United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

EPA-600/7-78-151
July 1978

EPA

Status of IERL-RTP Environmental Assessment Methodologies for Fossil Energy Processes

Interagency Energy/Environment R&D Program Report

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Status of IERL-RTP Environmental Assessment Methodologies for Fossil Energy Processes

by

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Contract No. 68-02-2612
Task Nos. 22 and 62
Program Element No. EHE623A

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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, DC 20460

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ABSTRACT

A summary of the current status of the following IERL/RTP environmental assessment methodologies is included:

- current process technology background
- environmental data acquisition
- current environmental background
- environmental objectives development
- control technology assessment
- environmental alternatives analysis

The need for additional research in four areas—basic research, analytical methods, environmental models, and multimedia environmental goal research—is reviewed.

Improved coordination is suggested in the following areas: contractor/EPA coordination, coordination of environmental assessment methodology development with health effects research, multimedia environmental goal coordination, dissemination of results, and interaction with other agencies.

A bibliography of all published reports and drafts of the Industrial Environmental Research Laboratory environmental assessment methodology program is included.

This report was submitted in partial fulfillment of Contract No. 68-02-2612, Tasks 22 and 62, by the Research Triangle Institute under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period 5 July 1977 to 5 June 1978.

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ACKNOWLEDGMENTS

The cooperation and assistance of all of the IERL/RTP staff and environmental assessment contractors and EPA Task Officer, Walter Steen, are gratefully acknowledged. A special note of thanks is due to R. P. Hangebrauck, who collected, prepared, and extensively reviewed much of the material in this report. This report could not have been prepared without their timely assistance and suggestions and specific inputs from a number of other persons including: 1) Jim Dorsey, who offered contributions and review regarding sampling and analytical procedures plus overall review; 2) Dale Denny, who reviewed the methodology examples for the textile industry and the source assessment methodology; and 3) Gary Johnson, who provided the material on the Environmental Assessment Data System. The report was edited by Debbie Blank and Kathleen Mohar of RTI's Report Editing and Word Processing Group.

SECTION 1.0

SUMMARY OF THE CURRENT STATUS OF IERL/RTP ENVIRONMENTAL ASSESSMENT METHODOLOGY

1.1 THE IERL/RTP ENVIRONMENTAL ASSESSMENT PROGRAM

This section includes a brief discussion of the overall environmental assessment program of IERL's Energy Assessment and Control Division. The exhibits and content of this section are based on several papers given by R. P. Hangebrauck, Director, Energy Assessment and Control Division, IERL/RTP. The most recent of these papers was "Environmental Assessment Methodology for Fossil Energy Processes," which was presented at the Environmental Aspects of Fuel Conversion Technology, III, meeting held at Hollywood, Florida, on September 13-16, 1977.

"Environmental assessment" has many meanings depending on the agency or individual using the term. As used by IERL/RTP and as used in this report, an environmental assessment (EA) is 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.

The EA methodologies discussed here are very important to EPA because they represent prototypical approaches to multimedia, multipollutant problem identification and control effectiveness evaluation for complex effluents from fossil energy processes. They are prototypes of potential future regulatory approaches that are holistic and are aimed at preventing problems before they occur. This should allow resolution of existing problems on other than a one-pollutant-at-a-time basis, which is fraught with endless studies, only partially effective results, and high costs at all levels of implementation.

The primary outputs of EA and related control technology development activities are:

- a defined research data base for standards,
- quantified control R & D needs,
- quantified control alternatives,
- quantified media degradation alternatives, and
- quantified nonpollutant effects and alternative siting criteria.

Some potential support uses of program outputs are listed in table 1, and the relationship of these outputs to each other and to EPA Program Offices is shown in figure 1.

Figure 2 shows the relationship of the following six functional EA research areas to control technology development and to fossil energy technologies:

- Current Process Technology Background - Provides a description of the energy processes, of the potential for national and/or regional use, and of development schedules. Serves as input for developing acquisition of environmental data.
- Environmental Data Acquisition - Includes: (1) sampling and analytical techniques for process sources, effluents and pollutants, (2) processes/facilities to be utilized for environmental assessment, (3) comprehensive characterization of waste streams and input/output materials, (4) description of source unit operations on a modular basis for each relevant energy process, and (5) development of assays for control technologies.
- Current Environmental Background - Includes: (1) a summary of key Federal regulations and criteria; (2) a summary of literature on transport models, occupational health studies, potential pollutants, multimedia impacts, and epidemiological studies for fossil energy technology industries; (3) development of a data base on ambient background concentrations; and (4) construction of scale models of fuel conversion facilities, sites, and their environmental interactions.

TABLE 1. EXAMPLES OF POTENTIAL SUPPORT OUTPUTS OF ENVIRONMENTAL ASSESSMENT AND CONTROL TECHNOLOGY DEVELOPMENT ACTIVITIES

I. ENVIRONMENTAL ASSESSMENT

A. Best Technology

1. Standards of Practice Manuals/Control Alternatives

2. Best Technology Multimedia Environmental Goals (MEG) for All Individual MEG Pollutants
   a. Existing
   b. 1983
   c. 1988
   d. 1993

3. Reviews
   a. New Source Performance Standards (NSPS)
   b. Effluent Guidelines
   c. Resource Conservation and Recovery Act (RCRA)/Hazardous Waste Standards

B. Research Data Base for Standards Development

1. Industry/Sources Problem Definition for Potential Standards Consideration
   a. Identification of Cases Where Effluent Pollutant Concentration Exceeds MEG
      (1) Air – Criteria, Hazardous, and Non-Criteria Pollutants
      (2) Water – Effluent Guidelines
      (3) Solids – Hazardous Waste Standards
   b. Identification of Control R&D Needs

