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A Program for the Environmental Assessment of Conventional Combustion Processes

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A Program for the Environmental Assessment of Conventional Combustion Processes

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ABSTRACT

Fossil fuels are now the nation's principal source of energy for industrial, commercial, and residential use. The conventional combustion of fossil fuels and their derivatives is likely to remain our primary means of obtaining useful energy for several decades. EPA has, since its inception, conducted research on the environmental effects of fossil fuel combustion. The three principal purposes of such research are (1) to assess the health and environmental effects caused by the release of combustion pollutants, (2) to define the need for technology to control the release of these pollutants, and (3) to develop standards to limit emissions.

In the past, much of EPA's environmental effects research has been performed in conjunction with control technology development. Recently, EPA has established a program to consolidate the several segments of its research on the environmental effects of pollutants from conventional combustion processes into a comprehensive, integrated effort. This report describes the development and initial results of the Conventional Combustion Pollutant Assessment (CCEA) program planning effort.

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The material in this report is also published as a MITRE/Metrek report with the same title, Report No. M-78-63.

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SECTION 1

INTRODUCTION

The United States uses more energy than any other nation--approximately five times the amount used by Japan, the second largest energy user among the nations of the free world. In 1976 more than 74.3 x 10^{15} Btu (78.4 x 10^{18} joules) of energy were used in the U.S. to heat and cool buildings, to operate transportation systems, and to power industry.[1] By 1985 this energy use is expected to increase by nearly 20 percent and by the year 2000, the United States is projected to increase its energy use to more than 100 x 10^{15} Btu (106 x 10^{18} joules).[8]

Historically, fossil fuels have made up the largest segment of the nation's energy resources. In 1972, for example, fossil fuels supplied more than 95 percent of the total U.S. energy use; even with the anticipated growth in nuclear, solar, and geothermal energy sources, fossil fuels are still expected to supply approximately 70 percent of the demand by the turn of the century.[2] These values serve to illustrate the magnitude of this country's current and future reliance on fossil fuels to supply its vital energy needs.

Conventional methods of converting fossil fuels to usable forms of energy are not without associated environmental penalties. The conventional combustion of fossil fuel impacts upon all environmental media--air, land, and water. Most conventional combustion processes emit oxides of sulfur, oxides of nitrogen, oxides of carbon, particulate matter, and other potentially harmful pollutants to air. In addition, solid residues from the combustion processes or from associated control technologies (e.g., ash material or sludge) pose solid waste disposal problems. Leaching of chemical compounds and heavy metals from the solid residues and oxidation of airborne pollutants by rain may also result in adverse water related health/ecological effects. To complicate matters, the effects of pollutants on air, land, and water are not separate and distinct but are interrelated, involving delicate balances and trade-offs. For example, flue gas scrubbing to remove SO_2 and particulates significantly increases the amount of solid wastes to be disposed. The physical and chemical characteristics of this sludge material must be carefully considered to insure that the method of disposal will not produce still other undesired effects on the environment.

In addition to the direct environmental impacts mentioned above, indirect impacts must also be considered in order to understand the total effect of combustion pollutants on the environment and human health. As an example, sulfur dioxide released as a constitutent of the flue gas from many common combustion processes can be transformed in the atmosphere to sulfates, which can lodge in the respiratory passages of humans and animals, with deleterious effects on health. Comprehensive identification and assessment of these multimedia and cross-media impacts, both direct and indirect, are essential to the environmentally wise use and control of conventional, fossil-fueled combustion processes.

To meet the need for a comprehensive assessment of the environmental effects of conventional combustion processes, the Environmental Protection Agency's Industrial Environmental Research Laboratory at Research Triangle Park (EPA/IERL-RTP), N.C., established a program for this purpose in February 1977. This Conventional Combustion Environmental Assessment (CCEA) program is chartered to assess comprehensively the effects of pollutants released from conventional combustion processes and associated control technologies on human health, the ecology, and the general environment, and to recommend measures for controlling adverse effects within acceptable limits.* The program concentrates upon stationary conventional combustion processes (SCCP) in the utility, industrial, residential, and commercial use sectors.

In the spring of 1977, IERL-RTP contracted with the Metrek Division of the MITRE Corporation to assist in the preparation of an implementation plan for the CCEA program. Within the same time frame, IERL-RTP also designated substantial segments of three ongoing, operational projects as a nucleus of the new CCEA program. Thus by mid-year 1977 the program had been set in motion with an operational component and a planning activity. Direction of the program, since its beginning, has been assigned to the Utility and Industrial Power Division of IERL-RTP.

This report describes the development and initial results of the CCEA program planning effort.

*Until the end of 1977, the CCEA program was known as the Combustion Pollutant Assessment (CPA) program.

SECTION 2

PURPOSE OF CCEA PROGRAM

OBJECTIVES AND SCOPE OF THE CCEA PROGRAM

The CCEA program is a unified, integrated program aimed at the comprehensive assessment of the environmental, economic, and energy impacts of multimedia emissions of pollutants from SCCP. The program integrates relevant, related R&D efforts into an overall environmental assessment structure, coordinates their activities, and serves as a centralized base of information on the environmental impacts of SCCP. Coordination and information exchange between CCEA activities help reduce duplication of effort and increase the return from available resources.

The principal objectives of the CCEA program are to identify and assess information from all relevant sources in order to:

(1) determine the extent to which available information can be utilized to assess the total environmental, economic, energy impacts of SCCP.

(2) identify and acquire additional information needed for such assessment.

(3) define the requirements for modifications or additional development of control technology.

(4) define the requirements for modified or new standards to regulate pollutant emissions.

The results of the CCEA program are aimed at providing a base of sound information for use by energy/environmental decision-makers for:

- Standards Setting
- Control Technology Development
- Policy Formulation
- Resource Allocation

Although the program is comprehensive in its approach and subject matter, there are some major boundaries that shape and focus the efforts of the program. The scope of the CCEA program can be briefly delineated as follows:

- The program is concerned with SCCP, and is focused principally on equipment and combustion processes used in the utility, industrial, commercial/institutional, and residential sectors.

- The program addresses environmental effects that result directly from the operations of the combustion process itself, as well as those that result from the operation of equipment to control the release of pollutants from the combustion process, such as leachate from flyash impoundment basins.

- The program addresses non-environmental criteria such as social, economic, and political/institutional effects.

- The program also addresses environmental effects from the conventional processing and storage of fuels at the combustion site, such as the crushing of coal at a power plant.

- The program does <u>not</u> address the effects of fuel processing and storage prior to delivery to the combustion site, or during transportation of the fuel.

- The program addresses environmental effects of utilizing synthetic fuels in conventional combustion equipment.

- The program does <u>not</u> address the environmental effects of converting fossil fuels to synthetic fuels, whether performed at the combustion site or elsewhere; thus it does not include consideration of the impacts of low-Btu gasification of coal when the gasification equipment is within the battery limits of the power plant where the gas is burned.

- The program is <u>not</u> directly involved in design or development of combustion processes or pollution control technologies.

- The program is <u>not</u> directly involved in the setting or enforcement of emission standards.

It is expected that as this program succeeds in achieving its objectives, it will serve as a model for the comprehensive environmental assessments of other energy and industrial related areas.

DEFINITION OF ENVIRONMENTAL ASSESSMENT

An Environmental Assessment (EA) is among the new categories of investigative studies being conducted as a result of the growing awareness of the direct and indirect environmental consequences of modern technology. The Energy Assessment and Control Division (EACD) of IERL-RTP has developed a working definition of an environmental assessment that is gaining wide acceptance by the research community. For EPA and its contractors, an environmental assessment of fossil-fueled processes is defined as "...a continuing iterative study aimed at:

"(1) determining comprehensive multimedia environmental loadings and environmental control costs, from the application of existing and best future definable sets of control/disposal options, to a particular set of sources, processes, or industries; and

"(2) comparing the nature of these loadings with existing standards, estimated multimedia environmental goals, and bioassay specifications as a basis for prioritization of problems/control needs and for judgment of environmental effectiveness."[4]

The CCEA program extends this definition to include the identification and assessment of the full range of health, ecological, and environmental effects. Hence under this program, the environmental assessment includes socio-economic and institutional effects, and cross-media impacts and trade-offs, in addition to the environmental loadings data, control costs, disposal options, bioassay specifications, and other factors included in the above-quoted definition. It must be emphasized, however, that environmental assessment activities of the CCEA program do not involve either the development or promotion of the combustion process or the development or promotion of technology to control emissions from the combustion process.

SECTION 3

CCEA PROGRAM PLAN

COMPONENTS OF THE PROGRAM PLAN

The CCEA program, in its current stage of development, consists of four major components. These four components are interrelated and should be considered in the context of the overall CCEA program.

The first major component is an initial set of long-term goals and intermediate-term objectives for the CCEA program. These goals and objectives reflect IERL-RTP's role in EPA's mission to protect human health, ecology, and the general environment from the adverse effects of conventional combustion. These goals and objectives have been defined in a manner that provides clear direction to the CCEA program yet allows the flexibility to address, within the context of the program, special priority concerns (such as newly suspected carcinogens or mutagens) as they are identified by the research community.

The second major component of the program plan is a methodology for comprehensively assessing the environmental effects of SCCP and their pollutants. This methodology, employed within the context of the overall CCEA goals and objectives, is a blueprint to systematically identify and evaluate approximately 200 different items of information in conducting an environmental assessment. It is structured in a manner to maximize coordination and information exchange between R&D efforts that are simultaneously addressing different aspects of the subject area. The time required to conduct a comprehensive environmental assessment is thus shortened and the results of the R&D efforts are used to a wider extent.

The third major component is a detailed procedure to analyze and compare the programmatic contents of relevant ongoing and planned R&D projects and to integrate these projects into the CCEA program. This analytical procedure (termed the EA Matrix Analysis Procedure) relies heavily on the environmental assessment methodology mentioned above in its project analysis and integration technique.

The fourth major component of the CCEA program plan is a set of recommendations for implementing the other three components in such a way that together they will produce a comprehensive assessment of the health, ecological, and environmental effects of SCCP. This fourth component is comprised of four separate but related subcomponents, namely: (1) recommendations for a management structure within EPA for administering the CCEA program; (2) recommendations for "core" projects to be initially integrated into the CCEA program;

(3) recommendations for refining, expanding, and implementing the analytical techniques/procedures and methodologies developed in this planning effort, and (4) recommendations on guidelines for the procurement of a major systems contractor to assist EPA in conducting the program. This last subcomponent has already been submitted to EPA under separate cover and will not be discussed in this report.

A brief overview of the four components of CCEA program plan is presented in Appendix B. The technical details, rationale, and other salient points of each of the four components are presented in Appendices C, D, E, and F.

POTENTIAL BENEFITS OF CCEA PROGRAM PLAN

Each component of the plan has been designed to provide a firm framework for the conduct of the environmental assessment while containing the degree of flexibility necessary for the day-to-day implementation of the program plan. The major potential benefits of each component of the CCEA program plan are listed below.

Goals and Objectives

- Goals and objectives are structured at two levels: major, long-term goals and intermediate objectives that contribute toward the accomplishment of major goals. The products associated with most of the objectives represent useful outputs in themselves, and can be beneficially used for a variety of purposes. For example, one objective is to establish an SSCP pollutant data base. This product could be widely used for many purposes not directly related to the CCEA program.

- The major goals of the program are defined as separate, although interrelated, entities that can be addressed by separate projects. These projects can, in most instances, be performed concurrently, thus reducing the time needed for accomplishing all goals. The same is true for most of the intermediate objectives.

Environmental Assessment Methodology

- The methodology provides a generalized structure into which the diverse activities associated with environmental assessment can be systematically incorporated. This structure outlines the interrelationships among the various activities that are a part of environmental assessment, and provides channels of communication for involved scientists and engineers in various disciplines.

- The methodology represents a comprehensive approach to environmental assessment, in contrast to many earlier programs that addressed only limited aspects of environmental assessments.

- The methodology is designed to allow many of the various activities that constitute an environmental assessment to be performed simultaneously, thereby reducing the overall time needed to complete the assessment. This characteristic of the methodology also encourages the documentation of intermediate results as they are completed, thereby permitting timely dissemination and transfer of such results to the concerned research community.

- Although the methodology is currently designed for an environmental assessment of SCCP, it can readily be modified to address other major energy and industrial technologies. The specific techniques, procedures, and models developed for use with SCCP can possibly be utilized immediately in other major ongoing R&D programs, thus reducing the time and resources required.

Environmental Assessment Matrix Analysis Procedure

- Two or more similar ongoing or proposed projects can be compared with the aid of this procedure to identify potential areas of programmatic overlap. If detailed examination verifies this overlap, then actions, including project redirection, could be taken to resolve the situation and to increase the return from available resources.

- The programmatic content of the complete set of projects included in the CCEA program can be compared with the elements comprising the comprehensive environmental assessment methodology to identify important areas where no R&D effort is currently ongoing or planned. Projects to perform the desired activities can then be initiated.

- In many cases, the results of one project are a direct input to the activities of another. When the matrix analysis procedure identifies two or more projects addressing similar or related areas, the milestones and schedules can be compared and coordinated to insure that necessary information is made available to each project in a timely manner.

- The matrix format permits decision-makers to quickly and efficiently identify all projects in the program that address similar subject areas or environmental assessment elements. Thus, for R&D efforts in a specified area, the matrix format could be used to identify all current projects and their activities addressing the area. Such information would be useful in the planning effort to utilize the results of other projects to a greater extent.

- The matrix format also permits decision-makers to quickly and readily identify all R&D currently being conducted that relate to a specific pollutant, fuel, control technology, combustion technology/process or media. If all data currently being developed on hydrocarbons (HC) were needed, for example, the matrix format would quickly identify the R&D activities involving HC and the specific projects involved. Direct review of these projects and activities would simplify the data acquisition and evaluation effort.

SECTION 4

CONCLUSIONS

In the course of performing the CCEA program planning activity, several conclusions that significantly focused the development of the overall CCEA program implementation plan were made. These conclusions are categorized into three general activity areas and listed briefly below. The assumptions and rationale for these conclusions are discussed in detail in the appendices.

CONCLUSIONS RELATED TO THE NEED, FUNCTIONS, AND USES OF THE CCEA PROGRAM

- A major effort is required to acquire and analyze existing data on the impact of pollutants released from SCCP and associated control technologies, and to supplement this data base with new or updated information to assess fully the total environmental effect. Examination of available sources of information and proposed and ongoing research indicates that a substantial base of useful information already exists[7]; however, these sources are quite specialized and dispersed, and the data are not of uniform quality for unambiguous interpretation.

- A comprehensive environmental assessment program must include major efforts on health and ecological impacts, environmental economics, energy requirements, and social/political/institutional constraints and impacts. Evaluation of relevant projects within IERL-RTP indicates that their primary emphases have been control technology evaluation and emissions characterization.

- An integrated program is indeed required now to coordinate separate R&D efforts, to increase information exchange, and to develop needed data in a timely manner. Evaluation of major projects in the environmental assessment of SCCP indicates that most projects are initiated and executed independently of other related or similar efforts; information exchange between these projects is generally minimal.

- The goals of a comprehensive environmental assessment program must include the assessment of the need for new or modified control technologies and emission standards. The majority of the programs in this subject area merely develop data that form the base of information. This information must be analyzed and specific recommendations in priority order must be developed to support the environmental assessment goals.

CONCLUSIONS RELATED TO MANAGEMENT ORGANIZATION

- The present organizational structure at IERL-RTP is not ideally suited to managing a broad multi-project program to achieve the required degree of integration and coordination. Projects included in the CCEA program are currently being conducted and managed by three divisions within IERL-RTP. Current lines of reporting are too rigid and circuitous for efficient program implementation and management.

- IERL-RTP has currently not committed sufficient staff for the efficient and effective development and implementation of a program of this magnitude, complexity, and importance. The implementation of this program requires the coordination of a host of projects as well as substantive and constant communication with project officers of EPA and non-EPA projects of relevance to the program, several contractors, and outside experts. In addition, in-house expertise in a variety of subjects is necessary to evaluate and guide the progress of the program. Such personnel resources are not currently available.

- Funding channels for the major portions of CCEA should be centralized. An important option for implementing and guiding the program includes the ability to institute modification or redirection of ongoing R&D projects. If funding channels for the major projects are not centralized the program manager will not have the necessary support to coordinate and redirect such projects.

CONCLUSIONS RELATED TO METHODOLOGIES, TECHNIQUES AND PROCEDURES OF THE CCEA PROGRAM

- A detailed and explicit methodology for conducting a comprehensive environmental assessment of SCCP must be adopted within EPA. Substantial work has been completed and is ongoing in developing environmental assessment methodologies. These various methodologies should be evaluated, expanded, and supplemented to provide the range and degree of guidance required for a comprehensive, unified effort. The present report describes a methodology that has proved useful in developing the CCEA program.

- A detailed and explicit procedure to evaluate and integrate relevant projects is necessary to efficiently implement the CCEA program. Due to the range and depths of topics addressed by the projects included in this program, evaluation and comparison between projects is at best difficult and complex. An explicit procedure to facilitate comparative evaluation and project integration is needed.

- A technique to rank relevant projects in priority order within the context of the CCEA program goals and objectives is also needed. External factors such as budgetary constraints, congressional mandates, or newly identified health/ecological concerns may effect a change in emphasis in program content and direction. The required priority-ranking technique must consider these factors in establishing priorities among projects.

SECTION 5

RECOMMENDATIONS

The overall goal of this program planning effort is the development of a set of methodologies, analytical procedures, and recommendations to assist EPA in the implementation and management of the CCEA program. As a package, these outputs comprise the program plan in its current stage of development. Recommendations that have resulted from the program planning effort are listed below. These are arranged under the headings of the four major components of the program plan identified in Section 3. The assumptions and rationale underlying the recommendations are discussed in the appendices.

RECOMMENDATIONS RELATED TO GOALS AND OBJECTIVES OF THE CCEA PROGRAM

- The goals and objectives of the CCEA program, as stated in this report, should be thoroughly reviewed by EPA management at the division (utilities and Industrial Power Division), the laboratory (IERL/RTP), and the headquarters (Office of Energy, Minerals, and Industry) levels to insure consistency with missions, policies, and objectives at each of these organizational levels, and to determine whether the stated goals and objectives adequately support such missions and policies.

- Following the reviews, the CCEA program manager should issue a document summarizing the program goals and objectives that received concurrence and support.

RECOMMENDATIONS RELATED TO THE COMPREHENSIVE ENVIRONMENTAL ASSESSMENT METHODOLOGY USED IN THE CCEA PROGRAM

- The CCEA program manager should assemble a panel of environmental experts to review the EA methodology presented in this report, to insure completeness and unity.

- The CCEA program manager should initiate efforts to insure that detailed (and standardized) analytical tools are available to address the various programmatic areas of the EA methodology.

- The Director of IERL-RTP should assemble a panel of experts to ensure compatibility between the environmental assessment methodology employed by the CCEA program and the one developed by EACD, IERL-RTP, and to promote the agency-wide adoption of a unified approach.

- The CCEA program manager should initiate an effort to ensure that CCEA contractors and other concerned environmentalists are informed of and utilize EPA methodologies and standardized analytical protocols, techniques and procedures where appropriate (e.g., Level 1, Level 2, Level 3 Analysis or SAM/IA, SAM/I, SAM/II).[5,6]

- The CCEA program manager should establish a data base of information (from available sources) needed to implement the environmental assessment methodology described in this report and provide for continued updating of this data base.

RECOMMENDATIONS RELATED TO THE MATRIX ANALYSIS PROCEDURE USED IN THE CCEA PROGRAM

- The CCEA program manager should instruct an appropriate contractor to modify the matrix analysis procedure developed by the present effort for use in a computer system, thereby providing EPA a highly useful management tool. The following actions should be included in this effort:

  - The Project Information Checklist should be revised to facilitate information acquisition and computer storage.

  - A detailed coding for this information should be developed.

  - The computer system should be programmed by key words, programmatic areas, projects, or organization to provide a variety of information searches and displays.

  - The computer system should be programmed to automatically ignore impractical or unreasonable combinations of programmatic areas in its searching methods (e.g., ignore SO_x when searching for studies involving the use of SNG in SCCP).

- The CCEA program manager should instruct the appropriate contractor to revise the matrix analysis procedure, as necessary, to be responsive to the evaluation and integration of the core projects finally selected by EPA for inclusion in the CCEA program.

RECOMMENDATIONS RELATED TO THE IMPLEMENTATION AND MANAGEMENT OF THE CCEA PROGRAM

- EPA should establish an organizational structure for CCEA program management that provides: (1) a full-time program manager, fully dedicated to the tasks of directing the program, (2) an adequate level of staffing to support a program of this size, (3) direct liaison with project officers of all EPA projects that fall within the purview of the CCEA program, (4) channels of communication to principal users of the products of this program, and (5) an advisory group to consult and provide technical and management support to the program manager. A recommended organizational structure is described in Appendix B.

- EPA should obtain the services of a systems support contractor to assist in the implementation of the CCEA program.

- EPA should consolidate the funding of projects and other R&D activities that fall within the CCEA program. This action should include provisions for technical and budgetary review and approval of such projects/activities by CCEA program management.

- The present CCEA program management should schedule periodic briefings and seminars at IERL/RTP and EPA Headquarters to inform management and technical personnel of the status and accomplishments of the program.

SECTION 6

REFERENCES

1. Independent Petroleum Association, "Report of the Supply and Demand Committee," 1976.

2. M. Beller, ed., Sourcebook for Energy Assessment, Brookhaven National Laboratory, BNL-50483, 1977.

3. Energy Research & Development Administration, "Inventory of Federal Energy-Related Environment & Safety Research for FY 1976," Volume 1, April 1977.

4. R. P. Hangebrauck, "Briefing Notes for Meeting with ERDA, Fossil Energy," in-house document, EPA/Industrial Environmental Research Laboratory, Research Triangle Park, N.C., May 17, 1977.

5. J. Dorsey, L. Johnson, R. Statnick, and C. Lochmuller, Environmental Assessment Sampling and Analysis: Phased Approach and Techniques for Level 1, EPA-600/2-77-115 (NTIS No. PB 268563), June 1977.

6. J. Cleland and G. Kingsbury, Multimedia Environmental Goals for Environmental Assessment, Volumes I and II, EPA-600/7-77-136a/b (NTIS No. PB 276919/276920), November 1977.

7. W. E. Thompson and J. W. Harrison, Survey of Projects Concerning Conventional Combustion Environmental Assessments, Research Triangle Institute, Research Triangle Park, N.C.

8. Executive Office of the President, Energy Policy and Planning, The National Energy Plan, U.S. Government Printing Office, Washington, D.C., April 1977.

APPENDIX A

CCEA PROGRAM PLANNING EFFORT

A. OBJECTIVES OF THE PROGRAM PLANNING EFFORT

The general objectives of the program planning effort are to: (1) develop a coherent, unified methodology for comprehensively assessing the health, ecological, and environmental effects of burning fossil fuels in SCCP, (2) define long-term goals and short-term objectives for the CCEA program, and (3) recommend a management plan for implementing the program.

Several intermediate objectives for the planning effort were established as steps toward the accomplishment of the general objectives stated above:

- Definition of a comprehensive environmental assessment methodology detailing its major components.
- Identification of on-going projects, within EPA and elsewhere, having components relevant to the environmental assessment of SCCP.
- Development and demonstration of a procedure or system for analyzing the programmatic contents of on-going and future CCEA-related projects to identify areas of overlap or omission, and to integrate such projects into the unified CCEA program.
- Recommendations for the types of information to be produced by environmental assessment projects.
- Identification of major needs and potential uses for environmental assessment results.
- Development of guidelines for securing a systems contractor to assist EPA in implementing the CCEA program.
- Recommendations for an organizational structure within EPA for implementation and management of the CCEA program.

The specific program planning approach adopted in this effort is designed to be responsive to the achievement of the above goals and objectives.

B. SCOPE OF PROGRAM PLANNING EFFORT

This program planning effort is in support of the actual implementation of the CCEA program. The present effort does not implement the program, but rather provides general methodologies, procedures/techniques, and recommendations to be used by EPA and a major systems contractor in accomplishing the objectives of the overall CCEA program. These methodologies and procedures/techniques are demonstrated in this report by application to selected projects. Recommendations are also made in the selection of projects for integration into the CCEA program. The final selection, evaluation, and integration are to be accomplished by EPA through its system contractor.

Although the major procedures/techniques and methodologies that result from this planning effort were developed primarily by MITRE, the overall program plan represents the combined work and thinking of IERL-RTP (through its designated CCEA project officer), Research Triangle Institute (RTI), and the MITRE Corporation. The CCEA project officer provided direction and guidance in focusing the program plan to meet EPA needs, while RTI assumed responsibility in providing necessary information on relevant projects being conducted in the subject area.

An initial constraint on the planning effort was that existing data, ongoing projects, analytical techniques, and assessment/evaluation procedures be incorporated into the CCEA program plan to the maximum extent practical. This greatly reduced the amount of detailed work to be done in formulating the environmental assessment methodology, since substantial progress has been made in this area. Similarly, the effort required for conducting the environmental assessment is greatly reduced, since a substantial base of data is now available and is currently being expanded through ongoing projects. However, the process of developing an implementation plan for efficiently coordinating the ongoing efforts, both in data development and procedure development, is complicated by the fact that ongoing projects highly relevant to the CCEA program have varying objectives and scopes and utilize varying experimental/analytical techniques and assessment/evaluation procedures. Analysis and comparative evaluation of the programmatic contents of these projects to develop a unified program is hampered by the lack of standard approaches. The development of a management structure to administer the program is also complicated by the fact that data utilized in the CCEA will not only be those within IERL-RTP, but also those in other parts of EPA. In addition, information developed by projects external to EPA will also be important in conducting the environmental assessment.

C. METHOD USED IN FORMULATING THE CCEA PROGRAM PLAN

At the beginning of the program planning effort, it was clear that IERL-RTP was performing several R&D projects that would fit totally into the scope of the unified CCEA program; also portions of other projects would logically be included. The number of EPA projects in either category was not clearly identified when the planning effort began. Projects of similar nature being performed by other parts of EPA or organizations outside of EPA were even less clearly identified. The program planning technique or procedure, therefore, had to include the full range of activities from identifying relevant studies to recommendations for administrative management of the overall CCEA program.

The planning procedure for the CCEA program is described below both in conceptual form and in terms of specific task activities actually undertaken in the planning effort.

1. Conceptual Description of the Planning Procedure

The approach used in formulating the CCEA program plan can be described in terms of the somewhat idealized steps described below.

First, define goals and objectives of the CCEA program.

Goals are defined on the basis of existing or anticipated standards for regulated pollutants and processes; acceptable ambient or emission levels for pollutants not currently regulated; control equipment capabilities and costs; health and ecological effects; and defined EPA responsibilities for controlling the environmental effects of SCCP.

