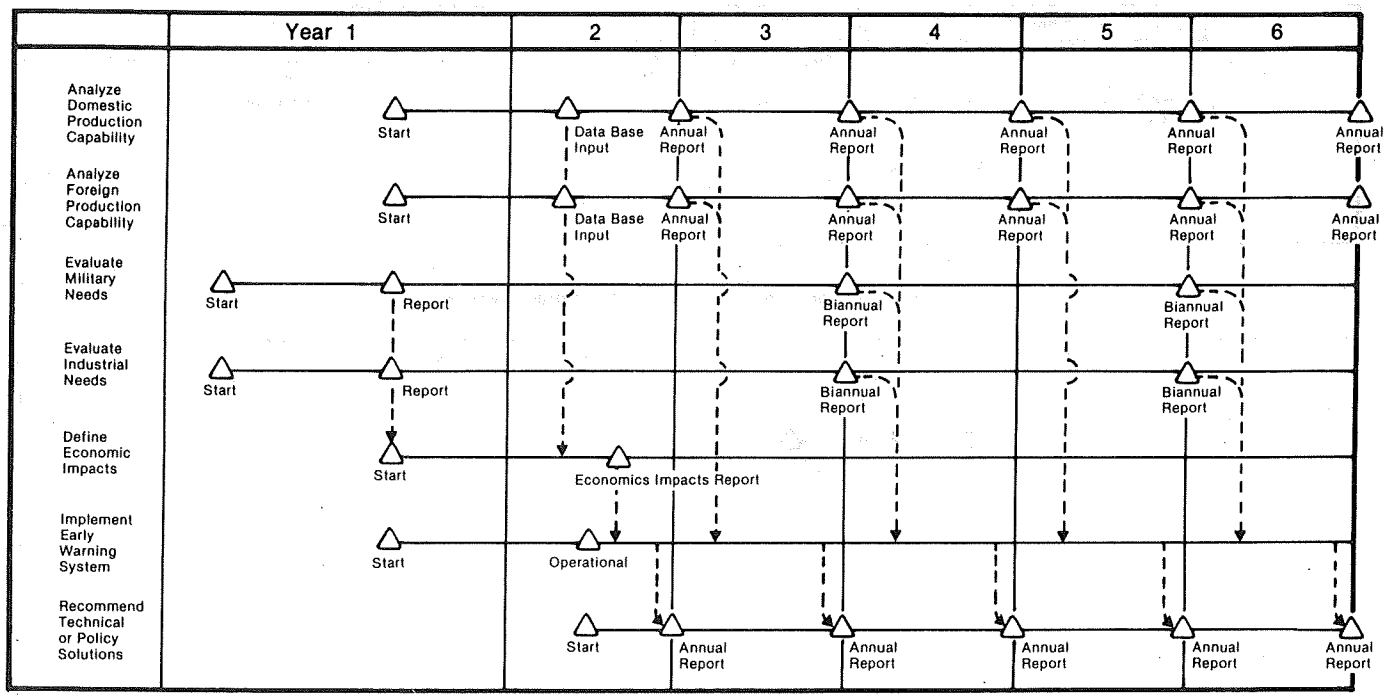
Policy and Legislative Recommendations



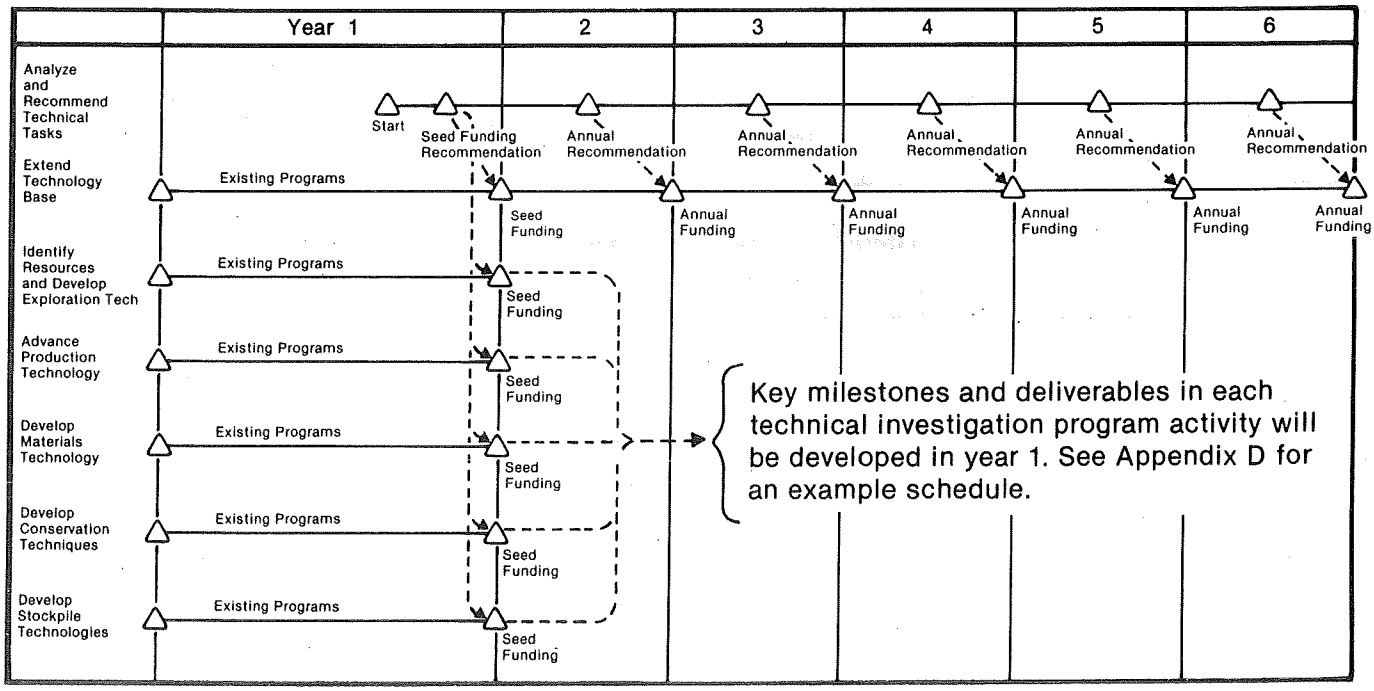
Materials and Minerals Characterization



Supply and Demand Analysis



Technical Investigations



10. BUDGET

Table 2 summarizes the preliminary program funding profile, in constant dollars, by program area. It can be seen that the major portion of the funding is allocated to the technological aspects of the program. This allocation reflects the need for a broad-based research and development effort to promote our self-sufficiency with respect to essential materials and minerals.

TABLE 2. PROGRAM BUDGET SUMMARY

	Year ($000's)						
	1	2	3	4	5	6	Total
National Management Overview	1,500	2,100	2,800	3,100	4,600	5,400	19,500
Policy and Legislative Recommendations	400	1,600	1,200	1,000	1,000	1,000	6,200
Materials & Minerals Characterization	3,700	7,900	5,300	5,200	5,200	5,200	32,500
Supply & Demand Analysis	1,700	3,400	2,400	2,400	2,400	2,400	14,700
SUBTOTAL	7,300	15,000	11,700	11,700	13,200	14,000	72,900
Technical Investigations	197,300	596,800	799,200	799,200	680,000	457,500	3,530,000
TOTAL	204,600	611,800	810,900	810,900	693,200	471,500	3,602,900

APPENDIX A

Public Law Summary

The history of the essential materials problem is reflected in the twenty or more material- or mineral-policy studies made over the years by government agencies and outside groups, and by the fact that many laws directly or indirectly affect production of nonfuel minerals, their movement in trade and, at times, their subsequent use, and as such constitute aspects of mineral policy.

A. Those laws that deal most directly with essential materials and minerals are reviewed below in chronological order.

1. Stockpiling Act of 1939

This Act was the first legislation directed toward the establishment of stockpiles of essential and critical materials for national defense. It also authorized exploration and development of domestic resources by the Department of the Interior.

2. Stockpiling Act of 1946

The legislative intent of this Act was to promote the acquisition of essential materials for a national stockpile through direct purchases, transfers of war surpluses, procurement through use of foreign counterpart funds from foreign aid programs, and barter of U.S. surplus agricultural commodities.

The second major purpose of the 1946 Act was to encourage development of sources of those materials within the U.S. by providing that the Secretary of the Interior, through the Directors of the Bureau of Mines and the Geological Survey, was authorized to "make scientific, technologic, and economic investigations concerning extent and mode of occurrence,

development, mining, preparation, treatment, and utilization of ores and other mineral substances" that are found in the U.S. and its territories or insular possessions, and which are essential for defense or industrial needs.