2. Optimum Complex Effluent Controls
   a. Identification of Control Approaches that Minimize Total Toxic Unit Discharge

3. Evaluation of Potential New Regulatory Approaches
   a. Minimum Acute Toxic Effluent (MATE)
   b. Complex Effluent Bioassays

II. CONTROL TECHNOLOGY DEVELOPMENT

A. Basis for NSPS

B. Basis for Effluent Guidelines

C. Basis for RCRA/Hazardous Waste Standards

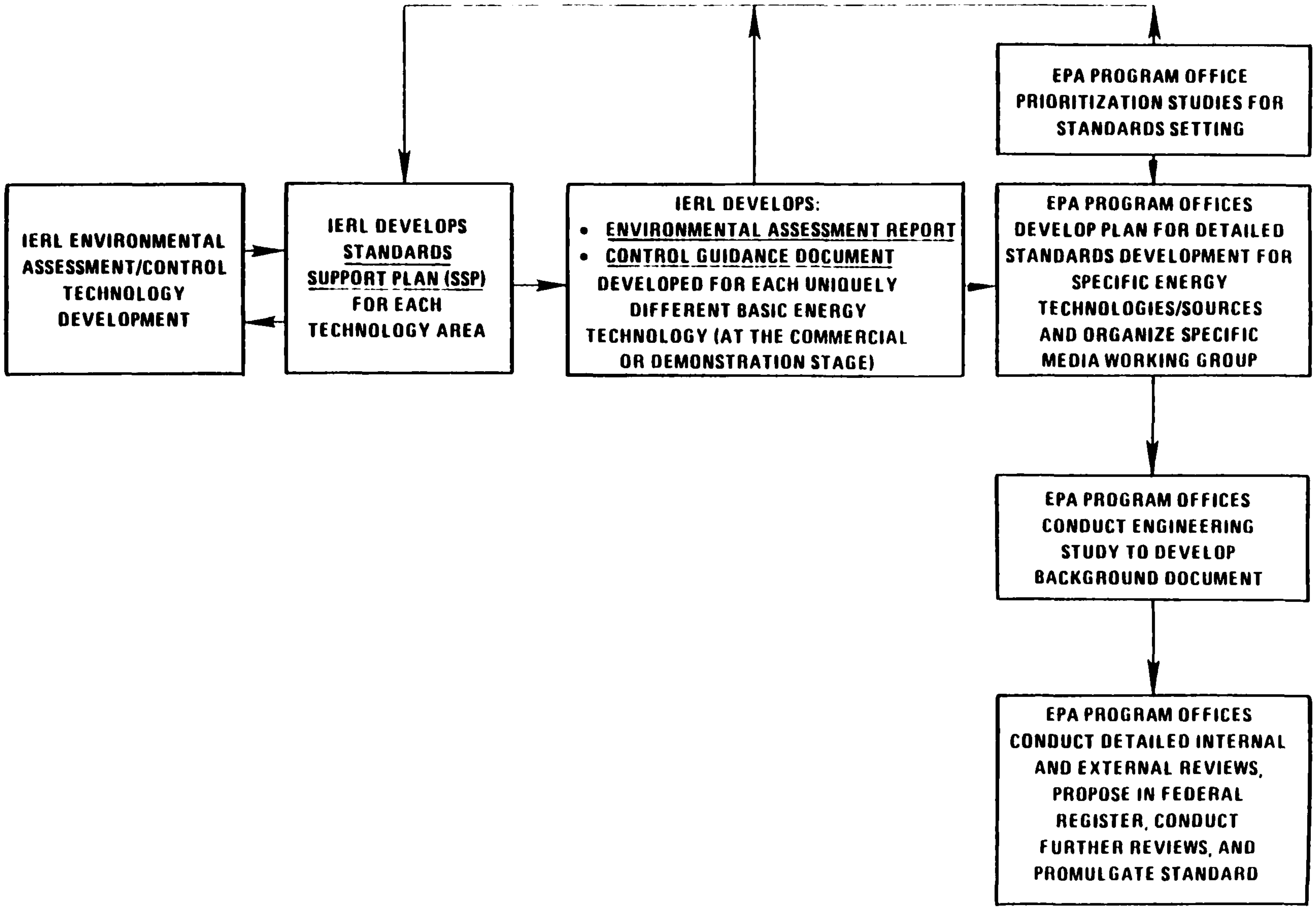


Figure 1. IERL/RTP standards development support R&D.