Second, identify ongoing and planned projects pertaining to a conventional combustion environmental assessment within EPA and other organizations.

This can be done by a survey of R&D work within IERL-RTP, EPA and other Federal and non-Federal organizations. An initial survey of this nature was performed concurrent* with the program plan development.

Third, evaluate the content and anticipated outputs of identified projects in terms of their relevancy for achieving defined goals of the CCEA program.

This step requires a procedure or technique for analyzing and evaluating the content of each project relative to the completeness of the CCEA program. Such a procedure was developed in conjunction with the program planning effort. The procedure will also aid in identifying gaps and overlaps among selected R&D projects.

Fourth, integrate the content and anticipated outputs of selected ongoing and planned R&D projects, and compare the overall results with the defined goals and objectives of the program.

This step also requires a procedure or technique for interrelating and integrating the anticipated accomplishments of relevant R&D projects and programs, and for comparing their results with the requirements for meeting CCEA program goals.

If the comparison at some specific time indicates that all defined goals are met, the program is complete. In the more likely circumstance that all defined goals are not met by identified projects, the comparative technique will indicate directions for additional R&D efforts needed to accomplish the goals.

Fifth, redirect R&D effort to fill identified omissions or to establish new R&D directions to more nearly accomplish defined goals.

The sequence of planning steps is outlined diagrammatically in Figure A-1.

*The survey was conducted by Research Triangle Institute.

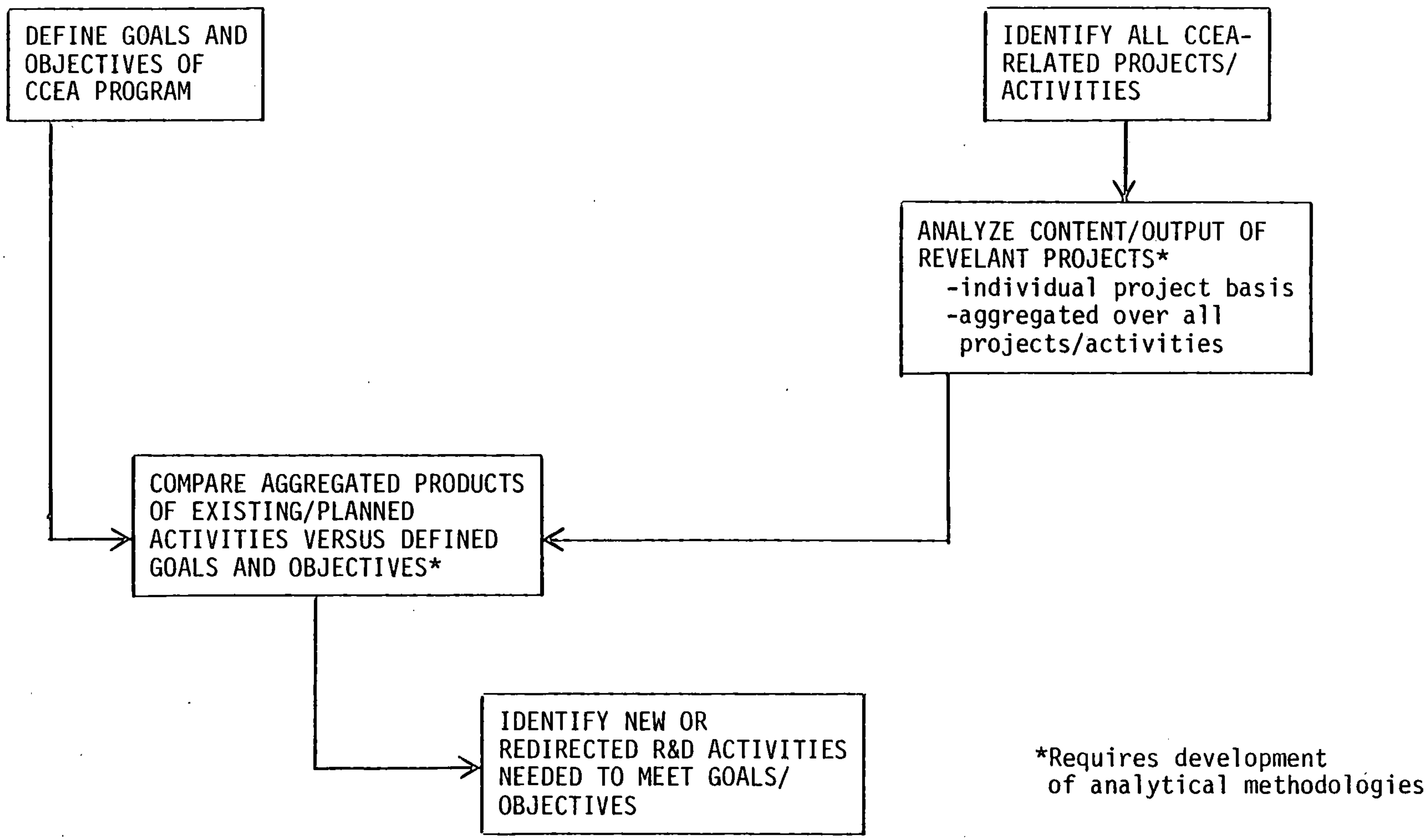

Figure A-1. Conceptual diagram of CCEA program planning procedure.

Each of the above steps can be performed at various levels of detail. For example, the first step -- defining goals and objectives -- may be considered in terms of meeting all applicable existing standards on a nationwide basis, or it may be considered in terms of meeting a set of "Multimedia Environmental Goals" (MEG)* for a specific chemical compound. Similarly, the third step -- evaluation of project content and output -- may consider only technical factors that affect human health and ecology. Alternatively, the analysis performed in this step may be extended to include second order social and economic effects such as increases in the cost of electric power that result from the costs of pollution control requirements.

The planning procedure outlined in the foregoing series of steps and in Figure A-1 is iterative in nature. It can be performed initially at a general level, then iterated to more detailed levels as additional information becomes available. It can also be readily adapted to be responsive to new circumstances such as new or revised standards.

It may be noted that two of the steps listed above require an analytical procedure or technique. In step three, such a procedure is needed for analyzing program content. In step four, an analytical procedure is needed for comparing R&D accomplishments with program goals. The development of these procedures, which are described in detail in Appendix E, has constituted a substantial part of the program planning effort.

2. Detailed Program Planning Procedure

In practice, the actual planning process for the CCEA program proceeded somewhat differently from the highly conceptual approach outlined above. The initial step was the inventory of potentially relevant R&D projects,**and the selection of subsets of highly relevant projects for detailed analysis. Following that, a procedure was developed for analyzing, comparing, and integrating the contents of R&D projects. The program planning procedure consisted of eight steps, or tasks:

1. Review of Estisting EPA/IERL-RTP CCEA Projects

2. Identification and Evaluation of Related Projects by Other Organizations

3. Disaggregation by Relevant Project Activities Within Environmental Assessment Functional Categories

4. Structured Aggregation of Relevant Project Activities Within Environmental Assessment Functional Categories

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*MEGs are emission or ambient level goals based on either control technology capabilities or on health and ecological effects. IERL-RTP is currently developing MEGs for approximately 350 organic and 300 inorganic substances.

**Performed by Research Triangle Institute, Final Report available from EPA/IERL-RTP.

5. Current Environmental Information Base

6. Development of Goals and Objectives for Unified CCEA Program

7. Evaluation of Integrated Existing CCEA Program

8. Development of Unified CCEA Program Plan.

Each of the steps involves a number of ancillary activities. The relationship among the principal steps and their ancillary activities is shown diagrammatically in Figures A-2(a) and A-2(b).

Task 1 involves the review of ongoing CCEA-related projects at EPA/IERL-RTP to identify their specific objectives, activities, milestones, and schedules. Simultaneous with Task 1, Task 2 identified, acquired, and reviewed information on past and ongoing combustion assessment-related projects outside of EPA/IERL-RTP to determine possible informational/program links with CCEA. Organizations surveyed within EPA included: Office of Energy, Minerals, and Industry (OEMI); IERL at Cincinnati; Office of Air Quality Planning and Standards (OAQPS); and EPA Regional Offices. Organizations surveyed outside of EPA included: Department of Energy (DOE) (Energy Research and Develpment Administration [ERDA]); Electric Power Research Institute (EPRI); Tennessee Valley Authority (TVA); Edison Electric Institute (EEI); Department of Commerce (DOC); Office of Science, Technology, and Policy (OSTP); Department of Agriculture (DOA); Department of Health, Education, and Welfare (HEW); and the National Science Foundation (NSF).

The information identified in Tasks 1 and 2 as being relevant to the unified CCEA program is analyzed in Task 3, where specific activities of the relevant projects are disaggregated into generic environmental assessment "functional categories." Functional categories are specific technical areas that are addressed by the project(s) being analyzed. Such categories are intended to aid in defining the technical content of the project. Although the concept of functional categories was established and used early in the program planning effort, specific functional categories were only vaguely defined at that time. In later stages of the planning effort, it became necessary to develop concrete lists of functional categories in order to disaggregate and analyze the content of specific projects. The current listing of functional categories is shown in Table A-1. Project activities addressing similar subjects or involving similar efforts in the various combustion assessment-related projects are then separated for comparative evaluation.

In Task 4, these activities are assembled into a logical environmental assessment matrix structure designed to facilitate comparison between individual projects, and between the aggregate of all projects and the requirements for meeting defined goals and objectives. By such structured integration, the basic characteristics of the unified CCEA are delineated and the relationships between the activities of the various programs identified.

Concurrent with the integration of relevant projects into environmental assessment functional categories, two independent tasks were conducted to develop the goals and objectives of the expanded, unified CCEA. In Task 5,

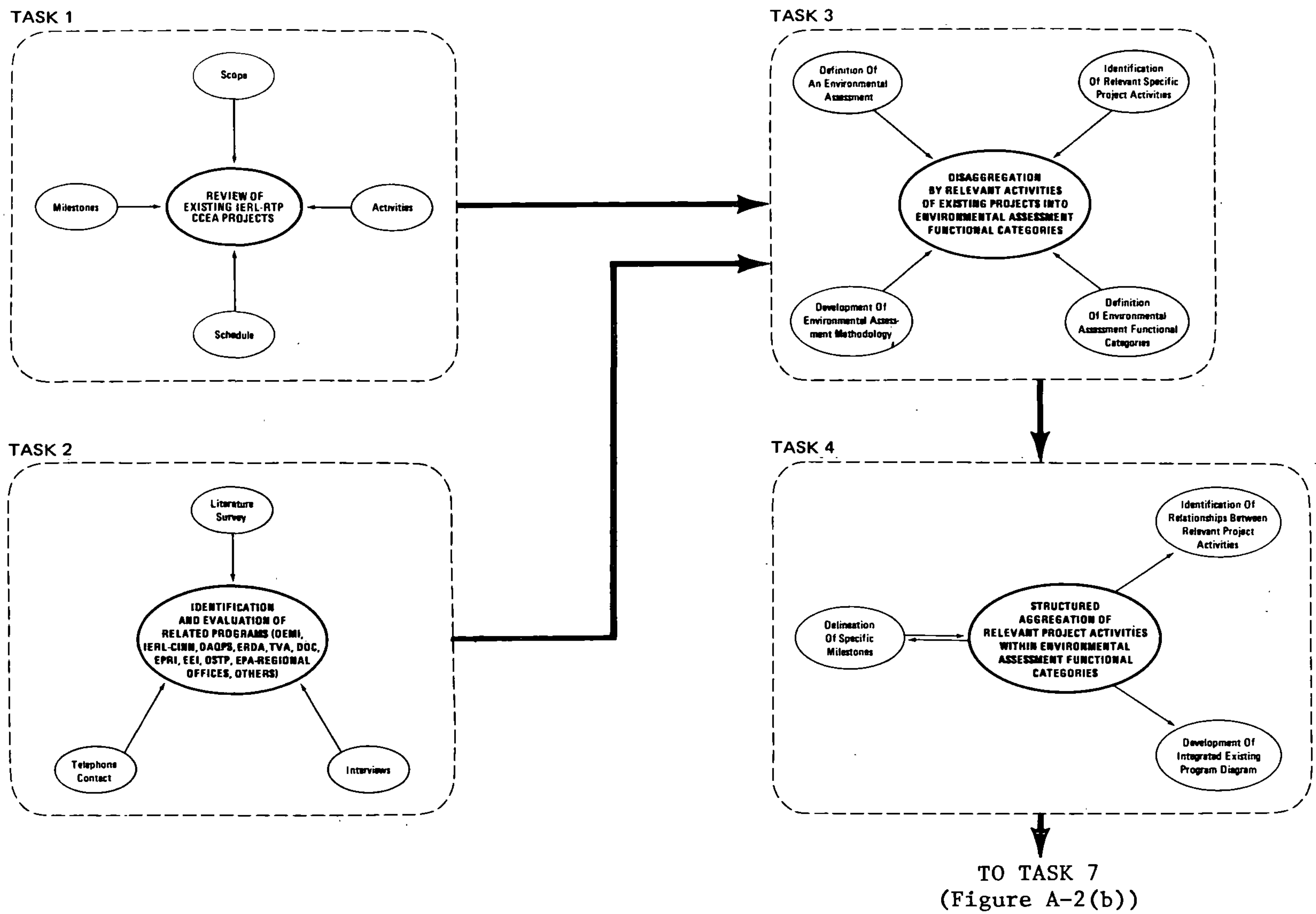

Figure A-2(a). Unified conventional combustion environmental assessment program planning.

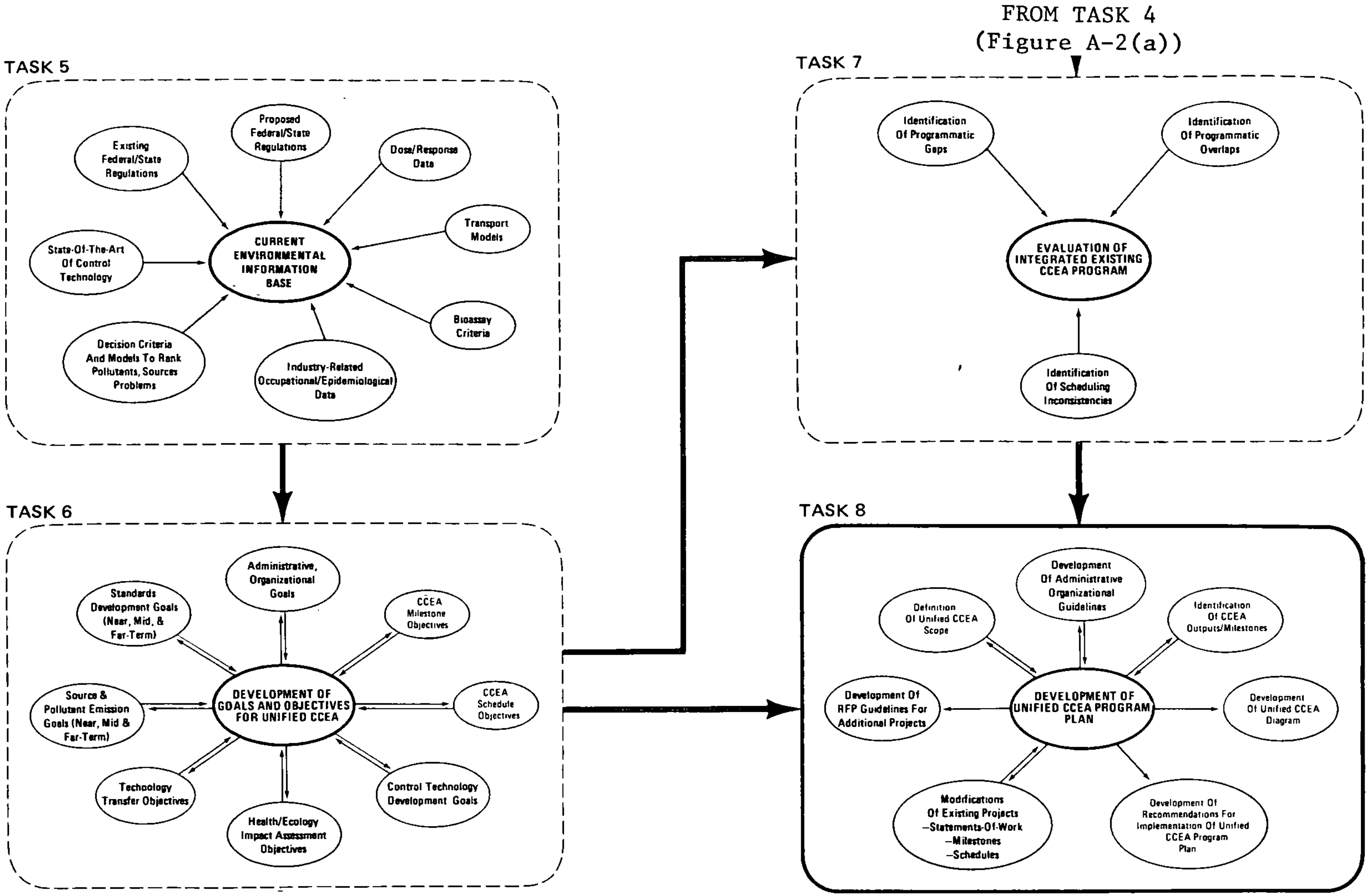

Figure A-2(b). Unified conventional combustion environmental assessment program planning.

TABLE A-1. MAJOR PROGRAMMATIC AREAS ADDRESSED BY CCEA PROGRAM

- Combustion Process Technology Background
- Development of Sampling and Analysis Techniques
- Fuels Characterization
- Input-Output Characterization
- Field Tests and Surveys
- Pollutant Transport, Transformation, and Fate Models
- Dose-Response Data
- Ecological Impacts
- Epidemiological Data
- Bioassay Data
- Emissions or Ambient Level Goals
- Social/Economic/Political/Institutional Considerations
- Statutory Constraints
- Ambient Pollutant Levels
- Combustion Process Use Projections
- Total Pollutant Load Calculations
- Synergistic and Multimedia Impacts
- Regional Geographic Data
- Pollutant Priority Rankings
- Control Alternatives
- Control Strategy Environmental Impacts
- Control Strategy Evaluation
- Standards Development Recommendations
- Control Technology Development Recommendations

an information base of the current environmental background was established. (The content of this information base is, however, continuously evolving.) The information base includes data on existing and proposed environmental regulations, health/ecology impacts, state-of-the-art of associated control technologies, and environmental modeling. This information was analyzed and utilized in Task 6 to develop the proposed goals and objectives of the expanded, unified CCEA program. Goals and objectives for standards recommendations, control technology development recommendations, and technology transfer activities were formulated. Administrative and organizational goals for the implementation of the unified CCEA program plan were also developed in Task 6.

The aggregated activities of the existing combustion assessment projects are integrated into functional categories in Task 4 and then evaluated in Task 7 with respect to the defined CCEA goals and objectives. By such a comparative evaluation, gaps within the coverage of the existing structure can be identified. Duplications or overlaps among the various existing projects as well as possible incompatibilities in scheduling can also be identified within this task.

The results of the comparative evaluation of Task 7 provide guidance for redirecting existing projects to eliminate unwarranted overlaps and for augmenting the existing program to insure that all critical R&D areas are addressed. Identification of duplicate activities, with a view toward eliminating unwarranted overlaps, is considered a matter of some urgency, since it could result in substantial savings of resources. The use of the aforementioned analytical procedures for this purpose is demonstrated in Appendix E.

In Task 8, the comparison is made at a higher level. Here, the functional categories and their constituents for all CCEA projects are compared against the program's goals and objectives to determine whether the current and planned program content is generally on target and to develop guidance concerning the adequacy and deployment of resources. This step has not yet been performed in a comprehensive manner because of the volume of information to be accumulated, processed, and analyzed for its detailed implementation. However, the analytical techniques of this planning procedure were used to review the content of some 30 major projects considered highly relevant to the CCEA program. The results of this review and analysis have provided guidance in formulating a unified and comprehensive program and in planning for the implementation of the program. In particular, the results of the comparative evaluation formed the basis for defining the scope of work, including the identification of specific outputs and milestones to support the achievement of detailed goals and objectives, for a systems support contractor to assist EPA in conducting the next two years of the CCEA program. Also, the comparison provided guidance for the formulation of an organizational structure for implementing and managing the program.

D. PRODUCTS OF THE PLANNING EFFORT

The program planning effort has thus far yielded four principal products which, together, constitute the CCEA program plan.

- An initial set of goals and objectives for the CCEA program.
- A methodology for the comprehensive environmental assessment of conventional combustion processes.
- Detailed analytical procedures for identifying, evaluating, and integrating the programmatic content of R&D projects pertaining to the environmental assessment of conventional combustion processes into the CCEA Program.
- A set of recommendations for implementing the above procedures and methodologies, and managing the CCEA Program.

These products are described in the following appendix.

APPENDIX B

DESCRIPTION OF CCEA PROGRAM PLAN

The program planning effort described in Appendix A resulted in the development of an initial plan for the implementation and management of the CCEA program. This initial plan consists of four interrelated components:

1. Goals and Objectives of the Program

2. A Comprehensive Environmental Assessment Methodology

3. A Matrix Analysis Procedure to Evaluate and Integrate Projects

4. Recommendations for Implementing and Managing the Program Plan.

Each of the components of the CCEA program plan is briefly described below. The assumptions and rationale used in developing the plan are discussed in detail in Appendices C, D, E, and F.

A. CCEA PROGRAM GOALS AND OBJECTIVES

1. <u>Long Term Goals</u>

The principal goals of the CCEA program may be briefly stated as follows:

(1) To assess comprehensively the effects upon human health, the ecology, and the general environment of utilizing fossil or other fuels in SCCP.

(2) To recommend measures for controlling adverse effects within acceptable limits.

The mere determination and assessment of environmental effects is not, in itself, considered an adequate statement of the program's long-term goals; the purposes for which the environmental assessment information will be used must also be reflected in any comprehensive statement of goals. For the CCEA program, the EA information is intended for use in making decisions pertaining to environmental standards and pollution control technology. More specifically stated, the long-term goals of the program include:

- Assessment of the adequacy of existing technology to control the release of pollutants from SCCP.

- Assessment of the need for modifications to existing control technology or for the development of new control technology and, if such needs exist, providing guidance and recommending priorities for the technology development effort.

- Assessment of the adequacy of existing emission or effluent standards designed to limit the release of pollutants to the environment.

- Assessment of the need for additional standards or modification of existing standards and, if such needs exist, providing guidance and recommending priorities of EPA's standard setting activities.

2. Intermediate Objectives

The implementation of the above goals requires the accomplishment of a number of intermediate objectives in the near- and mid-term. Principal among these is a thorough assessment of the effects of combustion pollutants on human health and the ecology. This, in turn, is dependent on the development of key information and the availability of effects-assessment techniques. In addition to contributing to the long-term goals, most of these intermediate objectives represent, in themselves, substantive and useful RD&D products. The key technical and administrative objectives have been identified and categorized as follows:

Combustion Process/Pollutant Characterization Objectives

- Develop a unified, comprehensive base of existing data on combustion pollutants.

- Obtain essential new data from field tests.

- Characterize emissions/effluents from each major type of SCCP.

Health/Ecology/Environmental Impact Assesment Objectives

- Estimate quantities of pollutants released from SCCP.

- Identify available models and other effects-estimating techniques.

- Develop quantitative estimates of health, ecological, and environmental effects (including associated economic costs) of pollutants from SCCP.

- Define priority areas for health/ecological/environmental impact studies.

Technology and Information Transfer Objectives

- Determine information needs of current/potential users of environmental assessment information.

- Transfer technical information to appropriate user organizations in a timely manner.

Control Technology Development Objectives

- Develop a comprehensive data base on the capabilities of existing technology to control the release of combustion pollutants to the environment and on the costs of applying such technology.

- Identify specific combustion processes and specific combustion pollutants for which additional control technology capability is needed to meet current standards.

Standards Development Objective

- Identify specific combustion processes and specific combustion pollutants for which modified or new standards are needed to limit pollutant emission/effluents to acceptable levels.

The dependence of the major program goals upon these intermediate objectives, as well as the interrelation among the more important of these objectives, is shown diagrammatically in Figure B-1. The rationale underlying the selection of intermediate objectives are discussed in greater detail, together with other program objectives, in Appendix C of this report.

B. COMPREHENSIVE ENVIRONMENTAL ASSESSMENT METHODOLOGY

When the CCEA program was initiated, EPA had in progress several projects that were considered to be within the purview of the program, either in total or in part. The comprehensive EA methodology provides a means to determine whether the projects and other activities that constitute the CCEA program can be expected to fulfill the goals and objectives of the program and, if they do not, to suggest directions for augmentation or modification of program activities.

1. Outline of the Methodology

The overall procedure involves the following steps to be performed for each type of combustion process. The interrelations among these steps are shown diagrammatically in Figure B-2. (This procedure, presented here in highly condensed form, is expected to be further refined and applied to major SCCP over a period of about five years.)

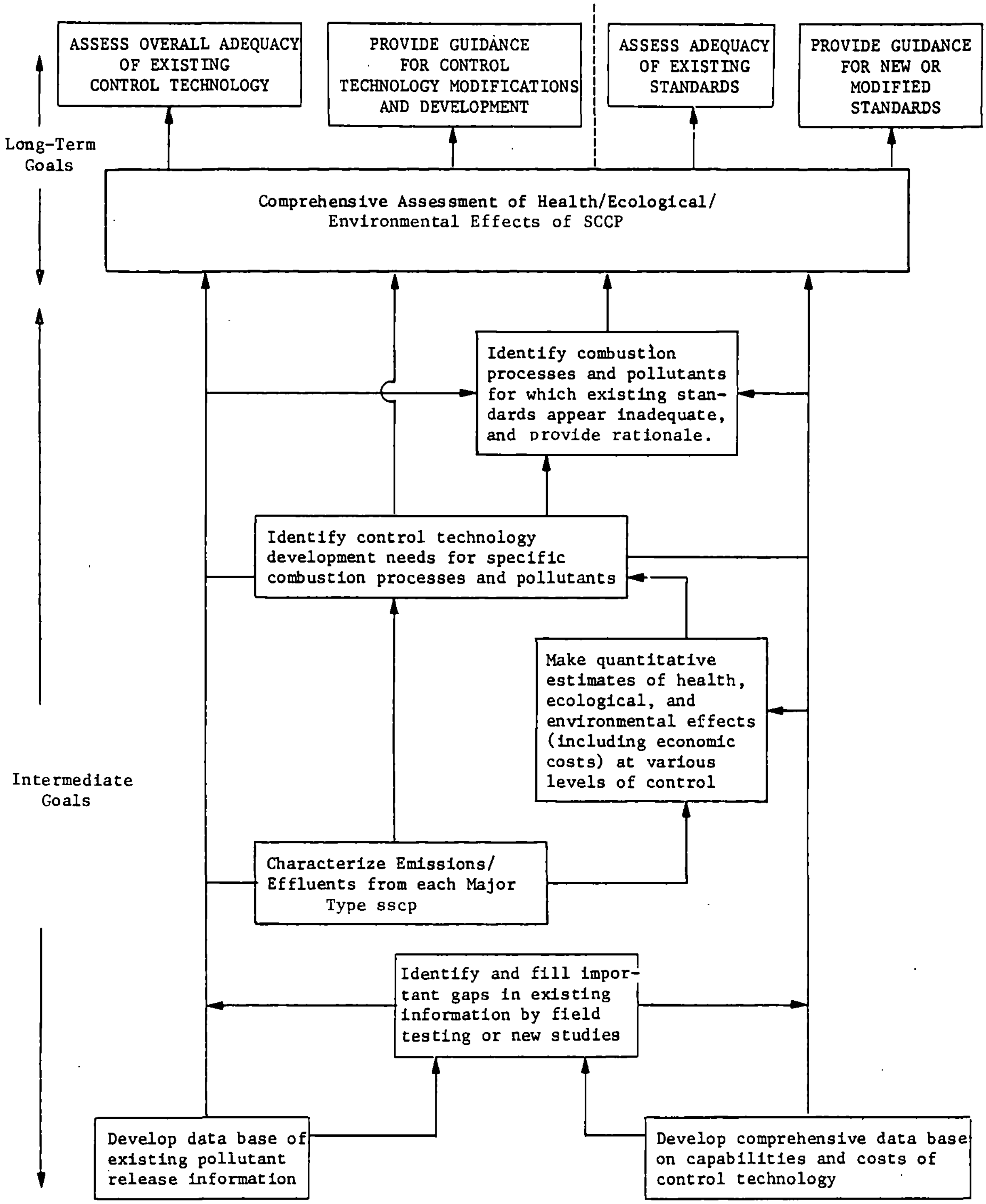

Figure B-1. Interrelations among long-term goals and intermediate objectives.