3. Defense Production Act of 1950

Title I of this Act, in response to the Korean War, provided specific authority for priorities and allocations. Title III of the Act provided broad authority for increasing materials supplies. Specifically, it provided for: loans or loan guarantees for exploration, development, and mining of essential or critical materials; purchases of or commitments to purchase metals, minerals, and other materials; encouragement of exploration, development, and mining of essential and critical materials; and the development of substitutes for essential and critical materials.

This Act is primary to the legislative history and future of essential materials. It has been amended greatly over the years (each amendment is a Public Law), and is due for a definitive review this year as stipulated in the National Materials and Minerals Policy Research and Development Act of 1980.

4. Mining and Minerals Policy Act of 1970

The purpose of this Act was to establish, for the first time, a "...broad, overall national minerals policy with particular emphasis on the need for an economically sound and stable mining and minerals industry." The Act is quite short and is basically a statement of principles and fundamental objectives. The responsibility for implementing the statement therein was to be that of the Secretary of the Interior.

5. Strategic and Critical Materials Stockpiling Revision Act of 1979

This Act reaffirms the need for stockpiling, conservation, and development of national resources. It specifies that the purpose of the stockpile is for national defense only, and is not to be used for economic or budgetary purposes.

6. National Materials and Minerals Policy Research and Development Act of 1980

This Act requires the President, in accordance with the provisions and requirements of the Mining and Minerals Policy Act of 1970, to submit a plan to implement a national policy. In addition, the Act recommends that the President shall coordinate the responsible Departments and Agencies and shall:

"...support basic and applied research and development to provide for (A) advanced technology for the exploration, discovery, and determination of nonfuel materials, (B) enhanced methods and processes for the use of renewable resources, (C) improved methods for the extraction, processing, recovery, and recycle of material which encourages the conservation of materials, energy, and the environment, and (D) improved understanding of new and current materials performance, processing, substitution, and adaptability in engineering designs; ...assess the need for technically trained personnel necessary for materials research and problem solving (A) by private corporations performing the same or related activities in materials industries and (B) by Federal and State institutions having shared interests or objectives."

B. Current Status of New Legislation

1. H.R. 3364. Rep. Santini et al.

This Bill attempts to remove barriers preventing pursuit of the recommendations made in the National Materials and Minerals Policy Research and Development Act of 1980. The purposes of the Bill are:

"...to encourage the development of economically sound and stable domestic mining, minerals, and materials industries,

to encourage the orderly development of domestic mineral and material resources,

to increase accessibility of public lands for mineral exploration and development,

to strengthen mineral data collection and analysis, and,

to promote and encourage research and development of technology for substitution, recycling, and conservation of essential minerals and materials."

Of particular interest for the purposes of this plan are these points: The Bureau of Mines is designated the principal federal agency for the handling of mineral data; the Bill provides for several types of land-use evaluations, including re-evaluation of all land-use plans developed under the Federal Land Policy and Management Act of 1976; the Bill mandates an inventory of lands withdrawn, restricted, or closed to mineral location and of lands made available for mineral location under this Act; the bill requires the Secretary of the Interior to review lands nominated by any persons to determine suitability for mineral location or leasing; and it extends the 31 December 1983 mining expiration date in the Wilderness Act to 31 December 1993.

This Bill is currently the subject of hearings in the Committee on Interior and Insular Affairs (29 October 1981). It is also scheduled for hearings in the Committees on Ways and Means, Judiciary, Armed Services, and Foreign Affairs.

2. H.R. 4281. Rep. Fuqua et al.

This Bill is referred to as the "Critical Materials Act of 1981." It establishes a 3-member Council on Critical Materials in the Executive Office of the President, to focus on materials and products rather than on mines and minerals as proposed by the Santini Bill. The Bill describes the Council and its responsibilities and authorities.

It is possible that this Bill might be combined with the Santini Bill.