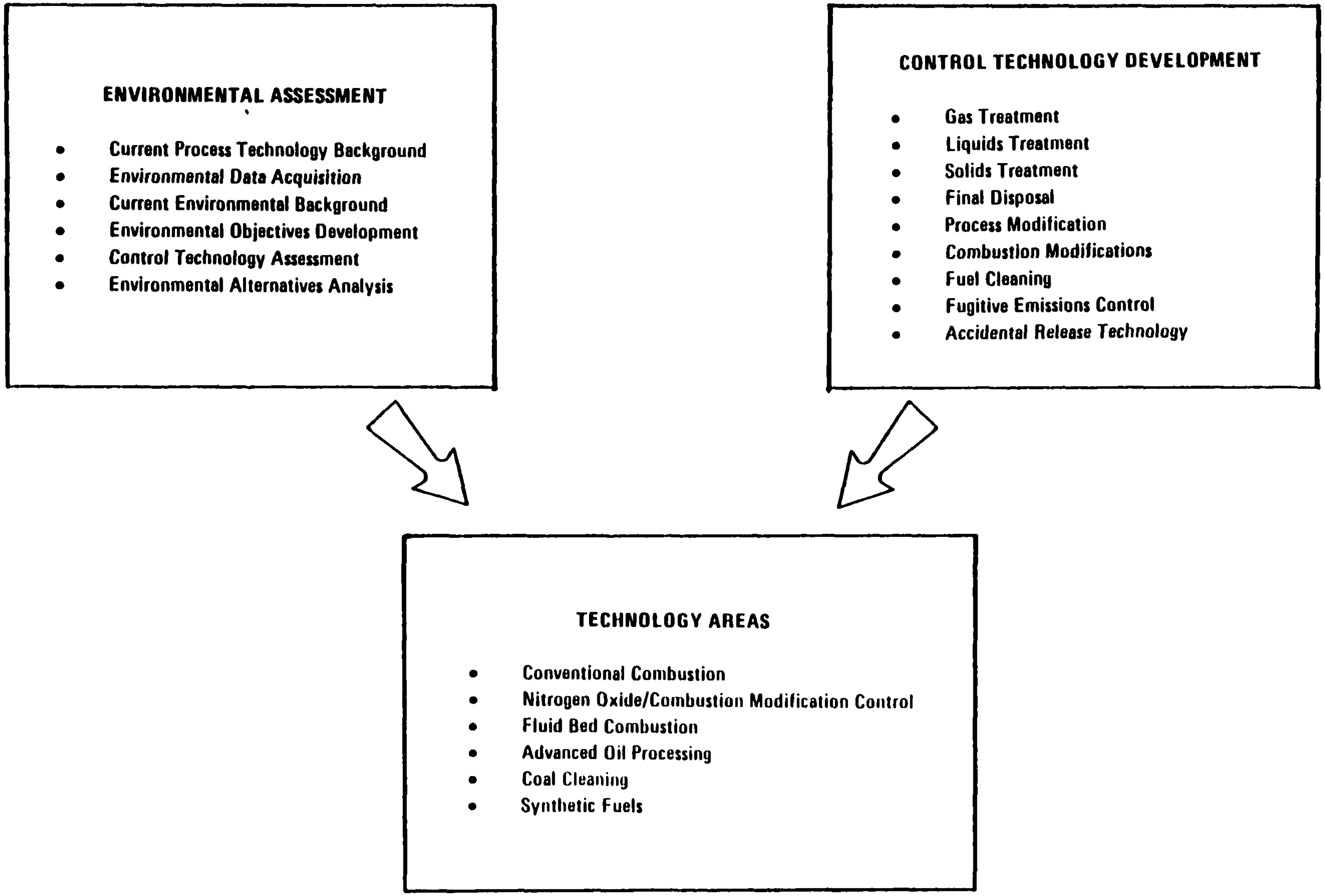


Figure 2. Environmental assessment and control technology development program.

- Environmental Objectives Development - Utilizes the Multimedia Environmental Goal (MEG) approach (see section 4.1 for a detailed discussion of MEG) to develop goals for organics, inorganics, radionuclides, microorganisms, heat, nonionizing radiation, noise, land-related physical factors, and water-related physical factors.
- Control Technology Assessment - Develops the multimedia environmental control engineering manual for energy technologies and assesses the effectiveness of various process control options.
- Environmental Alternative Analysis - Includes: (1) development of Source Analysis Models (SAM's), (2) interpretation of Levels 1, 2, and 3 results to determine maximum potential "degree of hazard" and "toxic-unit discharge rate," (3) assessment of compliance of each control/disposal option with various alternatives, and (4) ranking of effluent streams and pollutants of concern.

Figure 3 details further the relationship of these six functional EA areas to the development of environmental assessments and control technologies.

Figure 4 outlines the phased approach to environmental assessment methodology.