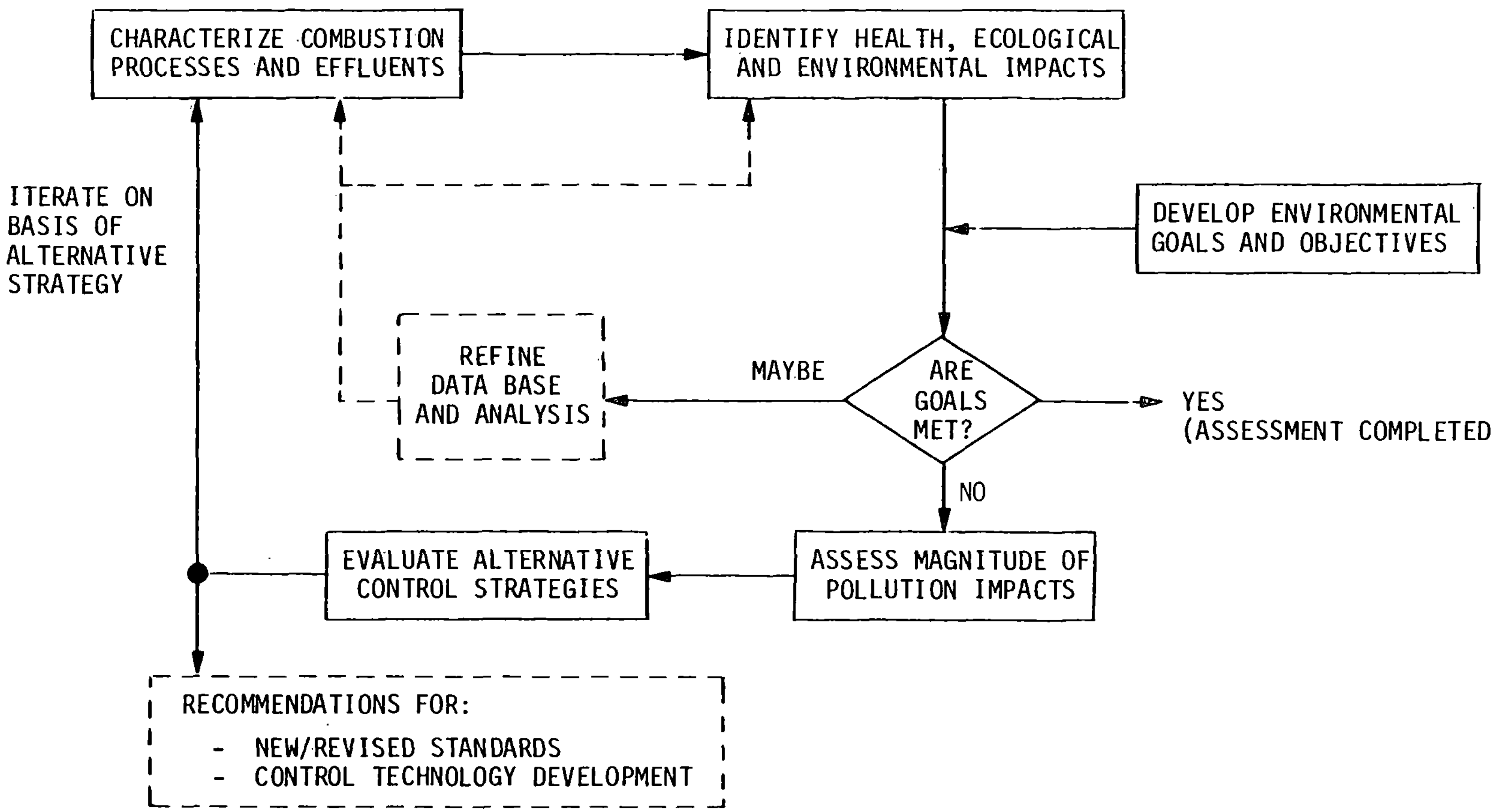

Figure B-2. Comprehensive environmental assessment methodology--principal steps.

- Characterization of Combustion Process (and Related Pollution Control Equipment) and Its Emissions/Effluents.

  For each principal type of SCCP the characteristics of fuels, control technology, and measurement and analytical techniques are identified. In particular, it identifies the quantities and characteristics of emissions and effluents.

- Identification of Health, Ecological, and Environmental Effects of Emissions/Effluents from the Combustion Process.

  This step includes the quantification of combustion pollutants (identified in the preceding step) in the ambient environment, and anticipated response of the ecology and the exposed population in terms of morbidity/mortality rates, media degradation factors and other appropriate measures. Such factors must take into account background levels of pollutants from noncombustion sources.

- Development of Environmental Goals and Objectives

  In the initial stages of this program, goals will be defined principally in terms of established standards or unofficial permissible media concentrations. In later stages, the set of goals may be expanded to include such factors as the promotion of a specific energy policy or direction of economic development.

- Comparison of Pollutant Emissions, Ambient Levels, and Health/Ecological/Environmental Impacts Against Environmental Goals and Objectives

  This comparison indicates whether established standards are being met, and other defined goals and objectives are being achieved.

This comparison may have three outcomes. (1) If it indicates that standards are, in fact, met and other goals and objectives have been met or can reasonably be expected to be achieved by ongoing R&D activities relating to the combustion process under study, then the EA procedure is completed for this process. (Repetition of the procedure is required for other processes.) (2) If there is some question of whether goals and objectives are being achieved, it may then be necessary to repeat the above three steps, possibly using better data or more precise analyses (see Figure B-2). (3) If the comparison indicates that goals and objectives are not being achieved, then the EA procedure is continued as follows:

- Determine the Magnitude of Pollution Impacts from the Combustion Process

  Quantities of pollutants released from continued use of SCCP at projected levels, ambient levels of such pollutants at appropriate geographic scales, and the degree of hazard (severity indices) associated with continued use of the combustion process are estimated.

- <u>Evaluation of Alternative Control Strategies for Achieving Goals and Objectives</u>

  Strategies that will contribute toward achievement of goals and objectives may include development of more effective pollution control technology or the use of other alternatives such as fuel switching and modification of combustion techniques; alternatively, the strategy may be to modify the existing standards or other goals/objectives.

This last step would indicate alternative approaches for meeting defined goals and objectives (e.g., suggested new technological or non-technological approaches for controlling pollutants from the combustion process under study), hence it provides new input for iterating the entire EA procedure. Iterations may be required for each viable alternative identified.

The comprehensive EA methodology is a complex and lengthy procedure which is described above only in general outline. Additional detail for the major steps in the procedure are indicated in Figure B-3 and a more detailed description of the entire procedure is presented in Appendix D.

It should be noted that the comprehensive EA methodology described here is based in substantial measure on an EA methodology developed by the Energy Assessment and Control Division (EACD) of IERL-RTP. The EACD methodology has undergone extensive development and has gained widespread acceptance in the technical community. The relationship between the CCEA comprehensive EA methodology and the prototype procedure developed at IERL/RTP is discussed in Appendix D.

C. EA MATRIX ANALYSIS PROCEDURE

The EA matrix analysis procedure is a technique to dissect or disaggregate each relevant R&D project into basic programmatic (or informational) elements addressed by it, and then to compare the project with others to identify potential areas of overlaps. In addition, the procedure facilitates integration of selected projects into the overall CCEA program and highlights important programmatic areas where little or no R&D activities are ongoing or planned. The procedure also provides a framework for a computerized information storage and retrieval scheme that would permit decision-makers to identify and evaluate CCEA activities in specific programmatic areas.

It is emphasized that the matrix analysis procedure does not, in any sense, evaluate or rate either the content or results of any project; rather, it provides an indication of a project's relevance to the CCEA program.

The overall approach of the procedure relies heavily on the comprehensive environmental assessment methodology described in subsection B above. The basic scheme is to list in detail the R&D programmatic areas addressed by each project and to compare them against elements of the environmental assessment methodology. The major programmatic areas into which each project is

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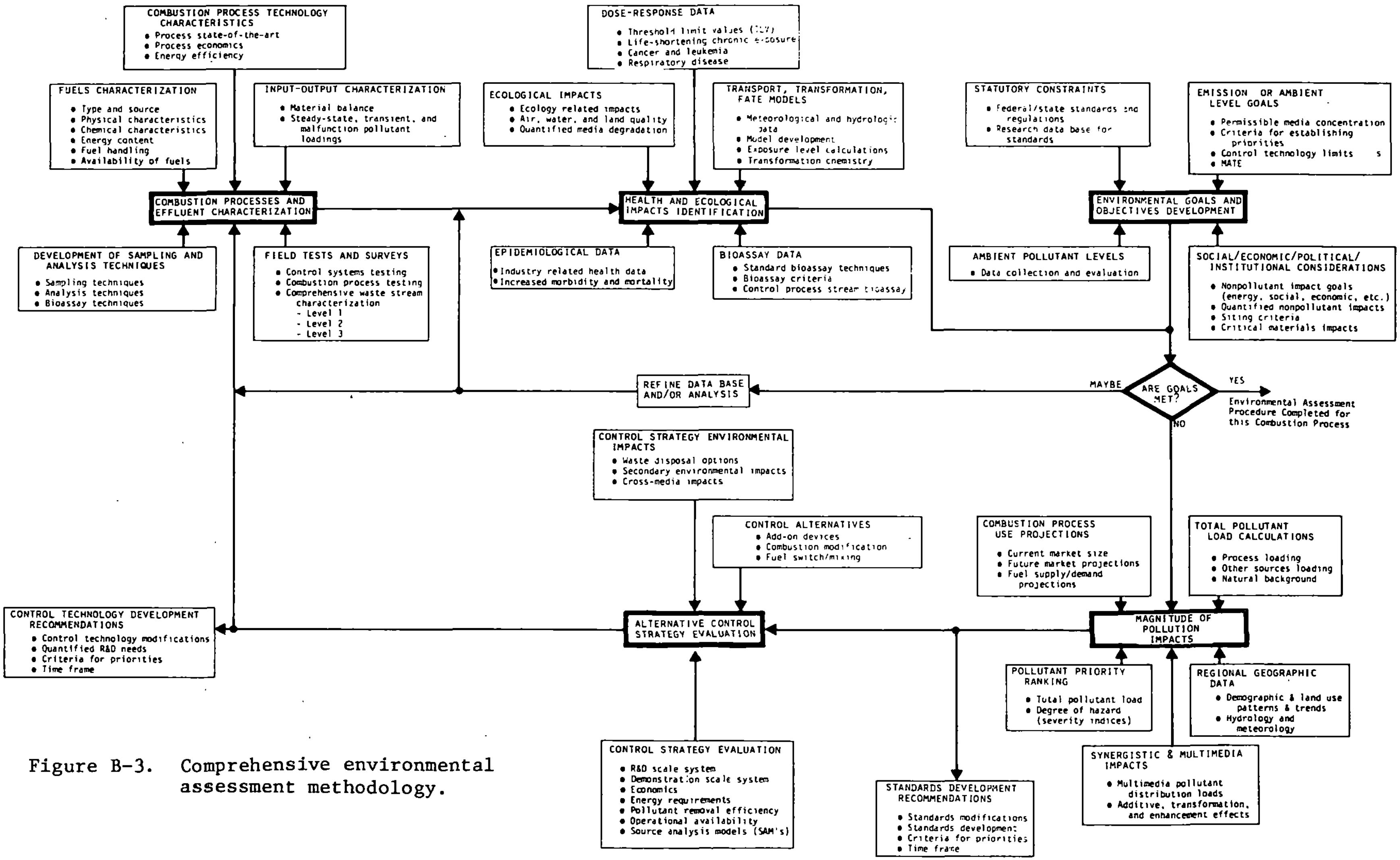


Figure B-3. Comprehensive environmental assessment methodology.

disaggregated are shown in Table B-1. (Each of these areas is divided into finer detail in the actual procedure.) The relationships between these programmatic areas and the functional categories of the EA methodology will be apparent from a visual comparison of Table B-1 and Figure B-3 in the preceding subsection.

To aid in the disaggregation process, a questionnaire-type checklist was developed to elicit information regarding the content of each project in each of the programmatic areas. The checklist also gathered information on the fuels, pollutants, control technologies, use sectors, polluted media, and specific combustion processes addressed by the selected project. The checklist is designed to provide more than a simple yes-no answer as to whether a given item is addressed. For some items, it is intended to obtain an indication of the depth to which the item is investigated, e.g., whether a waste stream is characterized at Levels 1, 2, or 3 as defined by the IERL/RTP sampling and analysis protocol. For other elements, the checklist obtains a narrative description of the related activities. Since the information gathered on each project is somewhat extensive, codes were developed to facilitate ease in data handling. A checklist was completed by the Research Triangle Institute for each project considered relevant to the CCEA program.

The information from the checklist on each selected project is entered onto a master matrix. This matrix displays all the R&D activities conducted by the group of projects in each programmatic area. Thus, potential overlaps between projects in R&D efforts will be highlighted by the matrix display. Similarly, gaps where little or no R&D effort is ongoing or planned will also be highlighted for condideration by decision-makers.

It is stressed that this procedure merely highlights areas of apparent or potential overlaps and gaps in the CCEA program -- a definitive determination must be based on a more thorough analysis of the programmatic contents of the projects involved.

A more detailed description of the EA matrix analysis procedure including a demonstration on the use of this procedure with two selected projects is given in Appendix E.

D. CCEA MANAGEMENT STRUCTURE

MITRE identified a number of alternative organizational structures for CCEA program management and selected five for detailed examination. These are listed below and described with organization charts in Appendix F.

1. Existing Structure

2. Existing Structure with Advisory Committee

3. Division-Level EA Unit

4. Program Office at Laboratory Level

TABLE B-1. MAJOR PROGRAMMATIC AREAS ADDRESSED BY CCEA PROGRAM

- Combustion Process Technology Background
- Development of Sampling and Analysis Techniques
- Fuels Characterization
- Input-Output Characterization
- Field Tests and Surveys
- Pollutant Transport, Transformation, and Fate Models
- Dose-Response Data
- Ecological Impacts
- Epidemiological Data
- Bioassay Data
- Emissions or Ambient Level Goals
- Social/Economic/Political/Institutional Considerations
- Statutory Constraints
- Ambient Pollutant Levels
- Combustion Process Use Projections
- Total Pollutant Load Calculations
- Synergistic and Multimedia Impacts
- Regional Geographic Data
- Pollutant Priority Rankings
- Control Alternatives
- Control Strategy Environmental Impacts
- Control Strategy Evaluation
- Standards Development Recommendations
- Control Technology Development Recommendations

5. Program Office at Interagency (Headquarters) Level.

Each alternative is analyzed, compared, and evaluated in terms of its advantages and disadvantages according to five evaluation criteria identified in Appendix F.

On the basis of these evaluations MITRE recommends that EPA adopt, for the long-term management of CCEA, the third alternative, which is briefly described as follows:

> Alternative 3. Program management is centered in a new division-level unit with responsibility for managing all environmental assessment activities within IERL-RTP. Policy and overall direction of the CCEA program, as one of the principal EA activities within the Laboratory, is set by an executive committee chaired by the director of the new division-level unit. Day-to-day activities are directed by a program manager who reports to the executive committee chairman.

The management structure for this alternative provides the communication channels needed for obtaining the needs, opinions and advice of all major users of CCEA products as well as communication between all CCEA participants (i.e., project officers of CCEA projects, contractors, etc.). By consolidating all major environmental assessment activities under a single line management at the division level, this structure facilitates planning, coordination, and direction of these activities to the benefit of the CCEA program as well as other major ongoing or planned EA programs. More than any other alternative considered, this one provides the level of managerial leverage and stability needed for successful implementation of the CCEA program.

The third alternative is not the most easily implemented, however. It involves a significant realignment of workload and responsibilities which effectively precludes immediate implementation. MITRE therefore recommends, as an interim measure, the immediate adoption of the second alternative, briefly described as follows:

> Alternative 2. Program management is centered in the existing organization at Utilities and Industrial Power Division, IERL/RTP, but is augmented by an advisory board representing a broad spectrum of potential users, and a working group representing major participating organizations (that is organizations conducting projects that fall within the CCEA program).

The structure implied by Alternative 2 provides the mechanism for improved communication among program management, program participants, and users of CCEA products (relative to the present management structure of the program) while not presenting any serious drawbacks.

The two-step approach to implementation of the long-term management structure will (1) permit continuous function of the CCEA program, (2) quickly provide needed inputs from an advisory committee that includes users of CCEA products, (3) quickly bring project officers of related projects into the CCEA management process at the working group level, and (4) provide for a strong, stable, long-term management structure for planning, coordinating, and directing all environmental assessment activities including CCEA.

E. CCEA PROGRAM CORE PROJECTS

The results of the survey to identify ongoing and planned R&D projects of relevance to the CCEA program yielded a set of over 500 projects.* The list included projects not only within IERL-RTP and EPA, but also in 14 different government agencies and other research organizations. While analysis of this vast body of information is central to achieving the overall goals and objectives of the CCEA program, resources currently available to the program prohibit the undertaking of an effort of such magnitude. Consequently, a manageable set of "core" projects is recommended for initial integration into the unified CCEA program. By application of the methodologies and analytical procedures described earlier to the set of core projects, the CCEA program would not only begin immediately to provide tangible results for use by decision-makers, but would also more fully test the methodology and facilitate any needed revisions within its various components.

Several basic selection criteria were developed to reduce the number of CCEA-related projects for inclusion in the core set. Since the selection process was carried out on preliminary data, some judgment in the use of these criteria had to be exercised. The five principal criteria used for the selection of core projects are outlined as follows:

1. Since those projects funded by EPA are more amenable to influence by the CCEA program than non-EPA projects, a greater weighting is given to EPA projects in selecting the core CCEA. In order to conduct a unified and coordinated environmental assessment, the CCEA program should have the capability to guide or redirect ongoing and future studies.

2. All projects selected should be ongoing or proposed.

3. Projects chosen should address a wide spectrum of environmental assessment areas. Since the CCEA program planning is an effort to develop an overall coordinated structure, the core selection should reflect the diversity of information necessary for the comprehensive environmental assessment of SCCP.

4. Projects chosen should reflect the emphasis of current environmental assessment R&D efforts. Priority should be given to heavily funded projects since funding levels usually indicate priorities established by the funding agencies.

5. Projects chosen should have substantial information readily available. This criterion is utilized after the others have been applied in order

*This survey was conducted by Research Triangle Institute. Results are reported in Reference 7 (listed in Section 6 of this report).

to provide a manageable number of R&D efforts for which a detailed analysis may be carried out.

The application of criteria 1 through 4 above yielded a set of 32 relevant projects from which the core CCEA projects were chosen. Criterion 5 was then applied to the above set to select 13 core projects for integration into the unified CCEA.* Table B-2 shows the title, EPA project officer, and period of performance of the selected core projects.

*It is stressed here again that the limited set of projects selected for detailed evaluation is not intended as a complete representation of the wide range of research being pursued by the many agencies involved in environmental assessment activities. Rather, it provides a basis for initial implementation of the CCEA program. Additional projects will be integrated as manpower and funding become available.

TABLE B-2. RECOMMENDED CORE CCEA PROJECTS

TITLE	PROJECT OFFICER	PERIOD OF PERFORMANCE
1. Characterization of Effluents from Coal-Fired Utility Boilers	R. A. Venezia	1/76-12/79
2. LG&E Full-Scale Scrubber Testing and Waster Disposal Program	J. W. Jones	3/76-9/78
3. Environmental Assessment of Stationary Source NO_x Control Technologies	J. S. Bowen	2/77-10/79
4. Design Optimization, Construction and Field Optimization of Integrated Residential Furnace	G. B. Martin	1/77-8/78
5. Combustion of Hydrothermally Treated Coal	J. D. Kilgroe	9/76-10/78
6. Emissions Characterization of Conventional Combustion Systesm	R. A. Venezia	3/77-1/80
7. Evaluation of Emissions and Control Technology for Industrial Stoker Boilers	J. H. Wasser	3/77-7/79
8. Environmental Assessment of After-burner Combustion Systems	J. H. Wasser	3/77-12/79
9. Test Program for the Full Scale Double Alkali FGD Utility Demonstration	N. Kaplan	6/77-6/81
10. Evaluation of Alternatives for Disposal of FGD Sludges	J. W. Jones	6/75-
11. Field Testing--Combustion Modifications of Industrial Combustion Equipment	R. E. Hall	1/76
12. The impact of Coal-Fired Power Plants on the Environment	G. E. Glass	7/75-7/78
13. Comparative Multimedia Assessment: Well-Controlled Coal-Fired and Oil-Fired Boilers	W. H. Ponder	3/77-12/78

APPENDIX C

DEVELOPMENT OF CCEA GOALS AND OBJECTIVES

A. RATIONALE

In the early developmental stages of the CCEA program planning, the goals and objectives of the program were simply defined. All of them related directly to control technology development. The principal goals were to determine whether additional control technology development is needed, and if so, to define and recommend among the several alternative courses of development. The interim objectives were to assemble the necessary data, characterize emissions/effluents from the more prevalent types of stationary conventional combustion equipment, determine levels of emission control required to meet standards, and assess whether existing technology is adequate to achieve these levels of control.

As the program planning progressed, it soon became apparent that the program goals and objectives could not be realistically defined solely in terms of control technology requirements, in isolation from emission/effluent and ambient standards, costs of achieving compliance, and at least a rough approximation of the effects of combustion pollutants on human health, the ecology, and the general quality of the environment. Questions immediately arose pertaining to the criteria against which adequacy of control technology is to be evaluated. Should the evaluation be limited to the capability to control the release of pollutants for which standards currently exist (or are currently being established)? If so, how should the release of other hazardous substances -- known toxic or carcinogenic material -- be treated? And how are emission concentrations of such materials to be measured when current field sampling and analysis techniques are not sensitive to the very low emission concentrations which can be bioaccumulated to levels known to be hazardous to health? Also, how should the cost of achieving compliance be factored into the program's recommendations pertaining to control technology development?

The program must address problems beyond the ability of existing control technology to meet existing standards if its findings and recommendations produced during the latter stages of the program are to be viable and relevant to conditions at that time. Moreover, if the program is to be forward-looking and anticipatory rather than totally reactive, it must take into account pollutants other than those for which standards have been written, and should assume the initiative of recommending other combustion-related materials for which additional standards and regulations appear warranted.

Another type of problem arose in connection with the highly simplified goals and objectives defined early in the CCEA planning process. This involved technical management, administrative and organizational responsibility of the work involved, flow of information, and implementation of recommended actions. The ongoing work on combustion pollutant assessment is now being performed by different organizational entities within EPA, and some related work is ongoing within non-EPA organizations. Through what mechanism could these diverse efforts be coordinated and their results integrated? How could the various participants be kept apprised of one anothers' objectives and results so as to minimize duplication of effort, promote utilization of one anothers' results, and thereby increase the efficiency of the aggregate effort? If substantive recommendations were made concerning the needs and priorities for control technology development or for the development of additional standards, how could these recommendations be most effectively conveyed to the appropriate implementing authorities? What provisions exist for review, feedback, and redirection among participants in the CCEA program and between CCEA participants and the users of their products (e.g., the implementing agencies)? The program must involve at least a minimal realignment of managerial responsibility if its results are to be effectively utilized and its recommendations are to be thoroughly evaluated and considered for implementation.

As a result of the several conceptual and practical problems, both technical and administrative, that came to light during the development of a program plan designed to meet the initial simplified set of objectives, the decision was made to expand the goals and objectives of the program. These were to include guidance and recommendations for standards setting as well as control technology development, and the structuring of an administrative/managerial system that would enable the diverse elements of the program to function effectively and to interrelate in a coordinated, mutually supportive manner. The supporting objectives were classified and defined in greater detail according to technical or administrative purposes served.

The subsections that follow identify and briefly describe both the goals and objectives arranged according to their principal function.

B. OVERALL OBJECTIVES

1. CCEA Organizational and Administrative Objectives

- Establish a centralized office for administering and directing all CCEA-related activities and integrating these into a cohesive program

  This objective is set forth in recognition of the existing dispersion within EPA of activities relating to the assessment of pollutants from combustion, and the need to coordinate and augment these activities into a comprehensive program.

- Establish channels for communicating CCEA results to implementing organizations, and for establishing and responding to dialog with these organizations

  The CCEA program is designed to develop and analyze data, and to make recommendations based on the analyses. The recommended actions are referred to implementing organizations, within EPA or elsewhere, to determine which actions are to be taken and to implement them. This objective is intended to insure that the implementing organizations are continually apprised of developments under the CCEA program which might impact their operations, and to insure that recommended actions and other outputs of the CCEA program are presented in a format, and with clarity and completeness to facilitate the decision-making processes of the implementing organizations.