APPENDIX B

Responsibilities and Authority

The responsibilities and authority of the Coordinating Group and the Executive Director are listed below:

A. Responsibilities

The responsibilities of the Coordinating Group are:

1. To assist and advise the Secretary of the Interior and, in turn, the President in establishing a coherent national materials policy consistent with other federal policies, and in carrying out activities necessary to implement such a policy;

2. To coordinate federal materials-related policies, programs, and research and development activities related to essential materials;

3. To review and appraise the various programs and activities of the federal government in accordance with the policy and directions given in the National Materials and Minerals Policy, Research and Development Act of 1980 and to determine the extent to which such programs and activities are contributing to the achievement of such policy and directions;

4. To formulate and recommend to the Secretary of the Interior and, in turn, the President, national policies designed to improve conditions affecting the essential minerals and materials needs and resources of the Nation, and to meet the social, economic, and national security goals of the Nation;

5. To advise the Secretary of the Interior and, in turn, the President, of minerals and materials trends, both domestic and foreign, the implications thereof to United States and world economies and to national security, and the probable effects of such trends on domestic industries;

6. To make or furnish such studies, analyses, reports, and recommendations with respect to matters of materials-related policy and legislation as the President may request;

7. To review annually the materials research and development authorization requests and budgets of all federal agencies and departments. In this activity the Coordinating Group shall, in cooperation with the Office of Science and Technology Policy, the Office of Management and Budget, and other federal offices and agencies deemed appropriate, ensure close coordination of the goals and directions of such programs with the policies as determined by the Coordinating Group; and

8. To assist the Office of Science and Technology Policy in the preparation of such long-range materials assessments and reports as may be required by the National Materials and Minerals Policy, Research and Development Act of 1980, and assist other federal entities in the preparation of analyses and reporting related to essential materials.

The responsibilities of the Executive Director of the Coordinating Group staff are:

1. To provide the professional and administrative staff and support for the Coordinating Group; and to implement its directives.

2. To assist the federal agencies and departments in appraising the effectiveness of existing and proposed facilities, programs, policies, and activities of the federal government, including research and development, which affect essential materials availability and needs;

3. To catalog, monitor, and evaluate the essential materials and materials-related research and development needs of the private and public sectors;

4. To initiate government and private studies and analyses designed to advance knowledge of essential materials issues and develop alternatives, including research and development, to resolve national essential materials problems;

5. To issue a biennial report providing a domestic inventory of essential resources with projections on the prospective needs of government and industry for these resources. This report will include a long-range assessment, prepared in conjunction with the Office of Science and Technology Policy in accordance with the National Materials and Minerals Policy, Research and Development Act of 1980 and in conjunction with such other government departments or agencies as may be considered necessary, of the prospective major essential materials problems which the United States is likely to confront in the near future and indicate how these problems may best be addressed. The first such report will be due within six months after implementation of this program.

6. To recommend to the Congress through the Secretary of the Interior such changes in the current policies, activities, and regulations of the federal government, and such legislation, as may be considered necessary to carry out the intent of the National Materials and Minerals Policy, Research and Development Act of 1980.

B. Authority

In carrying out the responsibilities assigned above, the Coordinating Group shall have the authority to:

1. Establish ad hoc committees consisting of federal, state, academia, and industry representatives,

2. Formulate and periodically update this national plan for execution by selected federal, state, academic, or industrial organizations,

3. Prescribe such rules and regulations as may be necessary for its operation,

4. Enter into contracts and acquire property necessary for its operation,

5. Request available information from private and public sources, and

6. Publish or arrange to publish nonproprietary essential materials information that it deems useful to the public and to private industry.

The Executive Director of the Coordinating Group staff shall have the authority to:

1. Employ a staff not to exceed twelve compensated employees to carry out the staff responsibilities,

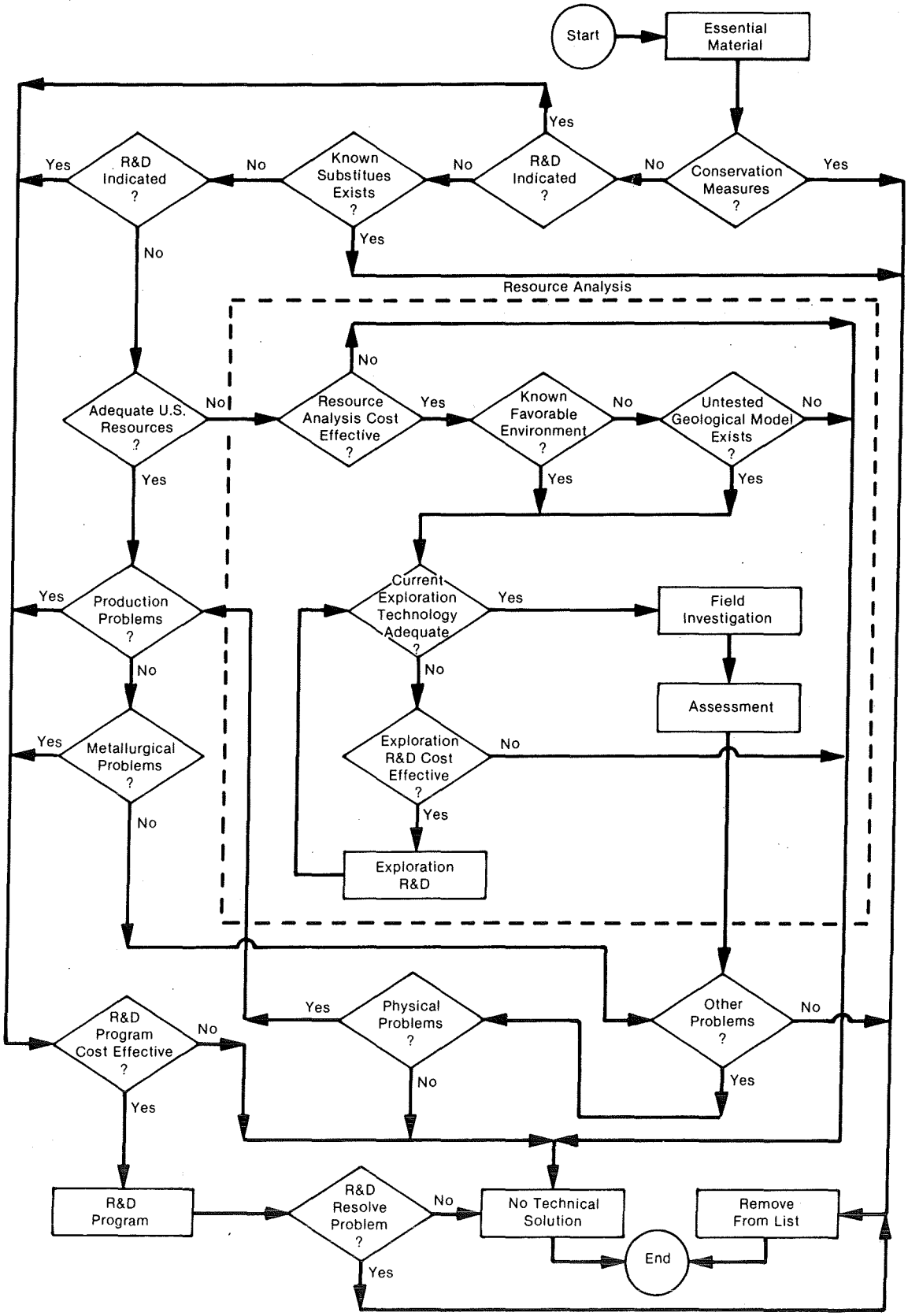
2. Obtain the services of consultants in accordance with the appropriate federal regulations, and

3. Develop rules and regulations necessary to carry out the National Materials and Minerals Policy, Research and Development Act of 1980 and other relevant legislation.

APPENDIX C

Simplified Flowchart for Essential Materials Studies

Appendix C
Simplified Flowchart for Essential Materials Studies



APPENDIX D

Detailed Tasks for Resource Identification Technical Activity

I. Compile Existing Data and Select Recognition Criteria.

A. Compile world-wide resource-occurrence data.

B. Develop a classification of occurrences for each commodity.

C. Select, develop, and analyze control areas for each occurrence class.

D. Develop recognition criteria for each occurrence class.

E. Develop exploration models for each occurrence class.

II. Select Target Areas

A. Obtain input from experts on U.S. areas likely to be analogous to occurrences described in I-B and I-D.

B. Screen and analyze existing geological, geophysical, and geochemical data to identify target areas.

C. Evaluate and assign priorities to selected target areas.

D. Determine need for additional data for each target area.

III. Collect and Analyze New Data, As Needed, For Target Areas

A. Conduct geochemical and/or geophysical surveys.

B. Interpret new survey data.

C. Perform geologic evaluations for each target area.

IV. Assess Resource Potential of Target Areas

A. Elicit data necessary to calculate resource potential.

B. Calculate endowment for each target area.

V. Conduct Supporting Technology Development Projects

As needs for new exploration technology are identified during Tasks I-IV, technology development projects will be planned and conducted in support of those tasks.

Schedule for Resource Identification Technical Activity