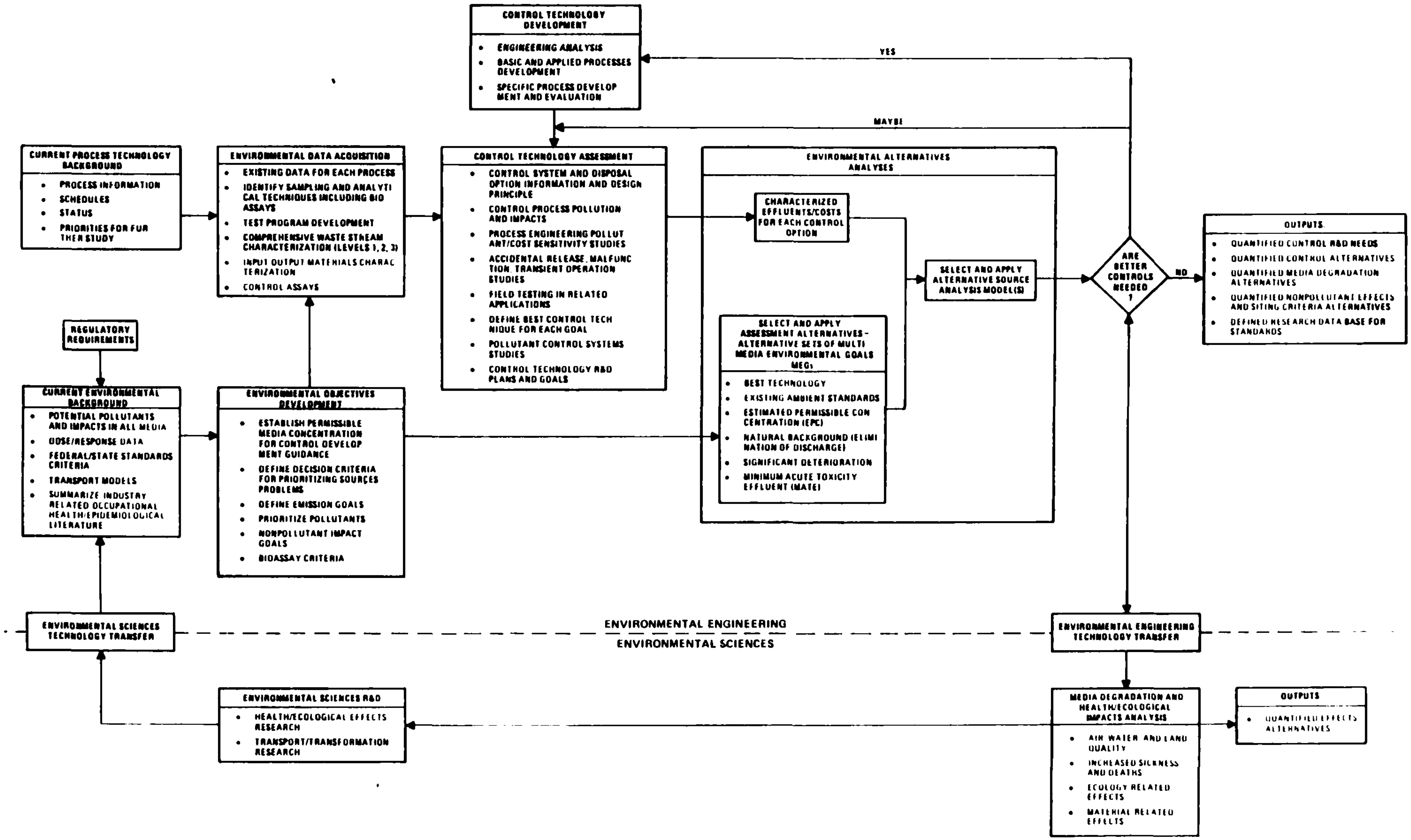


Figure 3. Environmental Assessment/Control Technology Development Diagram

Phase	Key E. A. Methodology Components Utilized			Phase Characteristics			
	Sampling & Analysis Used	Multimedia Environmental Goal Sets Used (Assessment Alternatives)	Source Analysis Models Used	Concentration Levels Measured	Concentration Levels Evaluated	Health & Ecological Effects Level Evaluated	Accuracy, Specificity, Cost, Time to Carry Out
1 (Comprehensive, Rapid Screening)	Level 1 Chemical	MATE*	SAM/IA (Rapid Screening)	Effluent	Effluent	Acute Exposure	Low
	Biological	Bioassay Criteria	–	Effluent	Effluent	Acute Exposure	
2 (Directed Detailed Screening)	Level 2 Chemical	MATE*	SAM/IA (Rapid Screening)	Effluent	Effluent	Acute Exposure	Higher
		EPC**	SAM/I (Screening Using Standardized Source Models)	Effluent	Estimated-Ambient	Chronic Exposure	
	Biological	Bioassay Criteria	–	Effluent	Effluent	Acute Exposure	
3 (Priority Pollutant/ Effluent Evaluation)	Level 3 Chemical	EPC**	SAM/II	Effluent	Estimated-Ambient	Chronic Exposure	Highest
		EPC**	–	Ambient	Ambient	Chronic Exposure	
	Biological	Bioassay Criteria	–	Ambient	Ambient	Chronic Exposure	

*MATE (Minimum Acute Toxicity Effluent)

**EPC (Estimated Permissible Concentrations – includes existing ambient standards)

Other Assessment Alternatives can also be applied.

Figure 4. Environmental assessment methodology—a phased approach.

1.2 CURRENT PROCESS TECHNOLOGY BACKGROUND

In conjunction with methodologies developed in the environmental data acquisition module, current process technology background methodologies will be used to assess control technologies. Key components of the current process technology background include: process information, schedules, status, and priorities for further study. The systems being studied using the methodologies discussed below include: (1) conventional combustion systems--nitrogen oxides/combustion modification control, (2) fluid bed combustion, (3) coal cleaning, (4) synthetic fuels, and (5) advanced oil processing.

Four methodologies are currently being established in this area: (1) technology overview reports format, (2) nomenclature for energy technologies, (3) source unit operations, and (4) process assessment criteria. Their status is reviewed in the following sections.

1.2.1 Technology Overview Report Outline

REFERENCES: E. C. Cavanaugh, W. E. Corbett, and G. C. Page, Environmental Assessment Data Base for Low/Medium-Btu Gasification Technology: Volumes I and II, EPA-600/7-77-125a and -125b, November 1977.

P. W. Spaite and G. C. Page, Technology Overview: Low- and Medium-Btu Coal Gasifications Systems, EPA-600/7-78-061, March 1978.

These reports will compile all pertinent information for a particular fossil energy technology at the beginning of an environmental assessment. The outline on the following page has been suggested by Radian Corporation for the reports, which would be about 50-80 pages in length:

1.2.2 Nomenclature for Energy Technologies

REFERENCE: R. P. Hangebrauck, Director, Energy Assessment and Control Division, Industrial Environmental Research Laboratory, Research Triangle Park, N.C.

To facilitate discussion among users of the Technology Overview Reports and other EA methodologies, the following standard nomenclature for energy technologies has been developed.

OUTLINE TECHNOLOGY OVERVIEW REPORT

I. **INTRODUCTION**

II. **STATUS OF TECHNOLOGY**

A. **Applicability** - Discussion of the applicability of the technology to potential product end uses such as direct combustion, chemical feedstocks, electricity, etc. Factors affecting the technology's rate of commercialization are also discussed. These factors consist of the total markets currently available for the product(s), the markets that are most suitable for the product(s), the product markets not yet developed, and other factors limiting commercialization.

B. **Commercial Prospects** - Current status of commercial systems is presented along with plans of industry to install new commercial systems in the future. Discussions of the factors that may affect these plans for commercialization, such as the time required to install these systems, are included.