2. Combustion Process/Pollutant Characterization Objectives

- Develop a comprehensive base of available data on combustion pollutants

  Much of the data and other information required for the CCEA program already exists at a variety of locations within CCEA projects and elsewhere while additional information is currently being developed. One of the first tasks scheduled to be undertaken in the CCEA program is the compilation of all available data pertaining to pollutants from SCCP. This compilation will include data on the components and quantities of emissions/effluents from each type of stationary combustion process as well as information on the effects of such materials on human health, the ecology, and the general environment. The compilation of available data, although a continuing process, is scheduled to develop rapidly during the early phase of the CCEA program, and to support the accomplishment of other interim objectives as well as long-term goals.

- Obtain essential new data from field tests

  The base of available data developed in achieving the preceding objective will permit data gaps to be identified and additional data needs defined. Principal among these will be data to be obtained by field measurement of combustion processes/equipment for which emissions have not been fully characterized. A major effort within the CCEA program, as currently planned, is the acquisition of new information by direct measurement on pollutant emissions from major types of combustion equipment operating under a range of conditions.

- Develop recommendations for existing sampling and analysis methods

  Detection and measurement of combustion pollutants in emission or effluent streams and in the atmosphere is necessary both for acquiring data to implement the CCEA program and for subsequent routine monitoring and enforcement. An objective of the program is to examine the adequacy of existing sampling and analysis methods for use in the CCEA program, and, if not fully adequate, to recommend additional development of methods and procedures for their use.

- Characterize emissions/effluents from each major type of stationary conventional combustion process

  From the field measurements made under the CCEA program plus data available elsewhere, pollutant types and quantities released from each major category of equipment will be determined during a range of standard and non-standard operating conditions. This comprehensive characterization is needed as a basis for estimating total aggregate quantities emitted from all sources of each type and for estimating the impacts on health and the environment. While complete characterization of all pollutant species from each major type of source is desired, some lesser degree of characterization may be acceptable during the early stages of the program as a basis for estimating health and ecological impacts and for identifying control technology requirements.

  This objective will involve determining the minimum acceptable degree of pollutant characterization, and implementing this characterization, for each major category of conventional stationary combustion equipment.

3. Health/Ecology/Environmental Impact Assessment Objectives

- Estimate health, ecological, and environmental effects of combustion pollutants

  These effects estimates are to be used as one of the major criteria for establishing priorities among the recommended actions for modification or development of control technology and standards. When such estimates of effects are not available from other studies, they are to be developed under the CCEA program by the use of mathematical models or other effects-estimation techniques, used in conjunction with pollutant emission data and meteorological, hydrologic, demographic and other characteristics of the areas affected by combustion pollutants. In stating this objective, the planners of the CCEA program recognize that a tremendous effort would be required if the effects estimation were begun anew. It is their observation that much of the effects information is already available, and that existing effects-estimating techniques will provide most of the (quantitative) approximations of health, ecological, and environmental impacts that are needed for decision-making relative to the development or modification of control technology and standards. Three supporting subobjectives follow.

- Estimate quantities of combustion pollutants released

One necessary step toward developing quantitative estimates of health and ecological effects of combustion pollutants is to obtain substantive estimates of the amounts of pollutants that would be released, assuming projected levels of fuel use for defined applications and various levels of pollution control. The estimated quantities of pollutants released will be used as input to effects-estimating techniques to obtain quantitative estimates of the impacts of combustion pollutants on human health, the ecology, and the general environment.

- Identify available models and other effects-estimating techniques

A second requirement for quantitatively estimating the health and ecological impacts of combustion pollutants is to have appropriate models or other techniques for translating quantities of emitted pollutants into quantitative measures of health, ecological, and environmental effects. An objective of the CCEA program is to identify the currently available models, such as the Source Analysis Models (SAM), and to assess their applicability and adequacy for producing quantitative estimates of effects with the accuracy and validity needed for decision-making.

- Define priority areas for health/ecology/environmental impact studies

All pollutants or potential pollutants are not of equal importance from the standpoint of their prevalence or their health and ecological effects. Some have been much more thoroughly investigated than others. Similarly, all types of SCCP are not of uniform importance from the standpoint of their prevalence or impacts. An objective of the CCEA program is to establish a priority ranking for specific pollutants and specific combustion processes. This ranking will be used to guide the projects and investigations conducted within the CCEA program, and will form the basis for recommended areas of study by other EPA operational programs and organizational components, particularly those concerned primarily with health and ecological effects.

4. Technology and Information Transfer Objectives

- Transfer technical information to appropriate user organizations

All principal activities of the CCEA program involve the acquisition and analysis of information, and the development of recommendations based on the analyses. If the program is to have practical results beyond the scope of an academic exercise, its conclusions and recommendations must be communicated to a number of key organizations within EPA and elsewhere with the responsibility and capability of evaluating the recommended actions and implementing those having greatest urgency or merit. If the CCEA program is to have maximum utility, its technical data and methods must be communicated to an even broader audience of potential users. These communications and technology transfer objectives are to be accomplished by a sequence of periodic publications on the status of the program (annual reports), published technical reports on results of individual CCEA projects, status briefings and conferences with EPA management, and general CCEA and EA symposia involving the technical community.

5. <u>Control Technology Development Objectives and Goals</u>

- <u>Identify promising new control technologies applicable to specific combustion pollutants and combustion equipment/processes</u>

  The identification of new or improved approaches for meeting established pollution control needs is an important output of the program. The results may be in any of several forms such as: new equipment designs; specifically identified opportunities for increased control efficiency of new or existing equipment; identification of additional reaction mechanisms not previously used for pollutant emission control; or the substitution of less expensive or more effective reactants for those in current use. These results are needed to support the program's major goals pertaining to control technology development, namely:

  - to assess the adequacy of existing technology to control the release of pollutants from combustion processes,

  - to assess the need for modifications to existing control technology and for the development of new control technology, and, if such needs exist, to provide guidance and recommend priorities for the technology development actions.

6. <u>Standards Modification and Development</u>

- The program's major goals relative to standards are:

  - to assess the adequacy of existing emission or effluent standards that limit the release of pollutants to the environment,

  - to assess the need for additional standards or modification to existing standards and, if such needs exist, to provide guidance and recommend priorities for EPA's standard setting activities (including identification of specific substances and combustion processes and equipment for which new or modified standards appear needed).

APPENDIX D

COMPREHENSIVE ENVIRONMENTAL ASSESSMENT METHODOLOGY

A. ENVIRONMENTAL ASSESSMENT DEFINITION AND OBJECTIVES

The growing awareness of the range of direct and indirect environmental consequences of modern technology has given rise to new categories of investigative studies along with new terminology to describe these studies. Technology Assessments (TAs), Environmental Impact Statements (EISs), Integrated Technology Assessments (ITAs), Environmental Assessments (EAs), etc., are being generated every year. Concise definitions of these terms, however, are quite difficult to find. This is especially true for an EA. Many studies are called environmental assessments when they are principally emission characterizations or a single pollutant impact identification.

The Energy Assessment and Control Division of IERL-RTP has developed a working definition of an environmental assessment that is becoming accepted by the research community. This definition is given in Section 3 of this report.

An environmental assessment involves neither the development or promotion of the combustion process nor the development or promotion of technology to control emissions from the combustion process. It is a continuing process that is carried out simultaneously with technology development to identify and evaluate the full range of impacts (including cross-media impacts and trade-offs) of the combustion process and/or control technology on the environment. The findings of an environmental assessment are aimed at providing a base of sound information for use by energy/environmental decision-makers for:

- Standards Setting
- Control Technology Development
- Policy Formulation
- Resource Allocation

Outputs from a comprehensive environmental assessment would range from mere listings of pollutant emissions and descriptions of evaluation techniques to identifications of quantified environmental impacts and to specific recommendations for decision-making.

B. FUNCTIONAL ACTIVITIES

What, then, is the range of activities that must be undertaken in order to satisfy the objectives of a comprehensive environmental assessment? What are the input requirements for these activities, and what are the relationships between the activities? Where does one draw the boundaries for an environmental assessment?

EPA/IERL-RTP has been active for some time in answering the above questions and in developing a methodology to incorporate EA components into its major programs. The environmental assessment methodology employed in the CCEA program draws heavily on the philosophies of the existing EPA/IERL-RTP methodology, but has been expanded and modified to be more responsive to the assessment of conventional combustion processes.

1. Generalized Environmental Assessment Methodology

In the most elementary of descriptions, an environmental assessment consists of three basic iterative steps (see Figure D-1).

(1) Characterization of the combustion process (including any associated pollution control devices) and its effluents.

(2) Assessment of the health and ecological impacts of the combustion process and its effluents on the environment:

- Identification of environmental (health and ecological) impacts.
- Development of environmental goals and objectives.
- Comparison of impacts with environmental goals and objectives.
- Assessment of pollution impacts' magnitude.

(3) Evaluation of alternative control strategies for use with the combustion process.

The first step in an environmental assessment is to characterize completely the combustion process in terms of a "black box" to identify all the pollutants emitted from the process, the quantities emitted, and the nature of the emissions (e.g., media involved, load distribution over time, and physical/chemical characteristics of the pollutants).

Once complete information on the effluents from the combustion process has been obtained, the second step of the environmental assessment is to determine the impacts of the process and its effluents on the environment. This process involves four general activities: (1) identification of the health and ecological impacts, (2) development of environmental goals and objectives, (3) comparison of the impacts with the goals and objectives to determine whether the impacts are acceptable, and (4) assessment of the pollution impacts' magnitude. If the results of activity three in this step indicate that the impacts of the combustion process and its effluents on human health and the ecology are acceptable according to current environmental goals and objectives, then no problem is foreseen and the environmental assessment process has been completed. If, however, the results

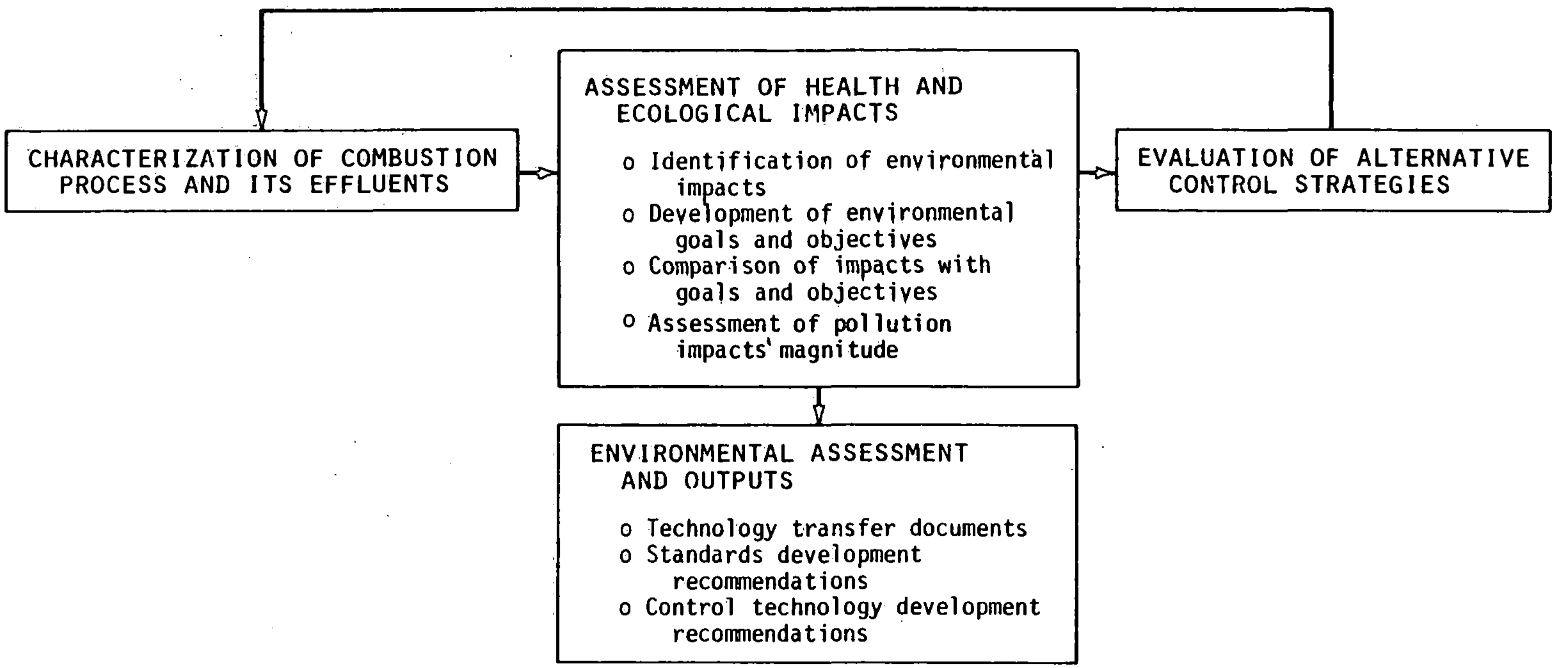


Figure D-1. Generalized environmental assessment methodology.

indicate that the impacts of the combustion process or its effluents are not acceptable according to current environmental goals and objectives, then the magnitude of the impacts must be assessed in activity four and ways to ameliorate these impacts must be identified.

The third step in an environmental assessment is to identify and evaluate alternative methods of reducing the deleterious environmental impacts and to select the optimum control strategy for use with the combustion process.

This entire procedure is repeated for the combination of the given combustion process and the control technology selected in step three and for each combustion process considered by the environmental assessment. Technical reports are developed at every stage in the application of the environmental assessment methodology. Where impacts of the combustion process or its effluents on human health or ecology are serious, or where optimum existing control technologies are inadequate, specific recommendations for the promulgation of stricter environmental standards or for the development of additional control technologies are made for consideration by the appropriate decision-makers.

Detailed Environmental Assessment Methodology

A detailed environmental assessment methodology consists of various functional categories of information which interact to provide the desired data, information, or results.

As stated above, the first step in a comprehensive environmental assessment is the characterization of the combustion process and its effluents. Such a characterization comprises five functional categories of information:

- Combustion Process Technology Characteristics
- Fuels Characterization
- Input/Output Characterization
- Development of Sampling and Analysis Techniques
- Field Tests and Surveys

Figure D-2 shows the elements of each functional category and the relationship between the characterization of the combustion process and its effluents and the identification of the health and ecological impacts activity of step two. Each functional category in this step is briefly described below.

Process Technology Characteristics is intended to provide detailed technical and operational information on the SCCP. Information on the state-of-the-art of the combustion process including development status and commercial availability, process economics, energy efficiency, and reliability are considered in this functional category.

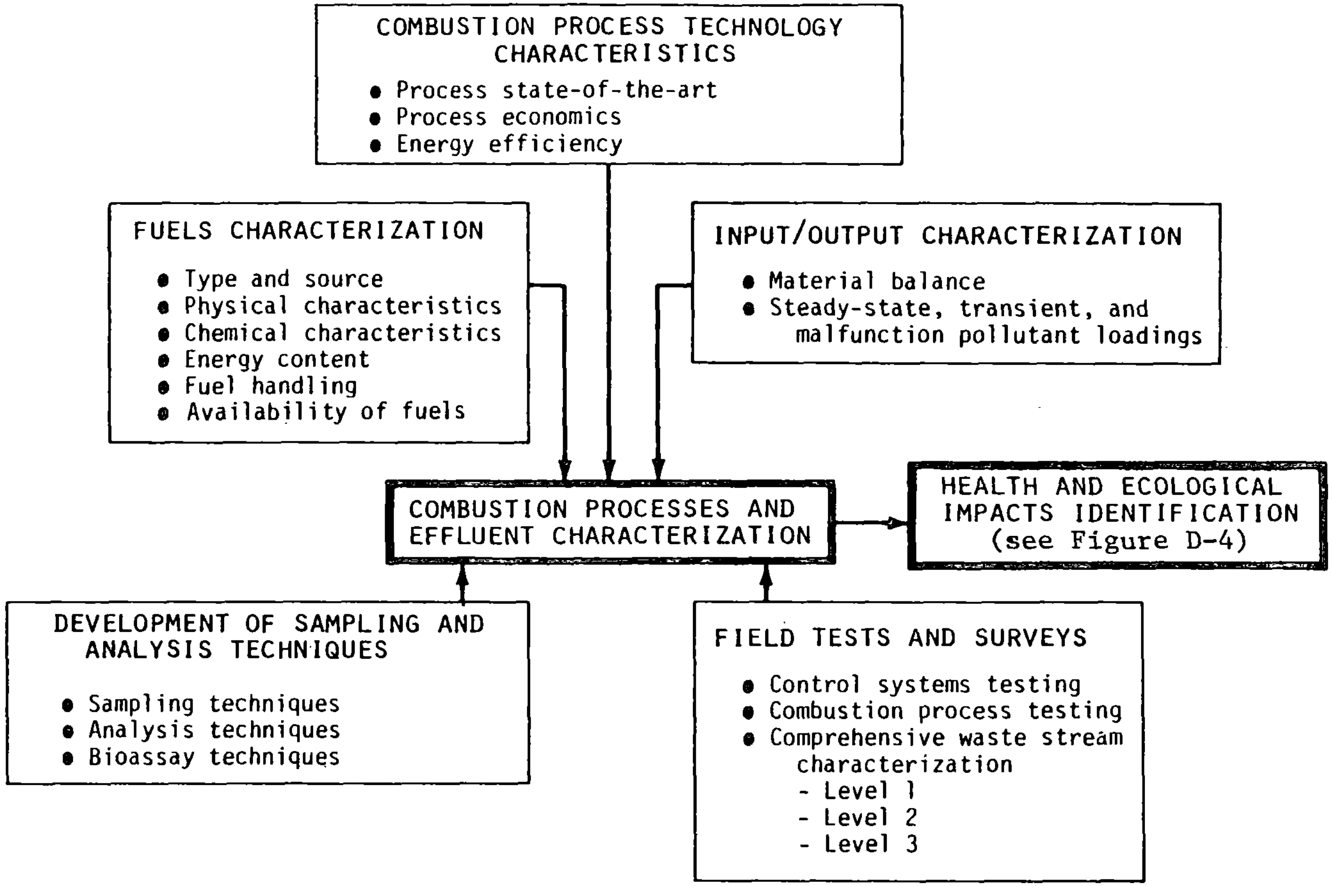


Figure D-2. Combustion processes and effluent characterization (step one).

Fuels Characterization includes a description of the type and source of the fuel, physical and chemical characteristics including potential pollutants, energy content, fuel handling including methods of delivery and storage, and availability.

Input/Output Characterization to establish the relationship among the process variables is an important environmental assessment functional category. Material balances for the combustion process and potential pollutant loadings for a variety of operating conditions such as steady-state, transient, and malfunction or other nonstandard states, are developed.

Development of Sampling and Analysis Techniques (including bioassay techniques) are essential for assuring consistent and reliable results for comparison of data obtained by various investigators.

Field Tests and Surveys using the standard sampling and analysis techniques are conducted to fully quantify and characterize the effluents. These tests and surveys are conducted on bench, pilot, demonstration, or full scale plants. EPA has established a detailed, phased screening, analysis, and monitoring protocol for various levels of waste stream characterizations.* The three levels of characterization are:

Level 1 - Comprehensive Screening (including "Criteria Pollutants").

Level 2 - Directed Detailed Analysis based on Level 1 findings.

Level 3 - Process Monitoring on Selected Priority Pollutants based on Level 1 and Level 2 findings.

The second step in an EA, the assessment of the health and ecological impacts of the combustion process and its effluents, is shown in Figure D-3. The assessment of health and ecological impacts involves four general activities.

1. Identification of the health and ecological impacts of the combustion process and its effluents.

2. Development of environmental goals and objectives.

3. Comparison of the impacts with the environmental goals and objectives.

4. Magnitude of pollution impacts.

The identification of the health and ecological impacts of the combustion process (including any associated control technology) is the first activity of the second step. It includes detailed analysis of the response of the environment and the exposed population's health to the pollutant loadings of the process. This includes data collection and analysis relating to the air, water and land quality, ecology-related effects, increased morbidity and mortality rates, and quantified media degradation alternatives.

*See References 4 and 5 in Section 6 of this report.

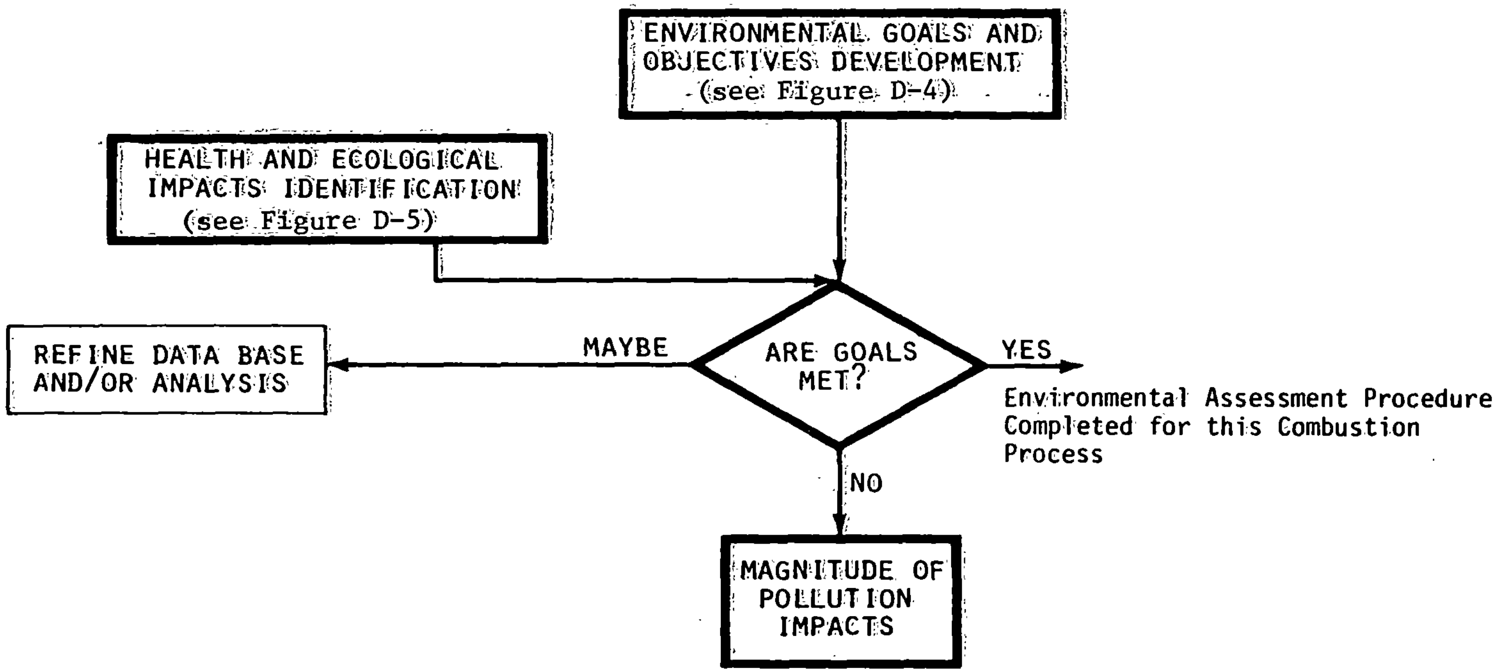


Figure D-3. Assessment of health and ecological impacts (step two).

Combustion process and effluent characterization (the first step), previously discussed, serves as an input in Figure D-4. Additional inputs to this activity are provided by the following functional categories:

- Ecological Impacts
- Dose-Response Data
- Pollutant Transport, Transformation, and Fate Models
- Bioassay Data
- Epidemiological Data

Ecological Impacts identification is necessary to evaluate relevant information to quantify such concepts as media degradation.

Dose-Response Data allow the translation of pollution concentrations in the environment into an estimate of the number and type of specific biological impacts to be expected in an exposed population. Dose-response data relate exposure concentration and exposure time to the probability of observing a given biological response. Thus the exposure to a given SO_2 concentration for 3 hours may be expected to result in a certain number of cases of respiratory ailments, or a given average annual SO_2 concentration may result in an estimate of increased mortality. In addition to available dose-response data such as threshold limit values (TLV) and lethal concentration for 50 percent mortality in the exposed population (LC 50), information in terms of cancer, leukemia, respiratory disease, or other chronic or acute responses is often important in identifying the health and ecological impacts of the combustion process and its effluents.

Pollutant Transport, Transformation, and Fate Models are used in calculating pollutant concentrations and exposure levels. Meteorological and hydrological data, and pollutant chemical transformation and reactivity data must be developed for use in the models.

Bioassay Data identifying the effects of varying concentrations of pollutants on living organisms serve to augment dose-response data. Included among the bioassays of interest are those relating to health and ecological effects. Health effects-related bioassays include:

- Microbial bioassays (e.g., *Salmonella typhimurium* bacterial mutagenicity screening test).
- *In vitro* bioassays (e.g., alveolar macrophage cytotoxicity tests, epithelial cell carcinogenicity screen).
- *In vivo* bioassays (e.g., mammalian toxicity tests, carcinogenicity screen).

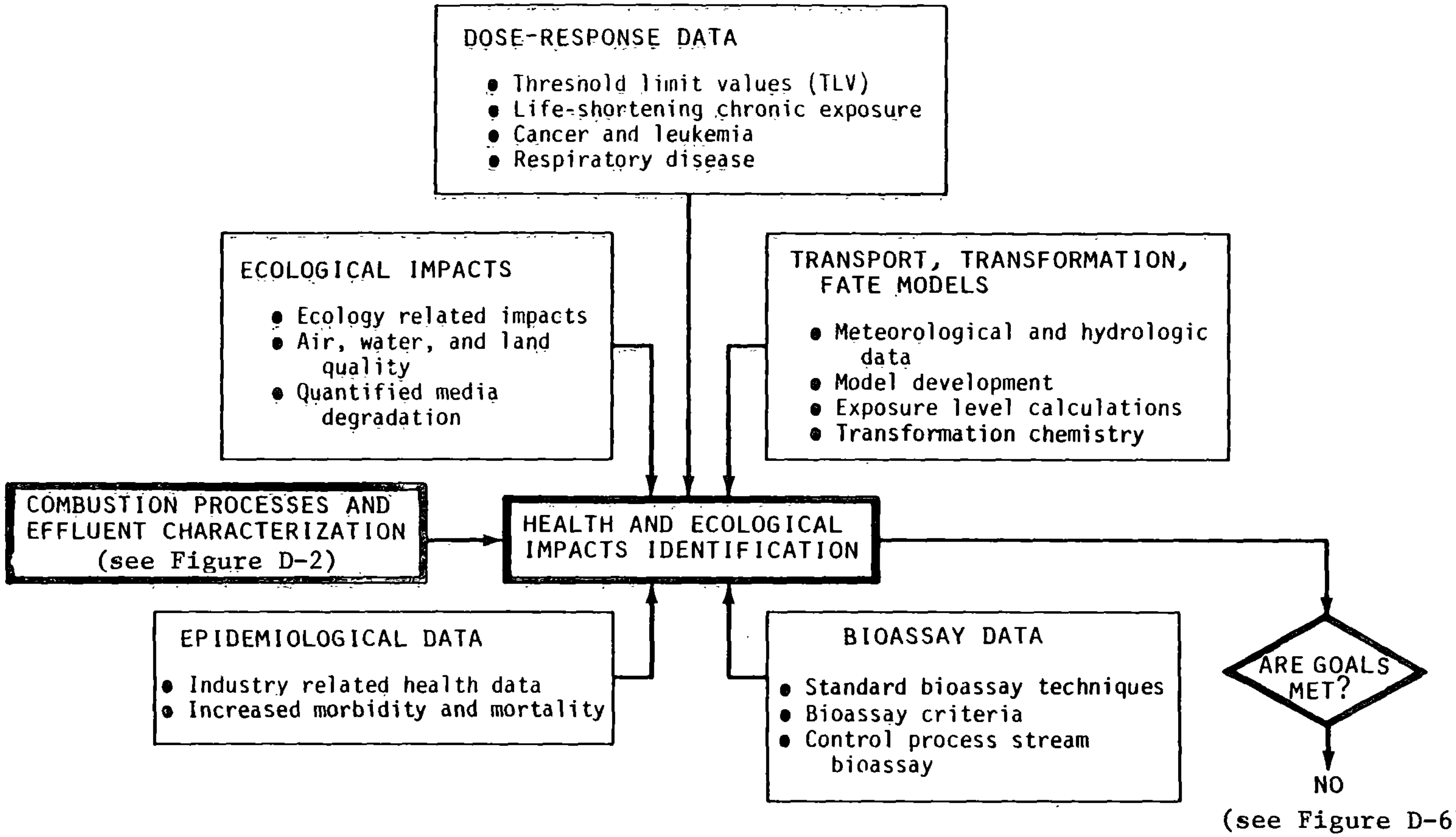


Figure D-4. Health and ecological impacts identification (first activity, step two).