C. **Development Activities** - Discussion of the agencies, institutions, and industries involved in the technology development activities. The types of activities (process, environmental, health effects, control technology, etc.) are described along with the activities associated with the development of new product markets.

D. **Energy Efficiency** - A discussion of thermal efficiencies, such as comparing the feedstock energy input to the product energy output or the total energy of the input to the total energy of the output is included. The effects of operating parameters, feedstocks, product end uses, and control technologies on the plant's energy efficiency are also discussed.

E. **Costs** - Factors affecting product costs include:

1. cost sensitivity to specific processes, control technologies, and product end use;
2. plant locations, available space, and capacity;
3. availability of fuels; and
4. Federal, State, and local environmental regulations.

III. **DESCRIPTION OF TECHNOLOGY**

A. **Processes/Systems** - The technology of concern is characterized by dividing the technology into specific operations and modules, each module having well-defined inputs, outputs, and functions. The total population of processes that can be used to produce the technology's products is presented along with the specific processes that have the greatest likelihood for near-term commercialization. These processes are then grouped by operating parameters (pressure, temperature, etc.), feedstock pretreatment requirements, and/or specific product end uses. A generalized flow diagram of the types of systems showing the combination of modules that represent typical commercial plants is also given.

B. **Raw Materials** - The raw material requirements for the processes used to produce the technology's product, and the effects of these raw materials on the operation of specific processes and on the product end uses are discussed.

IV. ENVIRONMENTAL IMPACTS AND DISCHARGE STREAM SUMMARY

A. **Environmental Impacts** - This section presents a summary of the multimedia discharge streams and their sources. Environmental implications and health effects associated with these streams are discussed.

B. **Discharge Stream Summary** - Multimedia discharge streams and their control technologies are presented. The discharge stream summary table identifies the operation and the module that is the source of the discharge stream, summarizes the current status of the data for the stream, and indicates why more data are required. The control technology summary table identifies (a) the discharge streams and their sources by operation and module, (b) the input and output streams from each module that needs to be characterized, (c) the applicable technologies for controlling the discharge stream, and (d) the data requirements and current status for each stream.

V. APPENDIXES

A. **Environmental Assessment/Control Technology Development** - This section presents a discussion of how the Technology Overview is incorporated into the Current Process Technology Background task area in the EPA's Environmental Assessment/Control Technology Development Program.

B. **Proprietary Systems** - A summary table listing the total population of processes that can be used, the process licensors/developers, and the current status of each process is given. A second table summarizes the processes (including their licensor/developer and status) that have the greatest potential for near-term commercialization.

C. **Process Module Descriptions** - Each module description contains the following entries: (a) general information on the processes in the module, (b) specific process information, and (c) discharge streams.

Energy Technology--An energy technology is made up of systems that are applicable to the production of fuel, electricity, or chemical feedstocks from fossil fuels, radioactive materials, or natural energy sources (geothermal or solar). A technology may be applicable to extraction of fuel (e.g., underground gasification) or processing of fuel (e.g., low-Btu gasification, light water reactor, conventional boilers with fuel gas desulfurization).

Operation--An operation is a specific function associated with a technology and consists of a set of processes that are used to produce specific products from certain raw materials. For example, the operations for low/medium-Btu gasification technology are coal pretreatment, coal gasification, and gas purification. The processes used in each of these operations are:

> Coal Pretreatment - drying, partial oxidation, crushing and sizing, briquetting, and pulverizing.
>
> Coal Gasification - fixed-bed/pressurized/slagging; fixed-bed/pressurized/dry ash; entrained-bed/pressurized/slagging; fixed-bed/atmospheric/dry ash; fluid-bed/atmospheric/dry ash; and entrained-bed/atmospheric/slagging.
>
> Gas Purification - wet or dry particulate and tar removal, gas quenching, and acid gas removal.

Process--Processes are basic units that make up a technology. A process is used to produce chemical or physical transformations of input materials into specific output streams. Every process has a definable set of waste streams that are, for practical purposes, unique. The term "process" used without modifiers is used to describe generic processes. Where the term "process" is modified (e.g., Lurgi process), reference is made to a specific process that falls in some generic class consisting of a set of similar processes. For example, a generic process in low/medium-Btu gasification technology is the fixed-bed/atmospheric/dry ash gasification process. Specific processes that are included in this generic class are Wellman-Galusha, Woodall-Duckham/Gas Integrale, Chapman (Wilputte), Riley-Morgan, Foster Wheeler/Stoic, and Wellman-Incandescent.

Process Module--A representation of a process that is used to display process input and output stream characteristics. When used with other necessary process modules, it can be used to describe a technology, a system or a plant. One example of the "process module" approach to environmental studies of energy technologies involved study of emissions from petroleum refining. A description was developed for the basic processes that make up a petroleum refinery; e.g., atmospheric distillation, catalytic cracking, etc. Information on air emissions, as a function of throughput, was collected as descriptive information for each process module. Individual process modules were assembled to describe plants with the process configuration that is typical of specific areas of the country; e.g., a refinery in the southwest United States, which maximized gasoline output, and another in the northeast United States, which produced more distillate fuel. Data on emissions and weather and air quality information from specific locations, for assumed plant sites, were used for diffusion modelling studies aimed at predicting the air pollution that would be experienced if a refinery was in operation at the assumed location.

Auxiliary Process--Processes, associated with a technology, that are used for purposes that are in some way incidental to the main functions involved in transformation of raw materials into end products. Auxiliary processes are used for recovery of byproducts from waste streams, to furnish necessary utilities, and to furnish feed materials such as oxygen, which may or may not be required depending on the form of the end product that is desired. For example, some auxiliary processes for low/medium-Btu gasification technology include (a) oxygen production used to produce medium-Btu gas, (b) the Claus process used to recover sulfur from gaseous waste streams, and (c) the Phenolsolvan process used to recover phenols from liquid waste streams.