Ecological effects-related bioassays include:

- Laboratory studies on single/multiple plant or animal species (e.g., acute toxicity studies, carcinogenicity screening tests).
- Microcosm studies of terrestrial, marine, or aquatic communities.
- Field studies of ecosystems.

Epidemiological Data developed from occupational exposure-related health information are important indicators of potential adverse pollutant impacts. Examination of vital statistics and data on specific illnesses and diseases in exposed populations may allow identification of the specific agent responsible or alert investigators to the possibility of such effects being associated with a particular process.

The second activity in the assessment of the health and ecological impacts (second step) is the development of environmental goals and objectives. These environmental goals and objectives are developed as standards or indices of acceptability. These indices of acceptability are based on a variety of interrelated factors including health effects, ecological effects, physical effects, socioeconomics, and institutional/political and legals constraints. These environmental goals and objectives may be expressed in such terms as process/pollutant emission rates, ambient pollutant concentrations in the various media, or environmental nondegradation criteria. As shown in Figure D-5, the four major functional categories to be addressed in developing the environmental goals and objectives include:

- Statutory Constraints
- Emission or Ambient Level Goals
- Social/Economic/Political/Institutional Considerations
- Ambient Pollutant Levels

Statutory Constraints considered in developing environmental goals and objectives include:

- National Primary and Secondary Ambient Air Quality Standards
- State Implementation Codes
- OSHA Standards for Air Contaminants
- National Emission Standards for Hazardous Air Pollutants
- New Stationary Source Performance Standards
- National Interim Primary Drinking Water Regulations
- EPA Effluent Standards

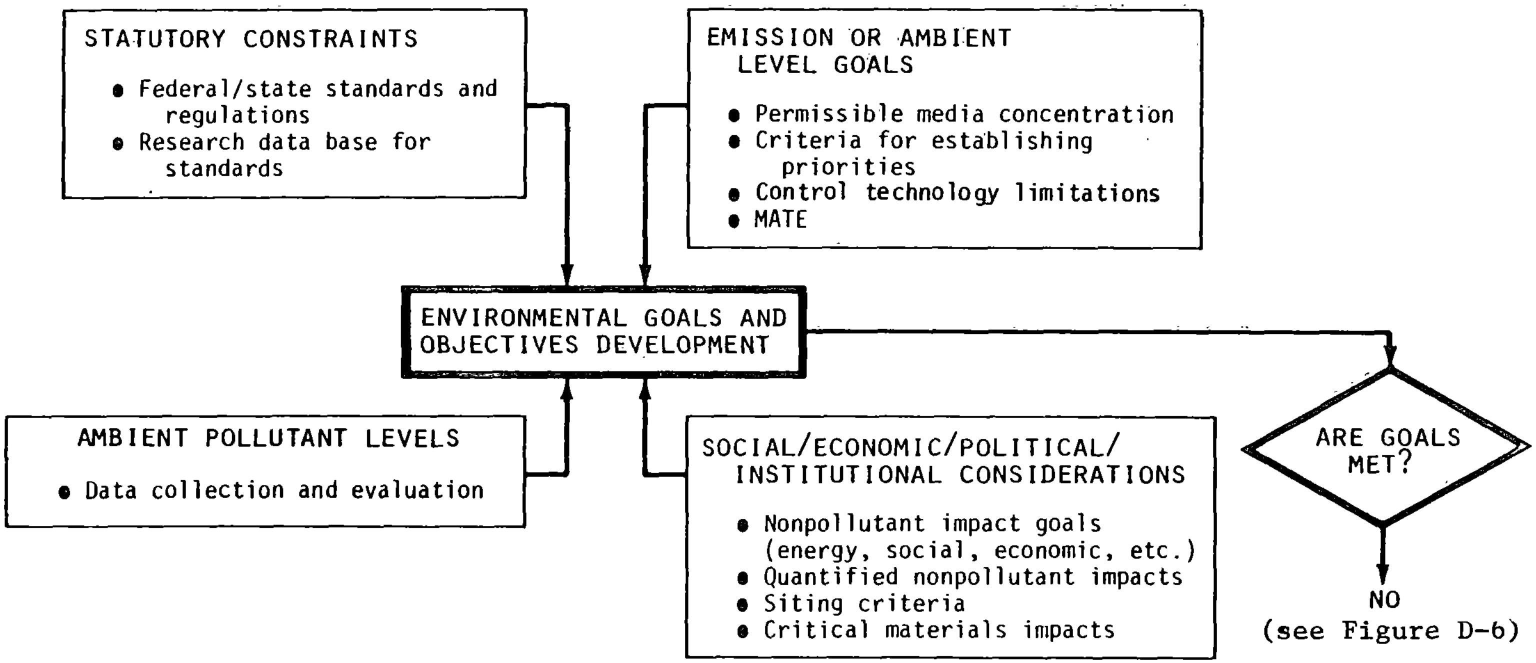


Figure D-5. Development of environmental goals and objectives (second activity, step two).

- EPA Toxic Pollutant Effluent Standards (proposed)
- EPA Pesticide Limits
- Criteria for the Evaluation of Permit Applications for Ocean Dumping of Materials

Emission or Ambient Level Goals for each of the applicable air, water or land media may be based on control technology capacilities or on ambient factors. Goals based on control technology capabilities consider performance data on Best Available Technology (BAT), Best Practicable Technology (BPT), or engineering estimates for developing technologies to establish pollutant emission level indices. Goals based on ambient factors are dependent on the health or ecological effects of the pollutant. Minimum Acute Toxicity Effluent (MATE)* values and Ambient Level Goals multiplied by appropriate dilution factors comprise two sets of emission level goals based on ambient factors. Ambient level goals reflect current or proposed Federal regulations or criteria or, in the absence of such established control levels, they are estimated permissible concentrations (EPC's) derived from existing toxicity data through various models.

Social/Economic/Political/Institutional Considerations in developing environmental goals and objectives include a variety of quantitative and qualitative factors such as the impact of the combustion process on land use and degradation, water use, and other factors including energy use patterns, social/cultural patterns, regional and national economy, aesthetics, siting criteria, and critical materials impacts.

Ambient Pollutant Levels must be considered in setting such environmental goals as "no significant deterioration" (elimination of discharge based on not exceeding natural background levels). This can best be achieved through extensive data collection and evaluation.

EPA/IERL-RTP has established a format for evaluating the information in each of the functional categories discussed above in order to develop measures of acceptability for each pollutant. These measures of acceptability called Multimedia Environmental Goals (MEGs)* are similar to the Emission or Ambient Level Goals described earlier, but include consideration of the other three functional categories. An example of a MEG for the compound 2-aminonaphthalene is shown in Table D-1. Table D-2 shows a background information sheet summarizing all pertinent information used in developing the MEG for the compound. Currently, approximately 350 organic and 300 inorganic substances are on the MEG list.

The third activity in step two is the comparison of the health and ecological impacts identified earlier with the goals and objectives developed above. If all the health and ecological impacts are acceptable by current goals and objectives, then the EA process is finished. If there is any question about the acceptability of the impacts due to insufficient or unreliable data, a data refinement and re-evaluation interaction may be necessary to draw final conclusions. If, on the other hand, the impacts of the combustion process and its effluents are unacceptable according to current environmental goals and objectives, then the magnitude of these impacts must be assessed and methods to ameliorate or control them must be identified.

*See References 4 and 6 listed in Section 6 of this report.

TABLE D-1. SAMPLE MEG CHART*

MULTIMEDIA ENVIRONMENTAL GOALS

X
10C
2-AMINONAPHTHALENE

EMISSION LEVEL GOALS

	I. Based on Best Technology		II. Based on Ambient Factors				
	A. Existing Standards	B. Developing Technology	A. Minimum Acute Toxicity Effluent		B. Ambient Level Goal*		C. Elimination of Discharge
	NSPS, BPT, BAT	Engineering Estimates (R&D Goals)	Based on Health Effects	Based on Ecological Effects	Based on Health Effects	Based on Ecological Effects	Natural Background*
Air, $\mu g/m^3$ (ppm Vol)			1.65E2		0.4		
Water, $\mu g/l$ (ppm Wt)			2.5E3	1.0E2	6	50	
Land, $\mu g/g$ (ppm Wt)			5.0E0	2.0E-1	0.012	0.1	

*To be multiplied by dilution factor

AMBIENT LEVEL GOALS

	I. Current or Proposed Ambient Standards or Criteria		II. Toxicity Based Estimated Permissible Concentration		III. Zero Threshold Pollutants Estimated Permissible Concentration
	A. Based on Health Effects	B. Based on Ecological Effects	A. Based on Health Effects	B. Based on Ecological Effects	Based on Health Effects
Air, $\mu g/m^3$ (ppm Vol)			59		0.4
Water, $\mu g/l$ (ppm Wt)			291	50	6
Land, $\mu g/g$ (ppm Wt)			0.6	0.1	0.012

*See Reference 6 listed in Section 6 of this report.

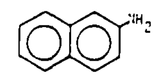
TABLE D-2. SAMPLE MEG BACKGROUND INFORMATION SHEET*

CATEGORY: 10C

WLN: L66J CZ

2-AMINONAPHTHALENE: $C_{10}H_9N$ (2-naphthylamine, β-naphthylamine).
White crystals that darken on exposure to light and air; volatile with steam.

STRUCTURE:



PROPERTIES:

Molecular wt: 143.19; mp: 113; bp: 306; d: 1.0614^{98}_{4}; vap. press.: 1 mm at 108° C; volatile in steam; slightly soluble in cold water.

NATURAL OCCURRENCE, CHARACTERISTICS, ASSOCIATED COMPOUNDS:

2-Naphthylamine does not occur as such in nature, but is formed by the pyrolisis of nitrogen-containing organic matter. It has been isolated from coal-tar (ref. 44). It has, in general, the characteristics of primary aromatic amines. It is a weak base.

TOXIC PROPERTIES, HEALTH EFFECTS:

Epidemiological studies have shown that occupational exposure to 2-aminonaphthalene is strongly associated with the occurrence of bladder cancer. There is no doubt that the compound is a human bladder carcinogen (ref. 44). 2-Aminonaphthalene is also reported to cause cancer in several animal species.

The EPA/NIOSH ordering number is 7628. The lowest dose to induce a carcinogenic response is reported as 18 mg/kg. The adjusted ordering number is 423.8.

LD_{50} (oral, rat): 727 mg/kg.

Aquatic toxicity: TLm 96: 10-1 ppm (ref. 2).

REGULATORY ACTIONS, STANDARDS, CRITERIA, RECOGNITION, CANDIDATE STATUS FOR SPECIFIC REGULATION:

2-Aminonaphthalene is recognized by ACGIH as a carcinogenic agent in humans. No TLV has been assigned.

2-Naphthylamine was the subject of a NIOSH Hazard Review Document (ref. 43).

OSHA standards dealing with exposure of employees to 2-naphthylamine has been established taking into consideration substantial evidence that 2-naphthylamine is known to cause cancer (ref. 17).

MINIMUM ACUTE TOXICITY CONCENTRATIONS:

Air, Health: $7 \times 10^4/423.8 = 165\ \mu g/m^3$

Water, Health: $15 \times 165 = 2.5 \times 10^3\ \mu g/\ell$

Land, Health: $0.002 \times 2.5 \times 10^3 = 5\ \mu g/g$

Air, Ecology:

Water, Ecology: $100 \times 1 = 100\ \mu g/\ell$

Land, Ecology: $0.002 \times 100 = 0.2\ \mu g/g$

ESTIMATED PERMISSIBLE CONCENTRATIONS:

$EPC_{AH2} = 0.107 \times 727 = 78\ \mu g/m^3$

$EPC_{AH3} = 0.081 \times 727 = 59\ \mu g/m^3$

$EPC_{WH1} = 15 \times 59 = 3{,}500\ \mu g/\ell$

$EPC_{WH2} = 0.4 \times 727 = 291\ \mu g/\ell$

$EPC_{LH} = 0.002 \times 291 = 0.6\ \mu g/g$

$EPC_{AC2} = 10^3/(6 \times 423.8) = 0.4\ \mu g/m^3$

$EPC_{WC} = 15 \times 0.4 = 6\ \mu g/\ell$

$EPC_{LC} = 0.002 \times 6 = 0.012\ \mu g/g$

$EPC_{WE1} = 50 \times 1 = 50\ \mu g/\ell$

$EPC_{LE} = 0.002 \times 50 = 0.1\ \mu g/g$

*See Reference 6 listed in Section 6 of this report.

The assessment of the magnitude of those pollution impacts not considered acceptable according to the goals and objectives is the fourth activity in step two (the assessment of health and ecological impacts). The major functional categories in this activity include:

- Combustion Process Use Projections
- Synergistic and Multimedia Impacts
- Total Pollutant Load Calculations
- Regional Geographic Data
- Pollutant Priority Ranking

These functional categories and their elements are shown in Figure D-6.

Combustion Process Use Projections are used to determine the number and distribution of the combustion process in use both now and in the future (to the year 2000). Factors considered in this functional category include current and projected market size and fuel supply/demand projections. Information developed in this functional category is used for total pollutant load calculations.

Synergistic and Multimedia Impacts are key considerations in comprehensive quantification of pollution impacts. For example, SO_2 emitted to the atmosphere may react with water to form acid and pollute surface and groundwater systems. Another multimedia effect is the leaching of heavy metals from solid waste disposal sites. Synergistic impacts such as the additive, transformation, or enhancement effects of two or more pollutants are also included in this functional category.

Total Pollutant Load Calculations are based on three types of information: (1) process loading, (2) loading from other sources, and (3) natural background loading. Total process loading is calculated in simple terms by multiplying the pollutant load from each combustion process by estimates of the number of such processes (determined in the process use projections functional category). Similarly, pollutant loadings from other conventional and nonconventional combustion sources must be determined to calculate the total pollutant loading from all combustion sources. In addition, natural background loading from non-manmade sources must be determined in calculating the total pollutant load to the environment.

Regional Geographic Data important in quantifying the environmental impacts include regional population growth projections, and local hydrology and meteorology. These data evaluated in terms of the regional total pollutant load and health effects data should form the basis of environmental impacts quantification.

Pollutant Priority Ranking is then developed using the above data and degree of hazard calculations (severity indices). This ranking is useful in identifying standards or pollution control needs.

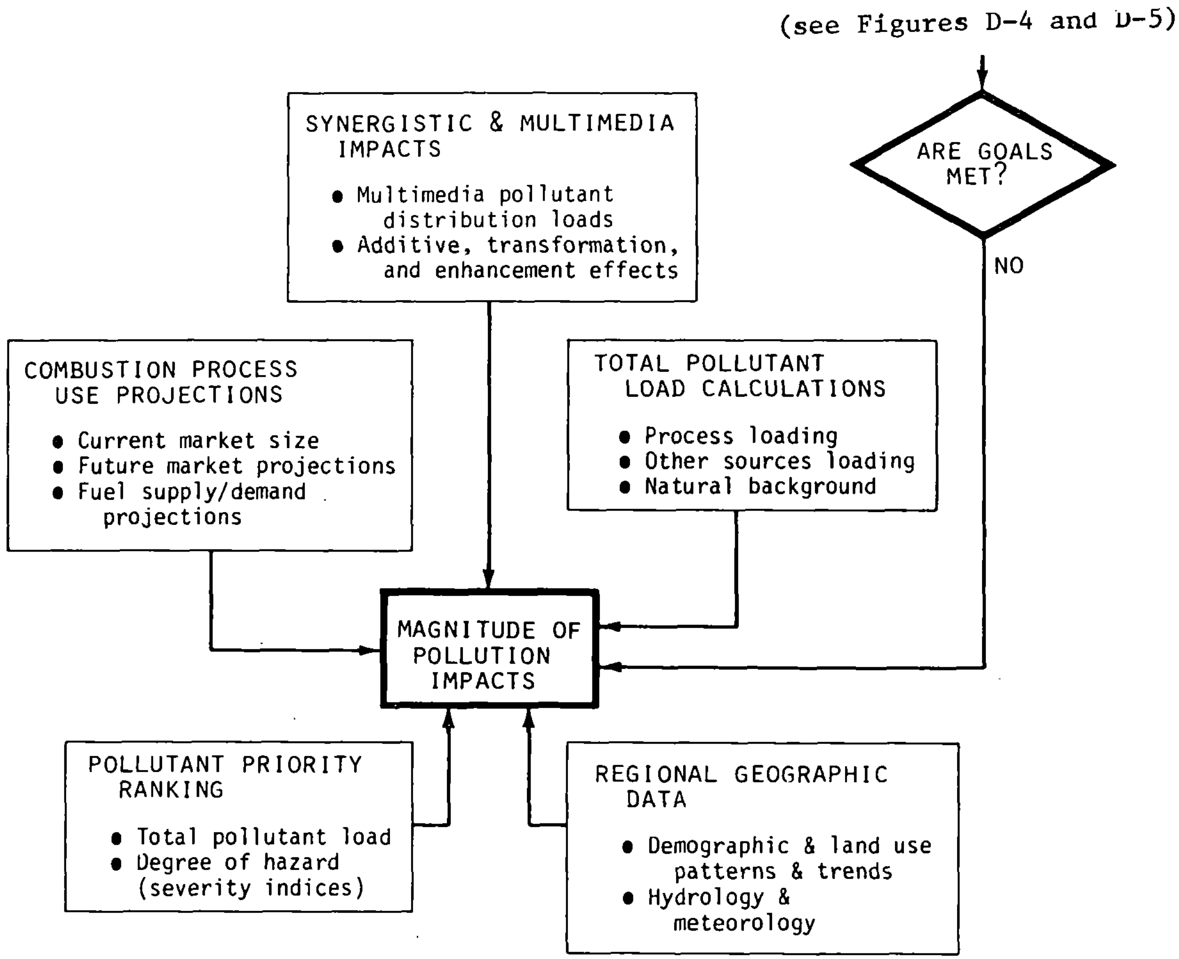


Figure D-6. Magnitude of pollution impacts (fourth activity, step two).

Standards Development Recommendations result when impacts of the combustion process or its effluents on human health or ecology are serious and no government standards exist to control these impacts. The identification of a need for modification or development of new standards is one of the major outputs of comprehensive environmental assessment. Recommendations for stricter (or more lax) standards should be ranked in order of priority and should be justified by specific data. Information on the degree of control desired and a time-frame for promulgation would accompany such recommendations.

The third step in a comprehensive environmental assessment, Alternative Control Strategy Evaluation, is heavily dependent on the results of the first two steps. As shown in Figure D-7, the identification, evaluation, and selection of optimum alternative strategies or technologies to control unacceptable environmental impacts of the combustion process or its effluents include functional categories of information on:

- Control Alternatives
- Control Strategy Environmental Impacts
- Control Strategy Evaluation

Control Alternatives addressing unacceptable pollutant impacts are identified based on existing technologies or on developmental technologies expected to become available in the near future. Alternatives considered include not only add-on control systems, but also such strategies as combustion modification or fuel switching/mixing. All reasonable alternatives are identified in this functional category for further evaluation and selection.

Control Strategy Environmental Impacts must be considered in order to assess any secondary environmental problems associated with the operation of the control system itself. This is necessary since many control systems emit substance(s) particular to their operation while others produce wastes (such as ash or sludge) as by-products of their operation. Options for the environmentally acceptable disposal of these wastes are identified and evaluated in this category. Cross-media impacts are also important elements to consider in evaluating the environmental impacts of the control system. For example, while flue gas desulfurization (FGD) reduces gaseous pollutant emissions, it has a cross-media impact by increasing liquid and solid pollutants that require environmental control.

Control Strategy Evaluation is aimed at determining the optimum pollution control alternative for the particular pollutant, effluent/emission stream, or combustion process. This evaluation could be applied to both R&D scale emerging control technology or to demonstration-scale or fully commercialized systems. In addition to the pollutant removal efficiencies and operational availabilities of the systems, economics (including by-product disposal cost) must also be considered. Information on energy penalties imposed by the control strategy, the specific fuel mix availability, and industry acceptance of the strategy are also included in this functional category. In general, this evaluation is site-specific since ambient concentration levels and local

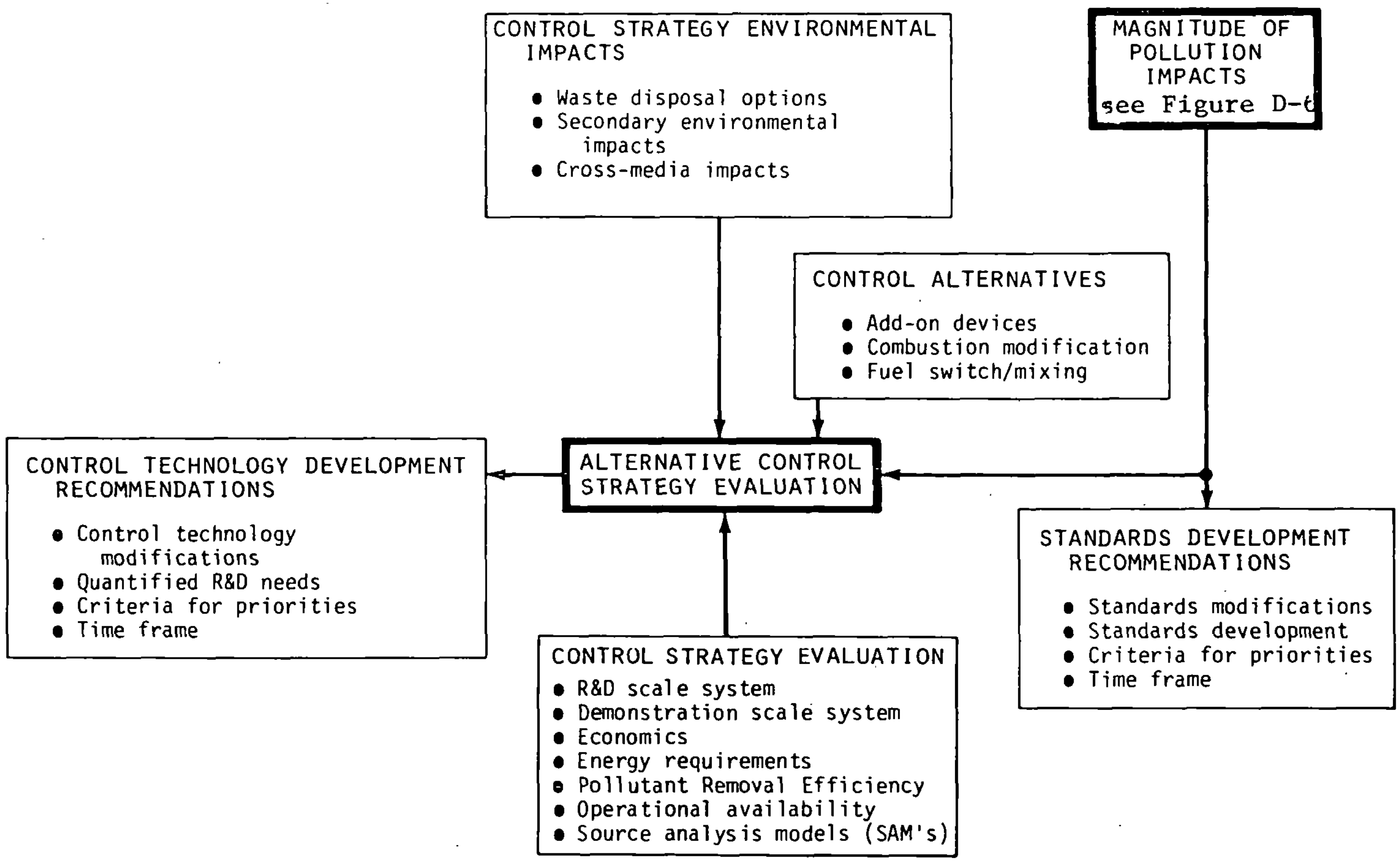


Figure D-7. Alternative control strategy evaluation (step three).

meteorology and hydrology are important factors. EPA has developed a set of Source Analysis Models (SAM's)* to rank sources and effluents in priority order and to evaluate the environmental effectiveness of control alternatives. Two sets of SAM's have been developed to date:

SAM/IA --- For Rapid Screening

SAM/I --- For Screening (draft procedure under review by EPA.)

Development of third set (SAM II -- A General Apprcach to Evaluating any U. S. Regional Site) is not yet complete.

Control Technology Development Recommendations are logically made when existing or developmental alternatives for controlling adverse environmental impacts are inadequate. The recommendations for additional control technologies are among the most important outputs of an environmental assessment. These recommendations should be quantified and ranked in priority order for technological and managerial decision-makers. The priority recommendations should be justified on engineering and environmental bases, and should include information on degrees of control required, additional R&D requirements, developmental cost estimates, and projected developmental schedules.

When optimum alternatives to control unacceptable environmental impacts are selected, they are applied to the original combustion process and the entire environmental assessment procedure is repeated for the combination of the combustion process and the control technology alternative. The complex, interactive and iterative nature of an environmental assessment is illustrated more clearly by combining each of the various steps and activities shown in Figures D-1 through D-7 into the detailed EA methodology diagram shown in Figure D-8. Ideally, the iterative methodology of Figure D-8 is continued until all impact on human health and ecology caused by the combustion process falls within acceptable limits of current environmental goals and objectives.