System--A specified set of processes that can be used to produce a specific end product of the technology; e.g., low- and medium-Btu gasification. The technology is comprised of several systems. The simplest system is producing combustion gas from coal using a small fixed-bed, atmospheric, dry ash gasifier coupled with a cyclone. One of the most complex systems has very large gasifiers with high efficiency gas cleaning being used to produce a fuel clean enough to be fired in the gas turbines of a combined-cycle unit for production of electricity.

Plant--An existing system (set of processes) that is used to produce a specific product of the technology from specific raw materials. A plant may employ different combinations of processes but will be comprised of some combinations of processes that make up the technology. For example, the Glen-Gery Brick Company low-Btu gasification facilities are plants used to produce combustion gas from anthracite coal.

Input Streams--Materials that must be supplied to a process for performance of its intended function. Input streams will include primary and secondary raw materials, streams from other processes, chemical additives, etc. For example, the input streams to a Lurgi gasifier consist of sized coal, lock hopper filling gas, oxygen, steam, and boiler feedwater. For auxiliary processes a waste stream from which a byproduct is recovered is an input stream.

Output streams--Confined discharges from a process, which can be products, waste streams, streams to other processes, or by-products. For example, output streams from a Lurgi gasifier include coal feeder vent gases, ash hopper vent gases, wet ash, steam blowdown, and crude medium-Btu gas.

Raw Materials--Raw materials are feed materials for processes. They are of two types: (1) primary raw materials that are used in the chemical form in which they were taken from the land, water, or air; and (2) secondary raw materials that are produced by other industries or technologies. For example, primary raw materials for low/medium-Btu gasification technology include coal, air, and water. Secondary raw materials include fluxes, makeup solvent, catalysts, etc.

Process Streams--Process streams are output streams from a process that are input streams to another process in the technology. For example, the crude medium-Btu gas from the Lurgi gasification process is the feed (input) stream to the tar and particulate removal quench process.

Products--Process output streams that are marketed for use or consumed in the form in which they exit the process. For example, the product from low-Btu gasification technology is the low-Btu gas exiting the final gas purification process.

Byproducts--Byproducts are auxiliary process output streams that are produced from process waste streams and are marketed or consumed in the form in which they exit the process. For example, tar is a byproduct produced by certain low-Btu gasification facilities. It may either be consumed in a tar boiler or sold.

Waste Streams--Waste streams are confined gaseous, liquid, and solid process output streams that are sent to auxiliary processes for recovering byproducts, pollution control equipment, or final disposal processes. Unconfined "fugitive" discharges of gaseous or aqueous waste and accidental process discharges are also considered waste streams. The tail gas from an acid gas removal process is an example of a waste stream in low/medium-Btu gasification technology. This stream can be sent to an auxiliary process to recover the sulfur as a byproduct.

Source--Equipment that discharges either confined waste streams (solids, liquid, gaseous, or combinations) or significant quantities of unconfined, potential polluting substances in the form of leaks, spills, and the like. Examples of sources include gasifier coal feed lock hoppers, which discharge emissions during coal feeding, and the Claus reactor, which recovers sulfur and discharges tail gases containing polluting sulfur compounds.

Effluent Streams--Confined aqueous process waste streams that are potentially polluting. These will be discharged from a source.

Emission Streams--Confined gaseous process waste streams that are potentially polluting. These will be discharged from a source.

Fugitive Emissions--Unconfined process-associated discharges, including accidental discharges, of potential air pollutants. These may escape from pump seals, vents, flanges, etc., or as emissions in abnormal amounts when accidents occur and may be associated with storage, processing, or transport of materials as well as unit operations associated with a process. They will escape from a source.

Fugitive Effluents--Unconfined process-associated discharges, including accidental discharges, of potential water pollutants that are released as leaks, spills, washing waste, etc., or as effluents in abnormal amounts when accidents occur. These may be associated with storage, processing, or transport of materials as well as unit operations associated with industrial processes, may be disposed of to municipal sewers, and can lead to generation of contaminated runoff waters. They will escape from a source.

Accidental Discharge--Abnormal discharges (solid, liquid, gaseous or combinations) that occur as a result of upset process conditions.

Unit Operation--Unit operations, like processes described above, are employed to take input materials and perform a specific physical or chemical transformation. The equipment making up a unit operation may or may not have one or more waste stream(s). A process is made up of one or more unit operations that have at least one source of waste stream(s). Examples of unit operations are: distillation, evaporation, crushing, screening, etc.

Final Disposal Processes--Processes that are used to ultimately dispose of liquid and solid wastes from processes, auxiliary processes, and control equipment in a technology. Examples of final disposal processes are landfills and evaporation ponds.

Control Equipment--Equipment such as electrostatic precipitators, wet scrubbers, adsorption systems, etc., whose primary function is to minimize the pollution to air, water, or land that results from process discharges. While the collected materials may be sold, recycled, or sent to final disposal, control equipment is not essential to the economic viability of the process. Where such equipment is designed to be an integral part of a process, e.g., scrubbers that recycle process streams, they are considered a part of the basic process.

Residuals--Gaseous, liquid, or solid discharges from control equipment and final disposal processes. Examples of residuals include gaseous emissions from control equipment (such as scrubbers), the tail gases from an auxiliary process (e.g., a Claus sulfur recovery unit), and the vapors from an evaporation pond.

1.2.3 Source Unit Operations

REFERENCE: E. C. Cavanaugh, W. E. Corbett, and G. C. Page, Environmental Assessment Data Base for Low/Medium-Btu Gasification Technology: Volumes I and II, EPA-600/7-77-125a and -125b, November 1977.