*See Reference 5 as listed in Section 6 of this report.

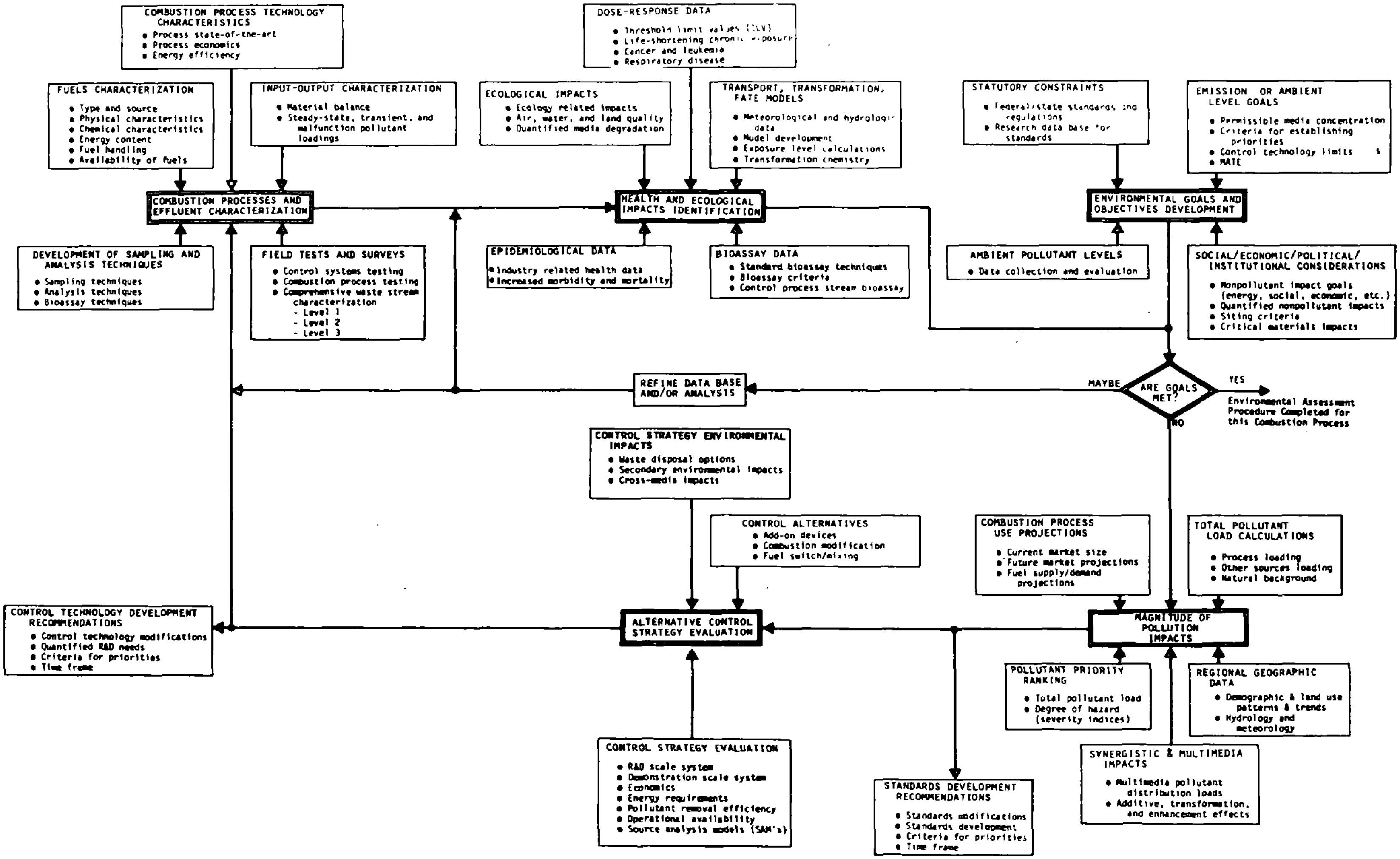


Figure D-8. Comprehensive environmental assessment methodology.

APPENDIX E

DEMONSTRATION OF THE EA MATRIX ANALYSIS PROCEDURE

A. DETAILED DESCRIPTION OF THE EA MATRIX ANALYSIS PROCEDURE

Information on the content of selected projects was obtained with the aid of an information checklist outlining the major elements (activities) of the comprehensive environmental assessment methodology. This checklist was used in identifying which of the EA elements were addressed by each of the projects. Thus, comparison between the contents of each project could delineate all the R&D efforts addressing a single EA element.

To facilitate the comparison between projects and, later, their integration in the unified CCEA program, a code corresponding to the elements of the EA methodology was developed and applied to the information in the checklist (Table E-1). The code specifies whether the particular project merely identifies existing information on the EA element, develops or designs information about the EA element, or performs the activity associated with the environmental assessment element. As an illustration of the use of this checklist, the programmatic content of the thirteen core projects recommended in the CCEA program plan is shown in coded form in Table E-2. From this table, it is readily apparent when a given EA element, or cluster of related elements, is addressed by more than one project or, alternatively, when a given element is not addressed by any of the projects.

In addition to the identification of environmental assessment elements addressed by each selected project, information regarding the fuels, use sectors, pollutants, and combustion technologies/processes involved is also necessary for comparative evaluation and future integration. Table E-3 lists the codes used for use sectors, fuels, pollutants, and combustion technologies/processes; Table E-4 shows the various categories of pollution control technologies.

The combination of the fuels (Table E-3), use sector (Table E-3), combustion technology/process (Table E-3) pollution control technology (Table E-4), media, environmental assessment elements (Table E-1), and pollutants (Table E-3), describes completely all the areas included in a comprehensive environmental assessment of SCCP. It is the goal of the CCEA program planning effort to integrate ongoing projects and recommend new projects to address all practical and reasonable combinations of the above categories of information. Table E-5 shows this above information for the 13 recommended core projects.

TABLE E-1. CCEA PROGRAM ENVIRONMENTAL ASSESSMENT ELEMENT CODE

MATRIX ENTRY NOTATION

(E)....Identify Existing Information or Define
(D)....Develop Information or Design
(A)....Perform Activity (e.g., Field or Lab Tests)
(-)....No, Negative, Not Addressed
(X)....Not clear from available information
(L1)...Level 1 Analysis
(L2)...Level 2 Analysis
(L3)...Level 3 Analysis
(L0)...Level Other

COMBUSTION PROCESS TECHNOLOGY BACKGROUND

A1...State-of-the-Art Overview

DEVELOPMENT OF SAMPLING AND ANALYSIS TECHNIQUES

B1...Sampling Techniques
B2...Analysis Techniques
B3...Bioassay Techniques

FUELS CHARACTERIZATION

C1...Fuel Characteristics
C2...Type and Source
C3...Fuel Handling
C4...Availability

INPUT-OUTPUT CHARACTERIZATION

D1...Material Balance
D2...Steady-State, Transient, and Malfunction Pollutant Loadings

FIELD TESTS AND SURVEYS

E1...Control System Testing
E2...Combustion Process Testing
E3...Comprehensive Waste Stream Characterization
- Level 1 Analysis
- Level 2 Analysis
- Level 3 Analysis
- Other Level of Analysis

POLLUTANT TRANSPORT, TRANSFORMATION, AND FATE MODELS

F1...Modeling
F2...Meteorologic and Hydrologic Data
F3...Transformation Chemistry
F4...Exposure Level Calculations

DOSE-RESPONSE DATA

G1...Dose-Response Data Collection and Correlations

ECOLOGICAL DATA

H1....Ecology-Related Impacts
H2....Air, Water and Land Quality
H3....Quantified Media Degradation Alternatives

EPIDEMIOLOGICAL DATA

I1...Industrial Related Health Data
I2...Increased Morbidity and Mortality

BIOASSAY DATA

J1...Bioassay Criteria
J2...Bioassay Techniques
J3...Control Process Stream Bioassay Data

EMISSIONS OR AMBIENT LEVEL GOALS

K1...Permissible Media Concentration
K2...Criteria for Establishing Priorities
K3...Control Technology Limitations
K4...MATE

SOCIAL/ECONOMIC/POLITICAL/INSTITUTIONAL CONSIDERATIONS

L1...Nonpollutant Impact Goals (Energy, Social, Economic, etc.)
L2...Quantified Nonpollutant Impacts and Siting Criteria
L3...Critical Materials Impacts

STATUTORY CONSTRAINTS

M1...Federal/State Standards and Regulations
M2...Research Data Base for Standards

Ambient Pollutant Levels

N1...Data Collection and Evaluation

COMBUSTION PROCESS USE PROJECTIONS

O1...Market Studies
O2...Fuel Supply/Demand Projections

TOTAL POLLUTANT LOAD CALCULATIONS

P1...Process Load Calculations
P2...Other Sources Load Calculations
P3...Natural Background

SYNERGISTIC AND MULTIMEDIA IMPACTS

Q1...Multimedia Pollutant Load Distributions
Q2...Additive, Transformation, and Enhancement

REGIONAL GEOGRAPHIC DATA

R1...Demographic Patterns and Trends
R2...Land Use Patterns and Trends
R3...Local Hydrology
R4...Local Meteorology

POLLUTANT PRIORITY RANKINGS

S1...Total Pollutant Load Calculations
S2...Degree of Hazard (Severity Indices)

CONTROL ALTERNATIVES

T1...Add-on Devices
T2...Combustion Modification
T3...Fuel Mixing/Switching

CONTROL STRATEGY ENVIRONMENTAL IMPACTS

U1...Waste Disposal Options
U2...Secondary Environmental Impacts of Control Strategy
U3...Cross-Media Impacts

CONTROL STRATEGY EVALUATION

V1...Control Assessment Criteria - Quantified Effluents and Costs
V2...Control Systems Economics
V3...By-product Disposal Costs
V4...Energy Penalties
V5...Fuel Mix Availability
V6...Pollutant Removal Efficiency
V7...Operational Availability
V8...Industry Acceptance
V9...Source Analysis Models (SAM's)

STANDARDS DEVELOPMENT RECOMMENDATIONS

W1...Standards Modifications Recommendations
W2...Standards Development Recommendations
W3...Criteria of Establishing Priorities
W4...Recommendations for Schedules

CONTROL TECHNOLOGY DEVELOPMENT RECOMMENDATIONS

X1...Control Technology Modifications Recommendations
X2...Quantified R&D Needs
X3...Criteria for Establishing Priorities
X4...Recommendations for Schedules

TABLE E-2(a). ENVIRONMENTAL ASSESSMENT ELEMENTS

Project Title \ Element Code	A1	B1	B2	B3	C1	C2	C3	C4	D1	D2	E1	E2	E3	F1	F2	F3	F4	G1	H1	H2	H3	I1	I2	J1	J2	J3	K1	K2	K3	K4	L1	L2	L3	M1	M2	N1	O1	O2
1. Characterization of Effluents from Coal-Fired Utility Boilers	E	E	E	-	-	E	-	-	-	-	-	-	L2	E	-	D	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E	-	-
2. Full Scale Scrubber Testing and Waste Disposal Program	E	x	x	x	x	x	-	-	D	D	A	-	L2	-	E	E	-	-	x	x	E	-	-	-	-	-	-	-	E	x	E	-	-	-	-	E	x	-
3. Environmental Assessment of Stationary Source NO_x Control Technologies	E	D	D	D	-	E	-	-	D	x	A	A	x	D	E	E	-	E	D	D	E	-	-	E	E	x	E	D	E	E	D	-	-	E	E	E	E	E
4. Design Optimization, Construction, and Field Verification of an Integrated Residential Furnace	E	-	-	-	-	E	-	-	D	D	-	A	L0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	-	D	-	-	-	E	E	-	-
5. Combustion of Hydrothermally Treated Coals	E	E	E	x	-	D	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	-	E
6. Emissions Characterization of Conventional Combustion Systems	E	D	D	-	E	D	-	E	D	D	-	-	L1 L2	-	-	-	-	-	E	-	-	-	-	E,D	E,D	D	E	D	-	E	-	-	-	E	E	E	E	-
7. Evaluation of Emissions and Control Technology for Industrial Stoker Boilers	E	E,D	E,D	E,D	A	D	-	x	D	E,D	A	A	L1 L2	-	-	-	-	-	D	D	-	-	-	E	E	D	-	-	E	-	D	-	-	-	E	E	E	E
8. Environmental and Energy Assessment of Afterburner Combustion Systems	E	D	D	D	-	E	-	-	x	E	A	A	L1	-	-	-	-	-	-	E,D	D	-	-	-	-	-	-	-	E	-	-	-	-	-	E	E	E	-
9. Test Program for Full-Scale Dual Alkali Demonstration---LGE	E	D	D	D	A	E	-	-	D	D	A	A	L2	D	E	E	x	-	D	D	-	-	-	E	E	D	D	E	E	x	E	E	-	E	E	E	-	-
10. Evaluation of Alternatives for Disposal of Flue Gas Desulfurization Sludges	E	D	D	D	-	-	-	-	-	-	-	-	L0	E	D	x	D	D	D	D	E	-	-	E	D	D	E	-	E	E	E	D	-	E	E	E	x	-
11. Field Testing: Application of Combustion Modification to Control Pollutant Emissions from Power Generation Combustion Systems	E	E,D	E,D	-	E	E	-	-	D	D	A	A	L1	-	-	-	-	-	-	E	-	-	-	E	E	-	E	-	E	-	E	-	-	E	E	E	-	-
12. The Impact of Coal-Fired Power Plants on the Environment	E	E,D	E,D	E,D	E	D	-	-	D	D	-	-	L0	E,D	E,D	E,D	D	E,D	E,D	E	E,D	-	E	E,D	E,D	D	E,D	D	-	x	D	E	-	E	E	E	-	-
13. Comparative Multimedia Assessment: Well Controlled Coal-Fired & Oil-Fired Boilers	E	E	E	E	E	D	-	-	D	D	A	-	L1 L2	E	-	-	-	E	E	E,D	-	E	-	E	E	D	E	E	E	E	E	-	-	E	E	E	-	-

TABLE E-2(b). ENVIRONMENTAL ASSESSMENT ELEMENTS

Project Title \ Element Code	P1	P2	P3	Q1	Q2	R1	R2	R3	R4	S1	S2	T1	T2	T3	U1	U2	U3	V1	V2	V3	V4	V5	V6	V7	V8	V9	W1	W2	W3	W4	X1	X2	X3	X4
1. Characterization of Effluents from Coal-Fired Utility Boilers	A	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Full Scale Scrubber Testing and Waste Disposal Program	A	-	-	x	x	-	-	E	-	-	-	-	-	-	A	D	D	D	-	E,D	-	-	D	-	-	-	-	-	-	-	D	x	-	-
3. Environmental Assessment of Stationary Source NO_x Control Technologies	A	E	E	D	E	E	E	-	-	D	D	-	E,D	D	-	D	-	B	D	E	D	D	D	D	x	E	-	-	-	-	D	D	-	-
4. Design Optimization, Construction, and Field Verification of an Integrated Residential Furnace	A	-	-	-	-	-	-	-	-	-	-	-	EDA	EDA	-	-	-	D	-	-	D	-	D	D	-	-	-	-	-	-	D	D	-	-
5. Combustion of Hydrothermally Treated Coals	A	-	-	-	-	-	-	-	-	-	-	-	-	EDA	A	D		D	D	D	D	-		D	-	-	-	-	-	-	-	-	-	-
6. Emissions Characterization of Conventional Combustion Systems	A	-	-	D	-	-	-	-	-	D	D	-	-	-	E	D		-	-	-	-	-		-	-	E	-	-	-	-	x	D	-	-
7. Evaluation of Emissions and Control Technology for Industrial Stoker Boilers	A	-	-	E	x	-	-	-	-	-	-	E	E	E	-	D	-	D	x	-	D	E	D	E	D	-	-	-	-	-	D	D	-	-
8. Environmental and Energy Assessment of Afterburner Combustion Systems	A	-	-	-	-	-	-	-	-	-	-	E	E	-	-	D	-	D	-	-	D	-	D	D	-	-	-	-	-	-	x	D	-	-
9. Test Program for Full-Scale Dual Alkali Demonstration--LGE	A	E	E	D	E	E	E	E	E	-	-	E	E,A	-	A	D	-	D	D	D	D	-	D	D	-	x	-	-	-	-	D	x	-	-
10. Evaluation of Alternatives for Disposal of Flue Gas Desulfurization Sludges	A	-	x	D	x	-	-	D	D	-	-	E	-	-	A	D	D	D	-	D	-	-	-	E,D	x	E	-	x	-	-	D	D	-	-
11. Field Testing: Application of Combustion Modification to Control Pollutant Emissions from Power Generation Combustion Systems	A	-	-	-	-	-	-	-	-	-	-	-	E,D	-	-	D	-	D	-	-	D	-	D	D	-	-	-	-	-	-	-	x	-	-
12. The Impact of Coal-Fired Power Plants on the Environment	-	-	E,D	D	D	E	E	E,D	E,D	E,D	E,D	-	-	-	A	D	D	D	-	D	-	-	E	-	-	x	-	-	-	-	-	D	-	-
13. Comparative Multimedia Assessment: Well Controlled Coal-Fired & Oil-Fired Boilers	A	-	-	-	-	-	-	-	-	-	-	E	-	-		A	D	D	D	x	E	-	x	E	-	E	-	-	-	-	-	x	-	-

TABLE E-3. USE SECTOR, FUELS, COMBUSTION PROCESS TYPE, COMBUSTION TECHNOLOGY, AND POLLUTANT CATEGORIES

USE SECTOR	U...	Utility
	C...	Commercial/Institutional
	R...	Residential
	I...	Industrial
FUELS	RO...	Residual Oil
	DO...	Distillate Oil
	AC...	Anthracite Coal
	BC...	Bituminous Coal
	SBC...	Sub-bituminous Coal
	LC...	Lignite Coal
	SRC...	Solvent Refine Coal
	R...	Refuse
	NG...	Natural Gas
	SNG...	Synthetic Natural Gas
	W...	Wood
COMBUSTION PROCESS TYPE	IC...	Internal Combustion
	EC...	External Combustion
COMBUSTION TECHNOLOGY	TF...	Tangential Fire
	T...	Turbine
	RE...	Recipricating Engine
	PWB...	Pulverized Wet Bottom
	PDB...	Pulverized Dry Bottom
	C...	Cyclone
	R...	Refuse Burner
	O...	Other
POLLUTANTS	1.	Particules
	2.	SO_x
	3.	NO_x
	4.	Inorganics
	5.	Organics
	6.	Trace Elements
	7.	Ions
	8.	General
	9.	Thermal
	10.	Other

TABLE E-4. POLLUTION CONTROL TECHNOLOGY CATEGORIES

Pollution Control Technologies

- Uncontrolled
  - Air
  - Water
  - Land
  - Other

- Gas Treatment
  - Mechanical Collection
  - Electrostatic Precipitators
  - Filters (fabric, granular, etc.)
  - Liquid Scrubbers/Contactors (aqueous, inorganic, organic)
  - Condensers
  - Solid Sorbents (molecular sieves, activated carbon)
  - Incineration (direct, catalytic)

- Liquids Treatment
  - Settling, Sedimentation
  - Precipitation, Flocculation, Sedimentation
  - Centrifugation and Filtration
  - Evaporation and Concentration
  - Distillation, Flashing
  - Liquid/Liquid Extraction
  - Gas/Liquid Stripping
  - Neutralization
  - Biological Oxidation
  - Wet Thermal Oxidation
  - Activated Carbon Absorption
  - Ion Exchange System
  - Cooling Tower (wet & dry)
  - Chemical Reaction & Separation

- Solids Treatment
  - Fixation
  - Recovery/Utilization
  - Processing/Combustion
  - Chemical Reaction & Separation
  - Oxidation/Digestion
  - Physical Separation (specific gravity, magnetic, etc.)

- Final Disposal
  - Pond Lining
  - Deep Well Reinjection
  - Burial and Landfill
  - Sealed-Container Storage
  - Dilution
  - Dispersion
  - Ocean Disposal

- Process Modification
  - Feedstock Change/Fuel Treatment
  - Stream Recycle

- Combustion Modification
  - Flue Gas Recycle
  - Water Injection
  - Staged Combustion
  - Low Excess Air Firing
  - Optimum Burner/Furnace Design
  - Alternate Fuels/Processes

- Accidental Release Technology
  - Containment Storage
  - Spill Cleanup Techniques

TABLE E-5(a). DISAGGREGATED PROJECT CONTENT OF THIRTEEN RECOMMENDED CORE PROJECTS

PRO. NO.	FUELS	USE SECTOR	COMBUSTION TECHNOLOGY/ PROCESSES	POLLUTION CONTROL TECHNOLOGY	MEDIA	ENVIRONMENTAL ASSESSMENT ELEMENTS	POLLUTANTS ADDRESSED
1	BC	U	EC/SWDP SWWP, HODP, HOWP, TDP, TWP SK,V,C	Not Specified	Air Water	A1, B1, B2, C2, E3, F1, F3, H2, M2, N1, P1, Q2, U3	7,8,9
2	BC	U	EC/SWOP, SWWP, HODP,HOWP, TDP,TWP, SK,V,C	Liquid Scrubber, Final Disposal	Air Water Land	A1, E1, E3, F2, F3, H3, K3, L1, N1, P1, U1, U2, U3, V1, V3, V6	2,9,10,14
3	RO,DO, SO,AC, BC,SBC, LC,NG, SNG,A,H	U,I, C,R	EC,IC/ TB,RE,SW, HO,T,SWDP, SWWP,HODP, HOWP,TDP, TWP,SK,V, C,WT,FT, CIB,S,O	Combustion Modification	Air Water Land	A1, B1, B2, B3, C2, D1, E1, E2, F1, F2, F3, G1, H1, H2, H3, J1, J2, K1, K2, K3, K4, L1, M1, M2, N1, O1, O2, P1, P2, P3, Q1, Q2, R1, R2, S1, S2, T2, T3, U2, V1, V2, V3, V4, V5, V6, V7, V9, X1, X2	3,5,6,8,9, 10,14
4	DO,A,H	R	EC/WT, FT, CIB, S	Combustion Modification	Air	A1, C2, D1, D2, E2, E3, K3, L1, M2, N1, P1, T2, T3, V1, V4, V6, V7, X1, X2	1,3,5,6

TABLE E-5(a)
(Continued)

5	BC	R,C,I	EC/O	Alternate Fuels	Air	A1, B1, B2, C2, E1, N1, O2, P1, T3, U1, U2, V1, V2, V3, V4, V7	1,2,3,9
6	RO,DO, AC,BC, SBC,LC	U,R,C,I	EC/SW, HO,T, SWDP,SWWP, HODO,HOWP, TDP,TWP, SK,V,C, WT, FT, C1B, S	Uncontrolled	Air Water	A1, B1, B2, C1, C2, C4, D1, D2, E3, H1, J1, J2, J3, K1, K2, K4, M1, M2, N1, O1, P1, Q1, S1, S2, U1, U2, V9, X2	2,3,5,6,8,9,
7	BC,SBC, LC	C,I	EC/SK	Staged Com-bustion, Alt. Fuels	Air Land	A1, B1, B2, B3, C1, C2, D1, D2, E1, E2, E3, H1, H2, J1, J2, J3, K3, L1, M2, N1, O1, O2, P1, Q1, T1, T2, T3, U2, V1, V4, V5, V6, V7, V8,X1, X2	1,2,3,4,5,6,9
8	NG,DO	C,I	EC/WT, FT,C1B, S,O	Afterburners	Air	A1, B1, B2, B3, C2, D2, E1, E2, E3, H2, H3, K3, M2, N1, O1,P1, T1, T2, U2, V1, V4, V6, V7, X2	1,2,3,4,6

TABLE E-5(a)
(Concluded)

9	BC	U	EC/SWDP, SWWP, HODP, HOWP, TDP, TWP	FGD	Air Water Land	A1, B1, B2, B3, C1, E1, E2, E3, F1, F2, F3, H1, H2, J1, J2, J3, K1, K2, L1, L2, M1, M2, N1, P1, P2, P3, Q1, Q2, R1, R2, R3, R4, T1, T2, U1, U2, V1, V2, V3, V4, V7	1,2,3,8,10,14
10	BC	U,I	EC/SWDP, SWWP, HODP, HOWP, TDP, TWP, SK	FGD	Land	A1, B1, B2, B3, E3, F1, F2, F4, G1, H1, H2, H3, J1, J2, J3, K1, L1, L2, M1, M2, N1, P1, Q1, R3, R4, T1, U1, U2, U3, V1, V3, V7, X1, X2.	2,9,10,14
11	BC, DO, NG	U	IC, EC/TB, SW, HO, T, SWDP, SWWP, HODO, HOWP, TDP, TWP,	Combustion Modification	Air	A1, B1, B2, C1, C2, D1, D2, E1, E2, E3, H2, J1, J2, K1, K3, L1, M1, M2, N1, P1, T2, U2, V1, V4, V6, V7	1,2,3,4,7,8, 9
12	BC	U	EC/SK, C, SWDP, SWWP, HODP, HOWP, TDP, TWP	Uncontrolled or Not Specified	Air Water Land	A1, B1, B2, B3, C1, C2, D1, D2, E3, F1, F2, F3, F4, G1, H1, H2, H3, I2, J1, J2, J3, K1, K2, L1, L2, M1, M2, N1, P3, Q1, Q2, R1, R2, R3, R4, S1, S2, U1, U2, U3, V1, V3, V6, X2	1,2,3,4,5,8,9 13,14.
13	BC, RO, DO, SBC	U,I	EC/SK, SW, HO, T, SWDP, SWWP, HODP, HOWP, TDP, TWP	Uncontrolled or Not Specified	Air Water Land	A1, B1, B2, B3, C1, C2, D1, D2, E1, E3, F1, G1, H1, H2, I1, J1, J2, J3, K1, K2, K3, K4, L1, M1, M2, N1, P1, T1, U2, U3, V1, V2, V4, V6, V7, V9	1,2,3,5,6,14

Figure E-1 describes the relationships between each of the above categories. With the type of CCEA program matrix shown in this figure, R&D being conducted for any given fuel could be traced for each use sector, combustion technology/process, pollution control technology, media, environmental assessment element, and pollutant. Or, if one were interested in all the research being conducted by the CCEA program on a particular pollution control technology, the CCEA matrix would facilitate a trace for any of the other parameters being addressed in terms of that control technology.

A specific example is included in the next subsection to illustrate the matrix analysis procedure and to discuss the uses of the results from this procedure.

B. SAMPLE EXERCISE OF PROCEDURE

The use of the EA matrix analysis procedure is demonstrated below for two of the projects from the list recommended for inclusion in core CCEA program. The example describes each project by using the matrix format and graphically illustrates how potential areas of overlap between the projects and areas of programmatic gaps may be identified by this procedure. It also suggests areas where coordination and information exchange could benefit both projects.