In order to better characterize a technology for an environmental assessment, a modular approach has been developed for source unit operations.

With this approach, the technology is first divided into the major operations that are required to produce the technology's product. These operations are then further divided into modules having well-defined functions, input, and output (including discharge streams). Specific processes that can perform the specified function of each module are then identified, and the multimedia discharge streams from these processes are determined. In turn, specific systems that are representative of commercial plants for producing the technology's product can be developed. From these systems, the discharge streams and technology required to control these streams can be determined and data gaps can be easily identified.

A set of these modules has been developed for low/medium-Btu gasification technology as a prototype. The technology was divided into three major operations required to produce low/medium-Btu gas from coal.

The operations were then divided into the following specific modules:

Coal Pretreatment Operation

- Crushing/Sizing
- Pulverizing
- Drying/Partial Oxidation
- Briquetting
- Coal Storage and Handling

Coal Gasification Operation

- Gasification
- Oxygen Production

Gas Purification Operation

- Particulate Removal
- Gas Quenching and Cooling
- Acid Gas Removal

To identify the control devices required for the multimedia discharge streams generated by these modules, three pollution control modules were defined and divided into the following processes:

Air Pollution Control

- Particulate Control
- Sulfur Control
- Hydrocarbon Control
- Nitrogen Oxides Control

Water Pollution Control

- Oil/Water Separation
- Suspended Solids Removal
- Dissolved Organics Removal
- Dissolved Inorganics Removal
- Ultimate Disposal

Solid Wastes Pollution Control

- Chemical Fixation
- Sludge Reduction
- Landfill

General flow diagrams for the modules in each operation and for the processes in the pollution control modules were developed to illustrate: (a) how these modules and control processes can be used in the technology, (b) how they relate to each other, and (c) how the multimedia discharge streams are generated.

In these general flow diagrams the gaseous, liquid, and solid waste streams are indicated by a specific symbol. However, if a module is a significant source of many hazardous discharge streams, it may be necessary to develop a flow diagram in order to identify the specific waste streams from specific processes in the module.

One of the major advantages of using the modular approach in characterizing a technology for an environmental assessment is that the modules can be replaced by specific processes to develop process and pollution control systems that are representative of commercial plants. However, before these systems can be developed and the multimedia discharge streams identified, detailed process and discharge stream data for each process need to be known and easily accessible.

A technique for presenting the detailed process and emission data for a specific process has been developed. It involves developing a concise format for preparing data sheets for each process and pollution control device that is or will be used in commercial low/medium-Btu gasification facilities. The contents of these data sheets are given in table 2.

By using these process data sheets, a process-specific low/medium-Btu gasification system can be developed. The multimedia discharge streams and the need for pollution control processes can also be readily identified.

The module characterization developed by the Radian Corporation serves as an input for Technology Overview Reports and for Source Assessment Methodology development.

1.2.4 Process Assessment Criteria

REFERENCE: Hittman Associates, Inc., Process Assessment Criteria (Draft), Contract No. 68-02-2162, U.S. Environmental Protection Agency, IERL, Research Triangle Park, N.C., February 1978.

Because candidate industrial processes need to be prioritized according to their commercialization and environmental degradation potentials at the start of environmental assessment, Hittman Associates is developing a methodology for assessing process effectiveness.

1.2.4.1 Selection of Assessment Criteria

After review of potential criteria and their compatability with the proposed ranking methodology, the following criteria and subcriteria for assessing processes were selected:

Commercialization Outlook

- Benefit/Cost Estimates
- Present Availability of Commercial Scale Components
- Commercialization Schedule
- Potential Market Size
- Existing Unit Size/Commercial Unit Size
- Number of Existing Units

Environmental Degradation Potential

- Relative Known Hazard
- Number of Waste Streams
- Pollutant Mass Flow Rate
- Relative Effectiveness of Existing Controls

1.2.4.2 Development of Criteria Weighting Factors

The development and assignment of appropriate weighting factors to both criteria and subcriteria were extremely difficult. The criteria could not

TABLE 2. CONTENTS OF DATA SHEETS FOR MOST PROMISING PROCESSES

GENERAL INFORMATION

- Process Function
- Development Status
- Licensor/Developer
- Commercial Applications
- Applicability to Technology

PROCESS INFORMATION

- Equipment
- Flow Diagram (with Discharge Streams)
- Operating Parameter Ranges
- Normal Operating Parameters
- Raw Material Requirements
- Utility Requirements
- Process Efficiency
- Expected Turndown Ratio
- Product Production Rate

PROCESS ADVANTAGES

PROCESS LIMITATIONS

INPUT STREAMS

DISCHARGE STREAMS AND THEIR CONTROL

- Gaseous Discharge Streams
- Liquid Discharge Streams
- Solid Discharge Streams

REFERENCES

be combined in any deterministic sense to give an absolute measure of a criterion's priority for a particular process. Consequently, the system of weights adopted gives only relative comparisons among candidate processes and requires subjective decisions during its development.

The DARE (Decision Alternative Rational Evaluation) decision model was used to simplify the subjective decisions required, to provide a mechanism whereby the judgment of several technical staff members could be employed, and to provide a procedure that could be repeated or changed if desired. This model requires pairwise numerical relevance comparisons within subcriteria and criteria sets. It produces a normalized set of weights (total equal to 1.0) for each set of criteria and subcriteria. The weights can be easily applied to subcriteria process scores in order to obtain total process scores that indicate the relative need for immediate further attention to candidate processes at the start of environmental assessment.

The DARE procedure will be expanded and improved in subsequent iterations to determine the final set of weights to be used.