The two projects selected for the example are second and ninth on the list of recommended core CCEA projects. They were selected here because of the similarity in their subject areas. The two projects are sponsored by the Emissions/Effluent Technology Branch (EETB) of the Utilities & Industrial Power Division (UIPD), IERL-RTP. Both the projects deal with the evaluation of full-scale scrubbers operated by Louisville Gas and Electric. SO_2 removal efficiency as well as the environmental impacts of the waste sludge disposal are evaluated by these two projects.

Project number 2 is titled "LG&E Full-Scale Scrubber Testing and Waste Disposal Program." The project is conducted by Louisville Gas and Electric and is funded at approximately $1.8 million for the period covering 3/76 to 9/78.

Project number 9 is the "Test Program for the Full-Scale Double Alkali Flue Gas Desulfurization Utility Demonstration." The contractor is the Research and Engineering Division of Bechtel Corporation. The project is funded at approximately $1.66 million for the period covering 6/77 to 11/80.

Figure E-2 shows pertinent information on project content for both in the format used by the matrix analysis procedure. This information was extracted from the CCEA Project Information Checklists as completed by the RTI survey. The upper portion of the figure indicates that project number 2 is concerned with SO_x, trace metals, ions, and other (TDS) pollutants discharged to the air, water and land media by a liquid contact scrubber and its associated solid waste disposal practices. This research applies to nine types of external combustion utility processes using bituminous coal. The 14 specific programmatic areas addressed by project two are delineated under the category labeled "E.A. Elements."

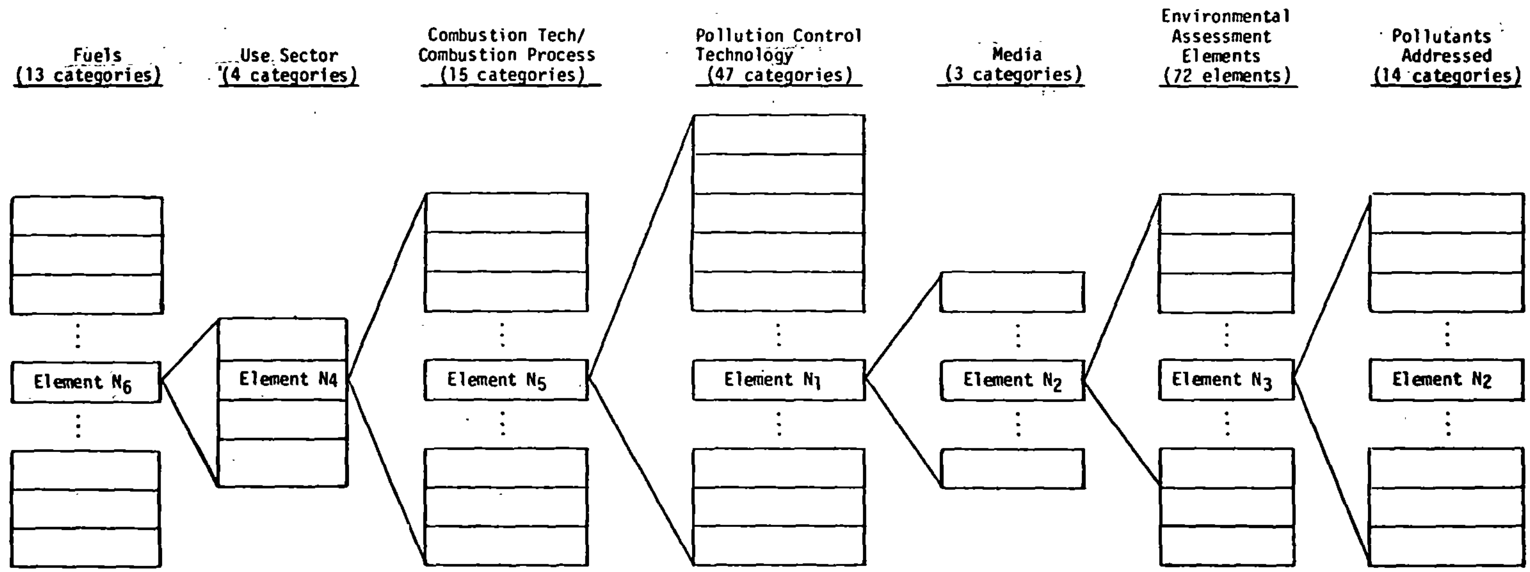
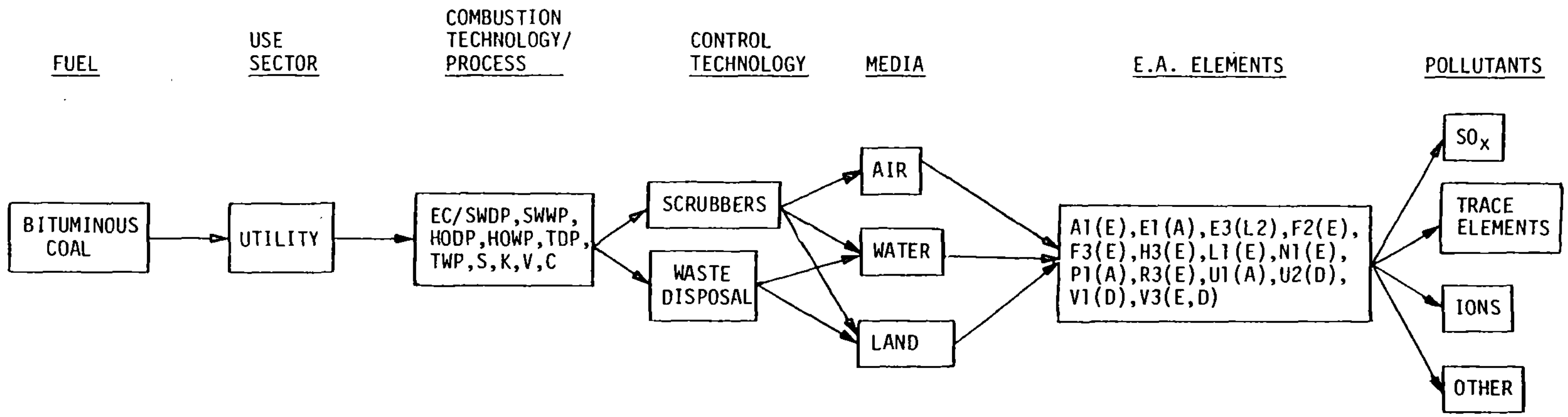
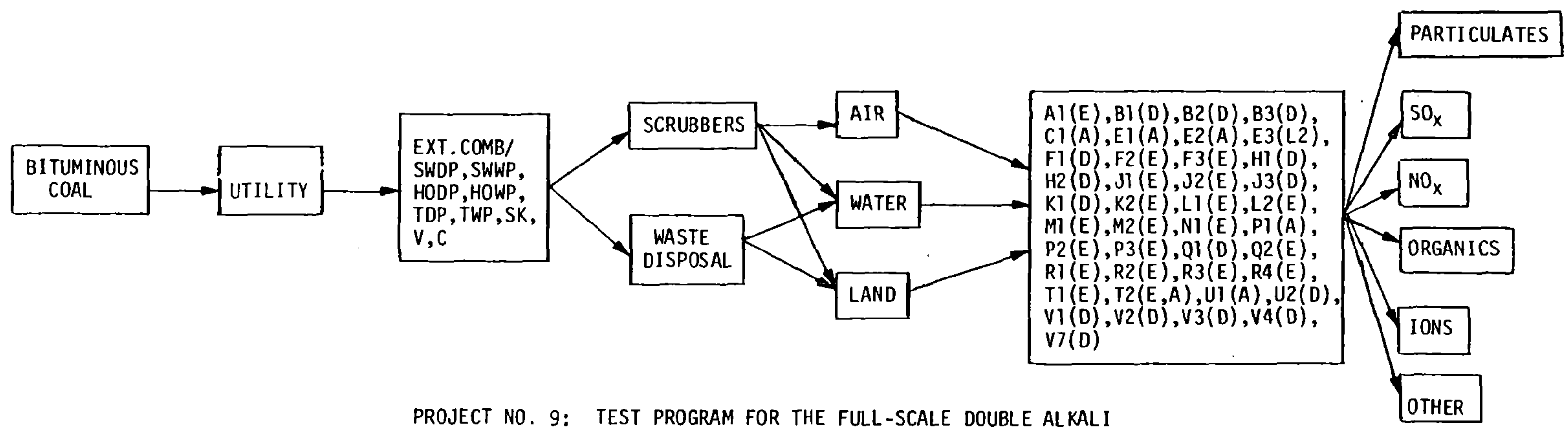


Figure E-1. Matrix of environmental assessment elements.



PROJECT NO. 1: LG&E FULL-SCALE SCRUBBER TESTING AND WASTE DISPOSAL PROGRAM



PROJECT NO. 9: TEST PROGRAM FOR THE FULL-SCALE DOUBLE ALKALI FGD UTILITY DEMONSTRATION

Figure E-2. Project information in matrix format.

The programmatic content of project number 9 is shown similarly in the lower half of Figure E-2. This project is concerned with particulates, SO_x, NO_x, organics, ions, and other (unspecified) pollutants to air, water, and land from a liquid contact scrubber and its associate sludge disposal. Again, this is done in the context of nine external combustion utility processes using bituminous coal, and the 41 specific programmatic areas addressed are shown under the EA Elements category.

Comparison of the information matrices for projects 2 and 9 identifies subject areas common to both projects, as shown diagrammatically in Figure E-3. Both projects address scrubbers and waste disposal practices of bituminous coal-fired utility external combustion processes, and both projects study air, water, and land impacts. However, only SO_x and ions appear to be the pollutants explicitly studied in both.* In addition, the results of this procedure indicate that only 10 environmental assessment elements are common to both projects. These 10 common elements represent areas of apparent programmatic overlaps. This indication should draw the attention of the program managers for closer examination of those specific activities in order to coordinate, exchange information, or effect redirection of either or both concerned projects.

One area of apparent overlap, for example, is EA element U1--Waste Disposal Options. Since both projects address full-scale nonregenerable FGD systems, sludge disposal is a common problem. Although the physical and chemical properties of the two sludges may be slightly different, it is likely that the process of evaluating final disposal options is quite similar in both cases. The results of such an evaluation process in one project would be of great help to the second project. Alternatively, if a coordinated generic evaluation is conducted, then each project would need only to superimpose site-specific information for its final evaluation. This would provide a common or "standard" approach to future sludge disposal options evaluation, and reduce the effort required by each individual project.

Similar comments could be applied to EA elements U2 and U3--Secondary Environmental Impacts of Control Strategy and By-Product Disposal Costs, respectively. A more detailed examination would be necessary for any conclusions in the apparent overlap of EA element A1--State-of-the-Art Overview of the combustion process technology background. The level of detail of each of the state-of-the-art overviews could differ according to specific project needs. Information exchange or a coordinated effort, however, would be highly desirable since both projects address the same nine types of bituminous coal-fired utility combustion processes.

Areas of programmatic gaps are identified by comparing the activities of project 2 and project 9 against the entire set of activities suggested by the comprehensive environmental assessment methodology. Figure E-4 shows the EA Elements and pollutants not addressed by either project for the given common area of fuel, use sector, combustion technology/process, control technology and media. This does not imply that no R&D is being conducted anywhere

*It is difficult to identify any other specific pollutants since the checklist and matrix analysis procedure coding provide limited classification.

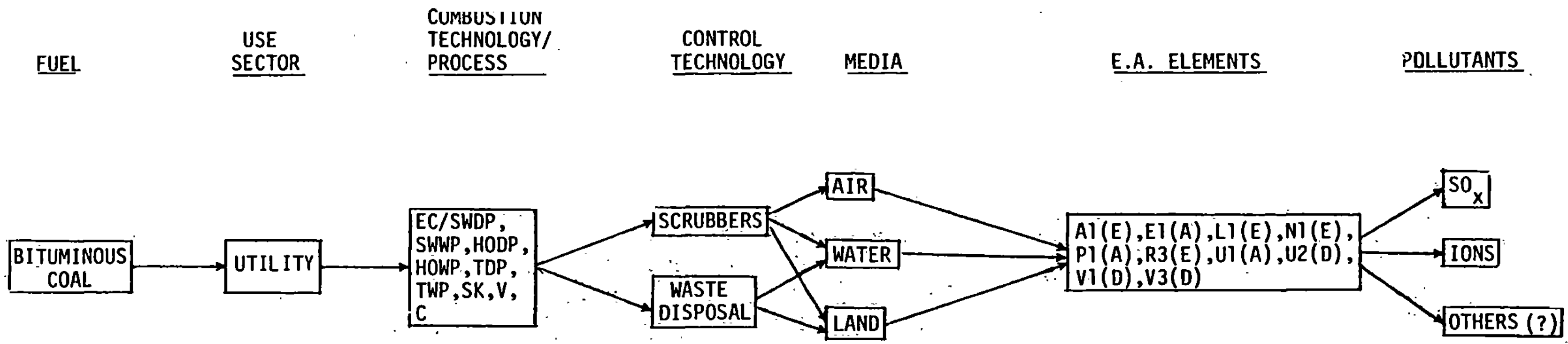


Figure E-3. Areas of apparent programmatic overlaps between project nos. 2 and 9.

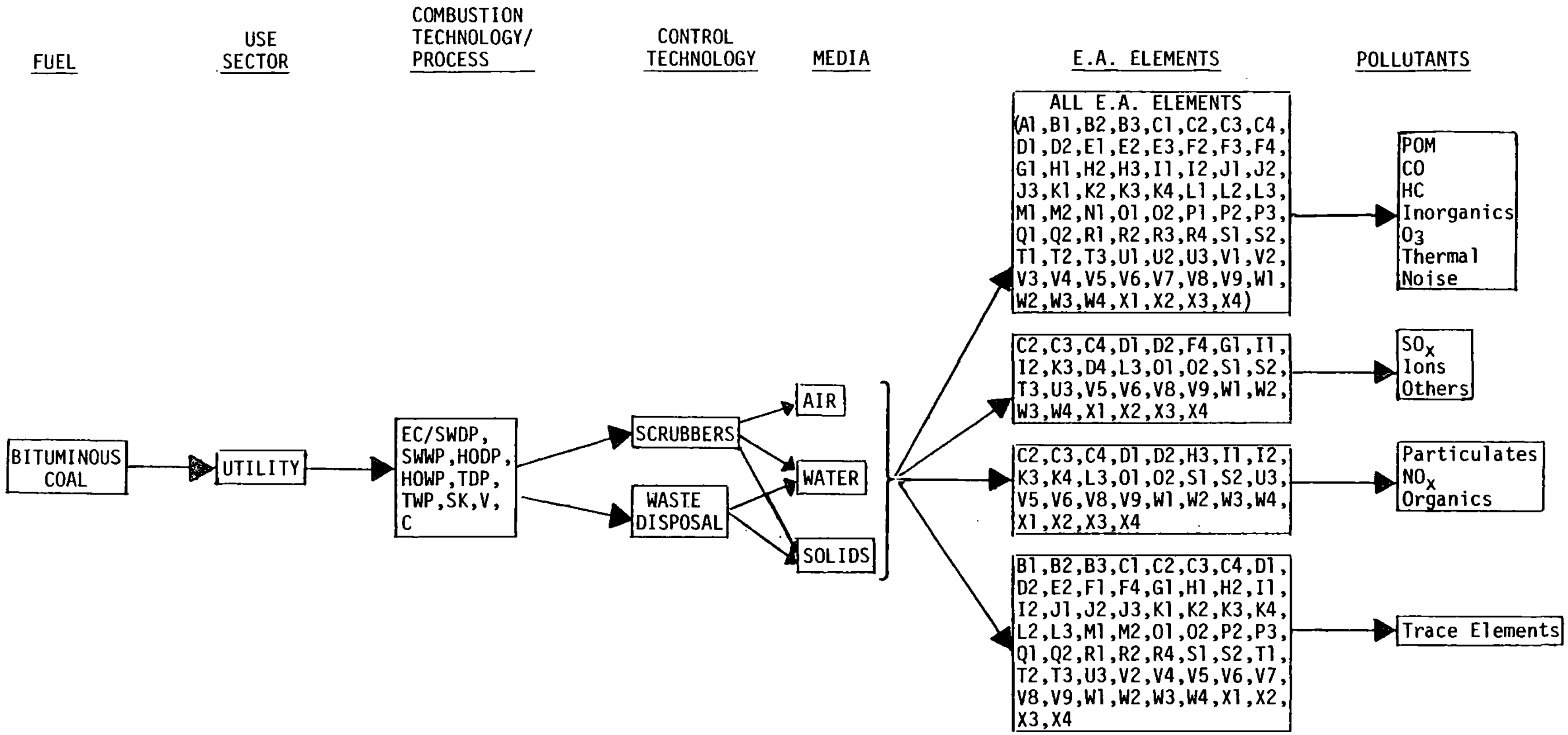


Figure E-4. Areas of apparent programmatic gaps in project nos. 2 and 9.

to fill these gaps, but merely that these two particular projects do not address them. As other selected R&D projects are integrated through the use of the matrix analysis procedure, the programmatic gaps would begin to be filled and a comprehensive environmental assessment of conventional combustion processes would near completion.

The example above is intended to demonstrate the matrix analysis procedure in broad, simple terms. The full use of the procedure in the CCEA program planning effort is somewhat more involved, and the conclusions drawn from the procedure are more specific in nature than the ones illustrated here.

APPENDIX F

ALTERNATIVE MANAGEMENT STRUCTURES FOR CCEA

A. ALTERNATIVE MANAGEMENT STRUCTURES

Development of alternative management structures for the CCEA program is complicated by three factors. First, the program encompasses R&D projects and related activities in various stages of development or completion. Some are ongoing and near completion; some are planned and currently being initiated; still others are yet to be defined as a result of CCEA activities. Second, the program includes projects being performed (or planned) by different divisions within EPA/IERL-RTP, by other parts of EPA, and by Federal agencies other than EPA. The non-EPA projects are funded totally or partially under the Interagency Energy/Environment R&D Program. A third important factor relating to CCEA management is that the products of the program are intended for use not only in the field of combustion technology and pollution control, but also in the area of standards setting and environmental impact analysis. Hence, the management of the program would benefit from advice and inputs of the full spectrum of potential users as well as direct participants in the R&D effort.

Since the CCEA program seeks not only to coordinate, but possibly to redirect, existing projects as well as to initiate new R&D activities, the argument could be advanced that its direction should be placed at a level that has some degree of managerial or budgetary control over most of the organizations where CCEA-related activities are performed--for example, at the level of the Interagency Energy/Environment R&D Program administered by EPA's Office of Research and Development.

On the other hand, the principal consolidated center of interest and technical expertise in the environmental assessment of SCCP within the Federal R&D establishment is EPA/IERL-RTP. This Laboratory is also the principal Federal participant in combustion related environmental assessment activities. Although this Laboratory is organizationally a part of EPA's Office of Research and Development, a strong argument can be advanced that CCEA program management should be centered at IERL/RTP because most of the CCEA activities take place there.

In the light of the foregoing conditions and considerations, five alternative management structures for CCEA, together with their advantages and disadvantages, are set forth.

Alternative 1. Existing Organizational Structure

The CCEA program would be managed within the Process Technology Branch of the Utilities and Industrial Power Division of IERL/RTP (see Figure F-1). Major policies of the program would be established by the Division Director in consultation with the Laboratory Director and the Branch Chief. All phases of program activity, from initial planning to publication of results, including management of contractors, would be carried out under direction of the CCEA program officer, who would be assisted by a staff of the required size and would be directly responsible to the Chief of the Process Technology Branch.

All communication pertaining to the CCEA program would proceed through normal Laboratory/EPA channels, with the exception of communication between the program officer and a liaison officer at the Office of Energy, Minerals, and Industry at EPA Headquarters, since the OEMI liaison officer would be an "ex-officio" advisor to the CCEA program manager.

Alternative 2. Existing Structure Augmented by Advisory and Working Groups

The CCEA program would be managed within the Process Technology Branch of the Utilities and Industrial Power Division of IERL. However, the Division Director would chair a CCEA Advisory Committee comprised of representatives of other offices within EPA as well as other Federal and industry organizations (see Figure F-2). As in Alternative 1, CCEA policy would be set by the Division Director, but in Alternative 2 this would be done in consultation with his Advisory Committee in addition to the Laboratory Director and Branch Chief.

All phases of CCEA activity would be managed directly by a program officer, who would report to the Chief of the Process Technology Branch. The program officer would again be assisted by a full-dedicated staff of the required size, and would chair a CCEA Working Group composed of project officers of all CCEA related projects within EPA and selected contractor representatives. The OEMI liaison officer and the Process Technology Branch Chief would be "ex-officio" members of the Working Group.

All CCEA-related communication would, again, flow through normal Laboratory/EPA channels.

Under this alternative, all managerial activities and responsibilities would remain within the UIPD Division, but advice would be available from external organizations and program participants.

Alternative 3. Division Level EA Unit

This structure would require the formation of a division-level organizational unit which would manage all environmental assessment activities. Such an organizational unit would logically include three component subunits that would address the three main areas of environmental assessment activity at IERL:

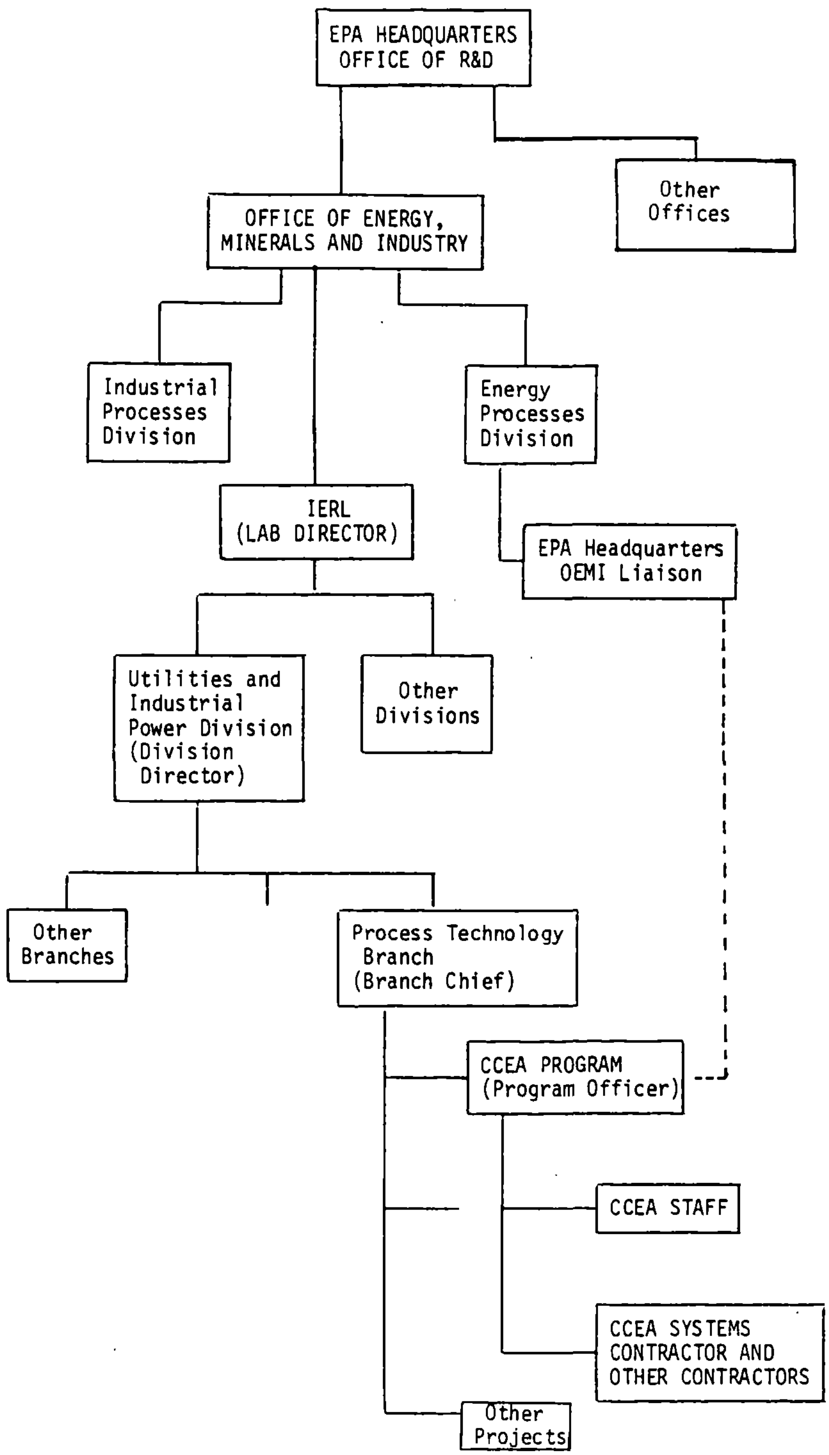


Figure F-1. Alternative 1: Existing structure.

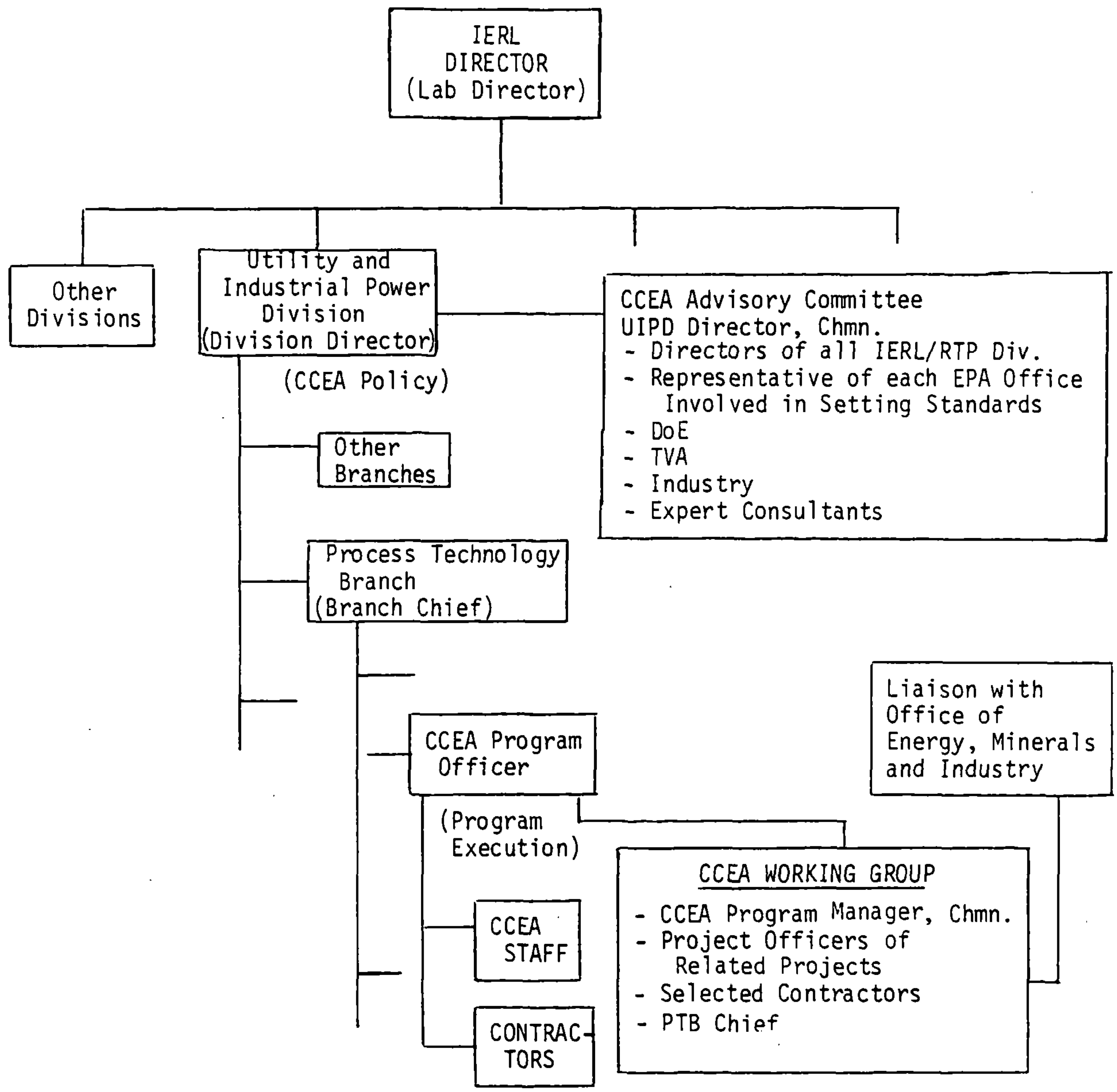


Figure F-2. Alternative 2: Existing structure plus advisory committee and working group.

- Environmental assessment of conventional combustion processes

- Environmental assessment of advanced combustion systems, synthetic fuel production, and fuels cleaning

- Development of environmental assessment methodologies, procedures and techniques

Given the existence of such an organization, the CCEA program would be managed by an Executive Committee chaired by the director of the division-level unit and comprised of representatives of other IERL/RTP divisions, other EPA program offices and the CCEA program manager (see Figure F-3).

The Executive Committee would establish CCEA policy and review program goals and objectives in consultation with the Laboratory Director and with the advise of two Advisory Groups, one of which would include representatives of EPA program offices and other appropriate organizational units; the other would consist of non-EPA participants (see Figure F-3). The intent of this structure is that all interested EPA components would be represented on either the Executive Committee or the Working Group; also that issues pertaining only to EPA could be discussed with the Advisory Group consisting of EPA participants only, without the need of involving participants from other organizations.

Day-to-day activities of the CCEA program would be managed by a CCEA program manager responsible to the Chairman of the Executive Committee. Logically, the program manager would be the same person that heads the organizational subunit responsible for conventional combustion environmental assessment activities. The program manager would be assisted by a staff of appropriate size and expertise, and by a working group of similar make-up to that in Alternative 2. A principal function of the working group is to insure coordination between CCEA program management and the project officers immediately responsible for the performance of all CCEA-related projects within EPA.

Communication between the program manager and any EPA participant in the CCEA program would be direct. Communication between the program manager and OEMI Headquarters would be through the OEMI/CCEA liaison, with information copies to the Chairman of the Executive Committee. Communication with any other component of EPA would go through the Executive Committee Chairman. Communication with organizations external to EPA would go through the Laboratory Director's office.

Alternative 4. Program Office at Laboratory Level

The CCEA program would be managed at IERL/RTP Laboratory level by an Executive Committee chaired by the Director of the Utilities and Industrial Power Division and comprised of the Directors of other IERL/RTP divisions and the CCEA program manager. The Executive Committee would have two advisory groups, as in Alternative 3 (see Figure F-4).

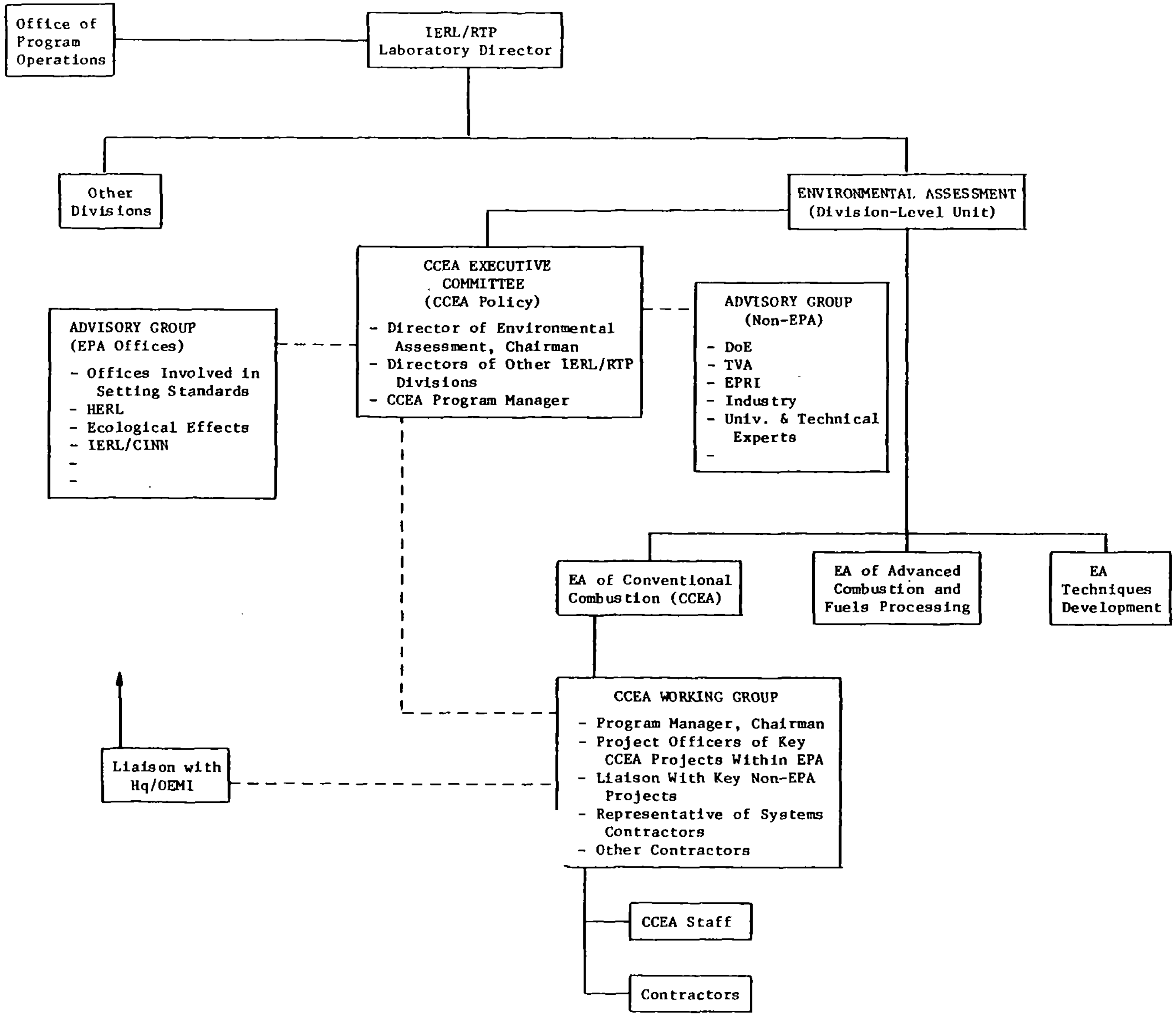


Figure F-3. Division level EA unit.

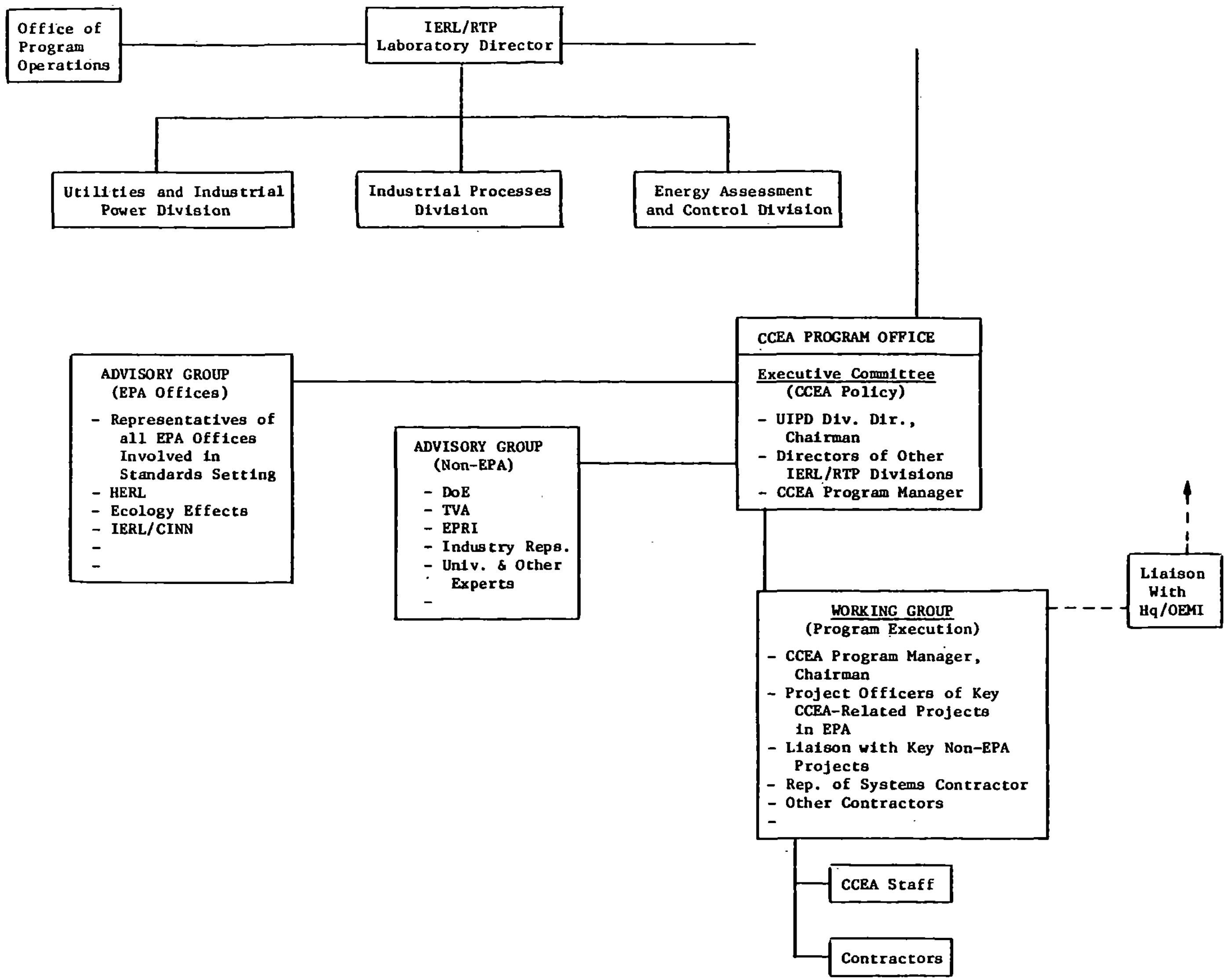


Figure F-4. Alternative 4: Executive committee and laboratory level.

The Executive Committee would establish CCEA policy in consultation with the Laboratory Director and with the advice of Advisory Groups composed of representatives of other Federal agencies, industry groups, and expert consultants. These groups would be similar in make-up to those in Alternative 3.

Day-to-day program activities would be managed by a CCEA program manager responsible to the Chairman of the Executive Committee. The program manager would be assisted by a staff of appropriate size and by a Working Group of similar make-up to that in Alternative 3.

Communication between the program manager and any EPA participant of the CCEA program would be carried out directly. Communications with any other component of EPA would go through the Executive Committee Chairman. All communications with organizations external to EPA would go through the Laboratory Director's special liaison representative on the Executive Committee.

Alternative 5. Executive Committee at Interagency (Headquarters) Level

This structure is similar to that of Alternative 4, except that the Executive Committee is chaired by a representative of the Interagency Energy/Environment Program and reports to the Deputy Assistant Administrator for Energy, Minerals, and Industry within EPA's Office of Research and Development (see Figure F-5).

Under this arrangement, the policy-making functions of the CCEA program would be essentially removed from IERL/RTP except to the extent that IERL/RTP is represented on the Executive Committee. Day-to-day project management remains within IERL/RTP, and primarily within UIPD, although the CCEA program manager is responsible to the Chairman of the Executive Committee for all CCEA activities.

Communications between the CCEA program manager and all EPA participants in the CCEA Program are made directly. Communications with other EPA components or with external organizations are made through the Executive Committee Chairman or through normal OEMI channels.

B. ADVANTAGES AND DISADVANTAGES OF ALTERNATIVE STRUCTURES

Each of the management structures identified above has advantages and disadvantages. These involve the following factors:

- Ease of establishing the organizational structure for program management.

  A management structure that can be easily set up would enable the program to function almost immediately, while one that is complex or administratively difficult to establish could impose unacceptable delays.

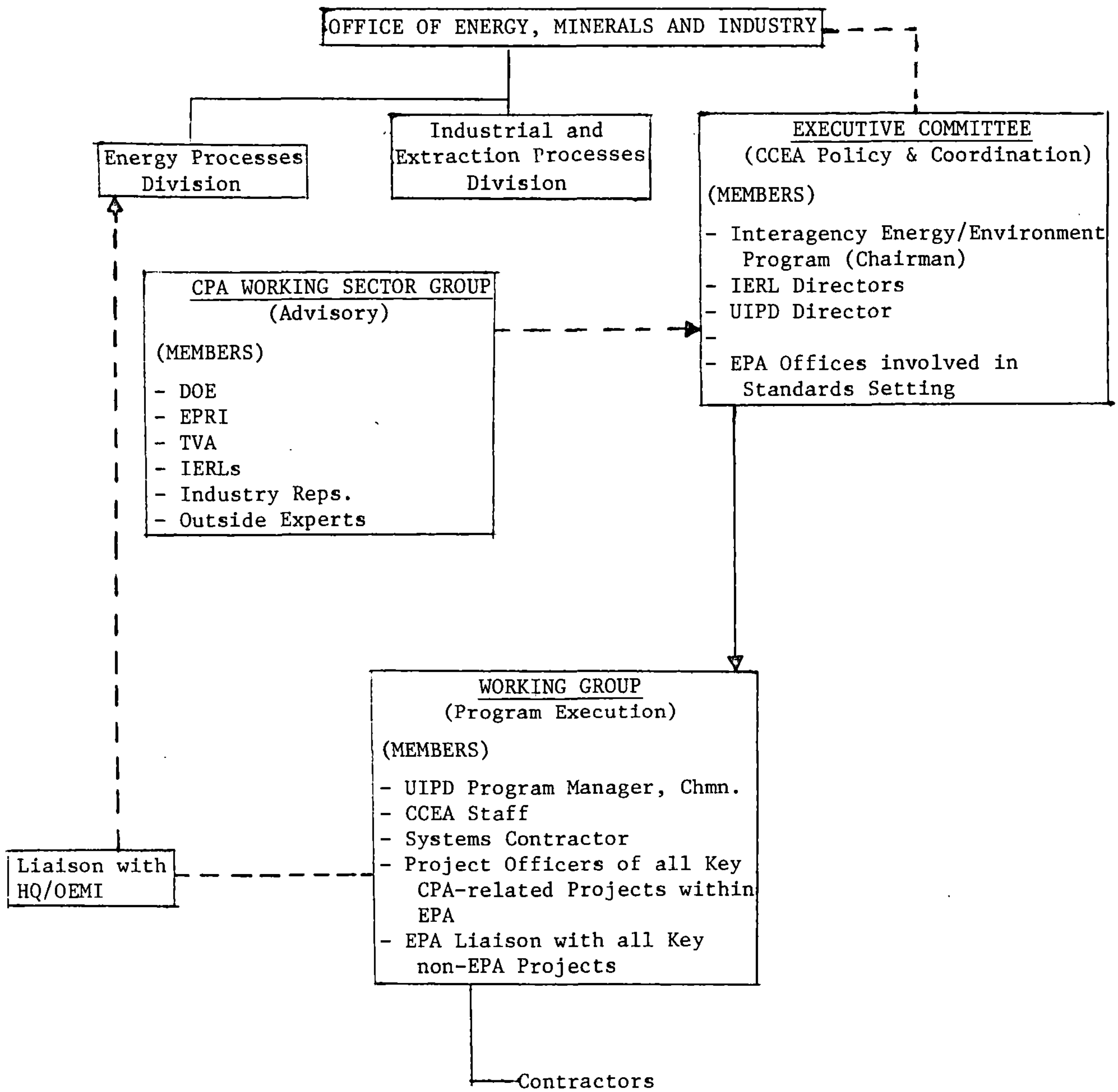


Figure F-5. Alternative 5: Executive committee at headquarters level.

- Scope of interests, needs and opinions available to CCEA program management.

  While most of the project activities related to CCEA are managed by IERL/RTP, many others are managed and performed by other organizations. Also, two of the principal goals of CCEA relate to standards development--a non-IERL function. It is important that the needs and opinions of all major participants in CCEA and all major users of its products be known to the management of the program.

- Ease of communication between CCEA program management and interested or participating organizations, both within and external to EPA.

  Free access and flow of information on recommended program content, user needs and priorities, and project status will permit CCEA program management to operate a more responsive, efficiently-run program. Also, ready access of CCEA-information and findings should increase the utility of the program to potential users of its products.

- Freedom of CCEA program management personnel from competing demands.

  CCEA is a major, long-term program with the difficult and complex function of integrating and coordinating activities in several organizations. It cannot be effectively operated on an intermittant basis, but must provide for continuity of effort. A fully dedicated program manager and support staff is needed for a program of this magnitude and complexity.

- Availability of required expertise to program management.

  The program management of a technically oriented program of this nature must have direct and immediate access to expert technical advice and information.

- Capability of CCEA program management to influence the direction of CCEA-related projects or other activities.

  EPA management or budgetary control at a sufficiently high level must be involved to insure that project redirection be implemented as needed.

The above criteria are not of equal weight. Some, such as the "ease of implementation" criterion, can virtually represent a no-go situation if the difficulty of implementation implies a long delay (say a year or more) in implementing a given management structure. Others, such as the capability of CCEA management to influence other projects or programs, have implications for whether or not the CCEA program can be operationally effective other than as a scientific data gathering exercise. The other criteria relate to how well, or how easily, the program can achieve defined objectives.

The management alternatives identified in the preceding subsection are analyzed in terms of the above factors, as follows:

Alternative 1. Existing Structure

Advantages:

- Can be implemented immediately.

- Technical expertise readily available.

Disadvantages

- No direct provisions for obtaining expression of needs and interests either from participants or potential users. Information input from IERL participants is through existing communication channels -- not directly.

- Communication with non-IERL participants through established channels -- not directly.

- Program officer subject to competing demands from management at Branch, Division, and higher levels.

- Little opportunity to influence direction of programs outside UIPD, except through intervention of Laboratory Director or higher levels of management.

Alternative 2. Existing Structure Plus Advisory Committee (Division Level) and Working Group (CCEA Program Level)

Advantages:

- Easily established.

- Required technical expertise readily available.

- Provides a channel of communication for opinions and interests of major participants and users.

- Provides direct communication and liaison with project officers of all CCEA-related projects within IERL (but not with those outside IERL).

Disadvantages:

- Inputs from non-UIPD participants is strictly advisory, with only limited potential for affecting program management.

- CCEA influence on projects outside UIPD may require participation of Laboratory Director.

Alternative 3. Division Level EA Unit

Advantages:

- Consolidates all major environmental assessment activities at IERL/RTP under a single line management, thereby facilitating planning, coordination, and direction of all EA projects within IERL/RTP.

- Provides for the direct communication of needs, opinions, and interests of all CCEA participants and users at all desired levels.

- Provides channels for suggesting redirection of EA projects outside IERL/RTP.

- Has separate advisory committees composed of (1) EPA participants and (2) non-EPA participants, thereby permitting matters internal to EPA to be discussed separately from matters of interest to all participants.

- Provides the required level of technical expertise at all levels.

- Removes the program manager from competing demands at branch level.

Disadvantages:

- Requires relatively extensive reorganization of Laboratory activities, including creation of a new division-level organization unit with attendant re-alignment of work assignments and responsibilities among divisions.

Alternative 4. Program Office at Laboratory Level

Advantages:

- Provides for direct communication of needs, opinions and interests of all participants and users at all desired levels.

- Provides a means of directly influencing IERL/RTP project direction, as needed, by working through the office of the Laboratory Director.

- Provides a means of suggesting redirection of projects outside IERL/RTP.

- Provides the required levels of technical expertise at all levels.

- Removes program manager and staff from competing demands at Branch and Division levels.

Disadvantages:

- Would require establishing a Laboratory-level separate project office outside the existing management structure.

Alternative 5. Executive Committee at Interagency Level (Headquarters)

Advantages:

- Provides for direct communication of needs, opinions, and interests at all desired levels.

- Provides a means of directly influencing project direction as needed throughout EPA and other interagency organizations.

Disadvantages:

- Extremely difficult to establish the organizational structure -- cannot be easily implemented because of number of levels of management involved.

- Uncertain whether required technical expertise would be readily available to program manager.

- Uncertain whether program manager would be sufficiently close to the scene of major CCEA activity (IERL/RTP) to permit effective program operation.

C. COMPARISONS AMONG ALTERNATIVE MANAGEMENT STRUCTURE

The five alternative management structures outlined above do not exhaust the range of alternatives, but are considered to span the range with respect to complexity and ease of implementation. Alternative 1 is simplest and most easily implemented. Alternative 5 is the most organizationally complex and probably the most difficult to implement because of the number of levels of management involved.

In view of the anticipated problems in implementing Alternative 5 (Headquarters-Level program management), together with its organizational complexity and tenuous chains of authority, responsibilities, and communication (within the management structure--not among technical participants of the Program), MITRE ranks this alternative as lowest among the five considered, and recommends against its adoption.

Alternative 1 (Existing Structure), while easily implemented, does not provide the means of obtaining advice, suggestion, and expressions of interest and need from CCEA participants and users of CCEA outputs outside of IERL/RTP. This lack, together with the other disadvantages cited above, is considered by MITRE to impair the functioning of the program manager to a degree that militates against the use of this alternative. MITRE ranks this as next to lowest among the five considered, and recommends against its adoption.

Alternative 2 (Existing Structure Plus Advisory Committee and Working Group) has many of the desired features, principal among which is its ease of implementation. Because it has no crippling disadvantages and can be implemented almost immediately at the Division level (including the appointment of the advisory and working groups), MITRE ranks this as an acceptable transition measure pending implementation of a suitable long-term management structure.

Alternative 4 (Laboratory-Level Management) has all of the desired characteristics with regard to the ease of obtaining user and participant advice, ability to influence most of the significant efforts, and ease of communication. It provides a high level of visibility to the CCEA program However, this alternative would require development of a new organizational unit--a program office--attached to the Office of the Laboratory Director. Also, it does not imply the degree of organizational stability that is generally associated with a line-management organizational unit. MITRE ranks this as second of two acceptable alternatives for the long-term management of the CCEA program.

Alternative 3 (Division-Level EA Unit) also provides all of the desired characteristics with regard to ease of obtaining user and participant advice, ability to influence the direction of all significant EA projects, and ease of communication. Most of these characteristics are achieved without the need for direct involvement of the Laboratory Director's Office. In common with Alternative 4, this alternative also requires the creation of a new organizational unit. The attendant restructuring of the organization and realignment of responsibilities is more extensive than that implied by Alternative 3, and could, therefore, introduce serious delays in carrying out the program. On the other hand, Alternative 4 provides a more stable and coherent organizational structure than does Alternative 3. Consolidation of all major EA activities into a single organizational unit at the division level is consistent with the increasing importance of environmental assessment activities relative to the overall missions of the Agency. For these reasons, MITRE ranks this as first of two acceptable alternatives for the long-term management of the CCEA program.

D. RECOMMENDATIONS FOR CCEA MANAGEMENT STRUCTURE

MITRE recommends that EPA, in planning the implementation of the CCEA program, give favorable consideration to the adoption of the organizational structure described in Alternative 3 (Division-Level EA Unit) for the long-term management of the program. Since it would be difficult to implement immediately, MITRE recommends implementation of Alternative 2 (Existing Structure Augmented by Executive Committee and Working Group) as soon as practical, and phasing into the Alternative 3 structure within a year. This approach will (1) permit continuous functioning of the CCEA program, (2) provide additional needed inputs from a broadly based advisory committee of principal CCEA participants and potential users of CCEA products, and (3) bring the project officers of key CCEA-related projects into the CCEA management process at the working-group level.

Implementation of the Alternative 3 structure will provide additional managerial leverage to the project manager as well as enhanced communication among participants and users of the program's products. The two stage implementation of the organizational structure will permit retention of the effective participants of the Alternative 2 advisory committees while providing an opportunity to replace those participants whose performance was not satisfactory.

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(Please read Instructions on the reverse before completing)

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9. PERFORMING ORGANIZATION NAME AND ADDRESS The Mitre Corporation/Metrek Division 1820 Dolley Madison Boulevard McLean, Virginia 22101		10. PROGRAM ELEMENT NO. EHE624A 11. CONTRACT/GRANT NO. 68-01-3539 and 68-01-3188, Task 86
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16. ABSTRACT The report describes the development of a program plan for EPA's Conventional Combustion Environmental Assessment (CCEA) Program and presents the status of the Program 1 year after the planning effort was begun. The CCEA Program was established recently to coordinate and integrate EPA's several research and development efforts for assessing the environmental effects of pollutants from conventional combustion of fossil fuels. Much of EPA's environmental assessment (EA) activities have, in the past, been performed in connection with research, development, and demonstration projects directed principally toward controlling specific pollutants from combustion. Overall program goals and objectives are defined, and existing research and development project involving EA of combustion pollutants are identified. A procedure for analyzing the content of such projects is described and its use demonstrated for a selected subset of current projects to identify duplication of effort or gaps in coverage of areas required for attainment of defined objectives. A set of recommended actions and milestones, based on the analysis of current projects and defined Program goals, is presented.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution Combustion Assessments	Pollution Control Stationary Sources Conventional Combustion Environmental Assessment	13B 21B 14B

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