1.2.4.3 DARE Weighting Procedure

To explain how DARE works it is appropriate to review some concepts of scoring models and their use. Suppose that a number of processes are candidates for time and resources in an environmental assessment. Assume further that seven appropriate criteria for evaluating these processes have been selected.

A simple evaluation technique would be to consider one process and assign a subscore to it for every criterion. The sum of subscores would constitute a score for the process. Algebraically this model is represented as:

$$A = S_1 + S_2 + S_3 + \dots + S_7$$

where A is the score of the process being evaluated and the S values are subscores of the process for each of the seven criteria being used. Candidate processes could be ranked according to their total A scores.

However, it is rarely the case that all criteria are of equal importance. If an evaluator could quantify his view of the relative importance of the criteria, he could construct a better model ascribing weights to each of the subscores:

$$A = S_1W_1 + S_2W_2 + S_3W_3 + \ldots + S_7W_7$$

where the W-values (weighting factors) reflect the relative importance of the criteria. This is called an additive weighting model. It is satisfactory provided that the criteria are independent of one another (that is, no two represent the same factor that needs attention in an environmental assessment).

In any real case, it is difficult to make all criteria completely independent of one another. Dependencies can often be reduced, however, by careful definition of the criteria.

Assuming that dependencies in our example are satisfactorily small, it remains to determine both the weighting factors, W, and the criteria subscores, S. The DARE method prescribes a simple way of assigning quantitative values to these variables, based on pairwise-comparison concept.

1.2.4.4 Procedure for Use of Methodology

The subcriteria evaluation scoring scales on the following page are suggested, though, in practice, other scales may be used for convenience or to reflect the nature of particular environmental assessments.

1.2.4.5 Computation and Interpretation of Total Process Scores

The computation of Total Process Scores is a simple, straightforward operation. Process subcriterion scores are totaled and normalized. The normalized subcriterion scores are then multiplied by their respective subcriterion weighting factors to obtain weighted subcriterion scores. Each weighted subcriterion score is in turn multiplied by the appropriate criteria weighting factor and the results totaled. This value represents the Total Process Score.

COMMERCIALIZATION OUTLOOK

(a) Benefit/Cost Estimates

Qualitative Benefit/Cost Comparison	Score
Inferior to Competition	0
Equivalent to Competition	3
Superior to Competition	6
Far Superior to Competition	9

(b) Present Availability of Commercial Scale Components

This subcriterion is scored on a seven point basis. Processes for which all purchased components are available off the shelf in commercial scale are assigned a score of seven. For each component not now produced in the size range needed, subtract one point. Zero can be assigned to processes with seven or more such components.

(c) Commercialization Schedule

Number of Years to Scheduled Commercialization	Score
0	39
1	38
2	37
3	36
4-5	35
6-7	34
8-9	33
10-11	32
12 or more	31

(d) Potential Market Size

This subcriterion, expressed in constant dollars, should indicate the maximum possible degree of process commercialization by the year 1985.

(e) Existing Unit Size/Commercial Unit Size

The numerical dimensionless ratio of these two sizes is used as the process score. The ratio may range from zero to one. If the largest existing test unit has the same general dimensions as the planned commercial unit, score a one. If no hardware exists, score a zero.

(f) Number of Existing Units

Use the number of known existing units of hardware.

ENVIRONMENTAL DEGRADATION POTENTIAL

(a) Relative Known Hazard

The process with the most hazardous discharges (when uncontrolled) is given a weight of nine and other processes are scored accordingly on a nine-point scale.

(b) Number of Waste Streams

A process is assigned a weight equal to its total number of liquid, solid, or gaseous waste streams.

(c) Pollutant Mass Flow Rate

The mass flow rate represents the total magnitude of environmental emissions. It may be scored by summing the quantity of all pollutants (lb/day, etc.) discharged to the air, water, and land. The mass flow rates should assume an uncontrolled process unit.

(d) Relative Effectiveness of Existing Control Technology

This subcriterion may be evaluated by assigning a score of nine to the least effectively controlled process and scoring other processes on a relative basis.

1.3 ENVIRONMENTAL DATA ACQUISITION STATUS

Adequate assessment of the effectiveness of control technologies requires judicious development of (1) existing data for control processes; (2) sampling and analytical techniques; (3) test programs; (4) comprehensive waste stream characterization at Levels 1, 2, or 3; and (5) input-output materials characterization.

In order to accomplish these goals and to insure adequate and reliable acquisition of environmental data, a phased approach (shown in figure 5) was developed by EPA. Level 1 is a comprehensive screening; Level 2 is a directed, detailed analysis based on Level 1; and Level 3 involves the process monitoring of selected priority pollutants based on Level 1 and 2 results.

Level 1 analysis identifies qualitatively the pollution potential of all process streams by biological assays and chemical testing and generates quantitative information about the organic and inorganic species of interest. Outputs from Level 1 are used to prioritize those process waste streams or their components for Level 1 analyses.

At Level 2, potentially hazardous substances in process waste streams are quantified. These data are used to guide control technology and health effects studies.

Level 3 extends Level 2 by identifying the potential for pollution from a waste stream based on process variables.

1.3.1 Level 1 Sampling and Analysis Procedures

REFERENCE: J. W. Hamersma, S. L. Reynolds, and R. F. Maddalone, IERL/RTP Procedures Manual: Level 1 Environmental Assessment, EPA Report No. 600/2-76-160a, June 1976 [New edition available late 1978].

The goal of Level 1 sampling and analysis is to identify a source's pollution potential with a target accuracy of a factor of ±2 to ±3. Consequently, no special procedure is employed to obtain a statistically representative sample. The chemical, physical, and biological testing has survey and/or quantitative accuracy consistent with the characteristics of the sample.

The sampling and analysis are designed to show the presence or absence, the approximate concentrations, and the emission rate of inorganic elements,

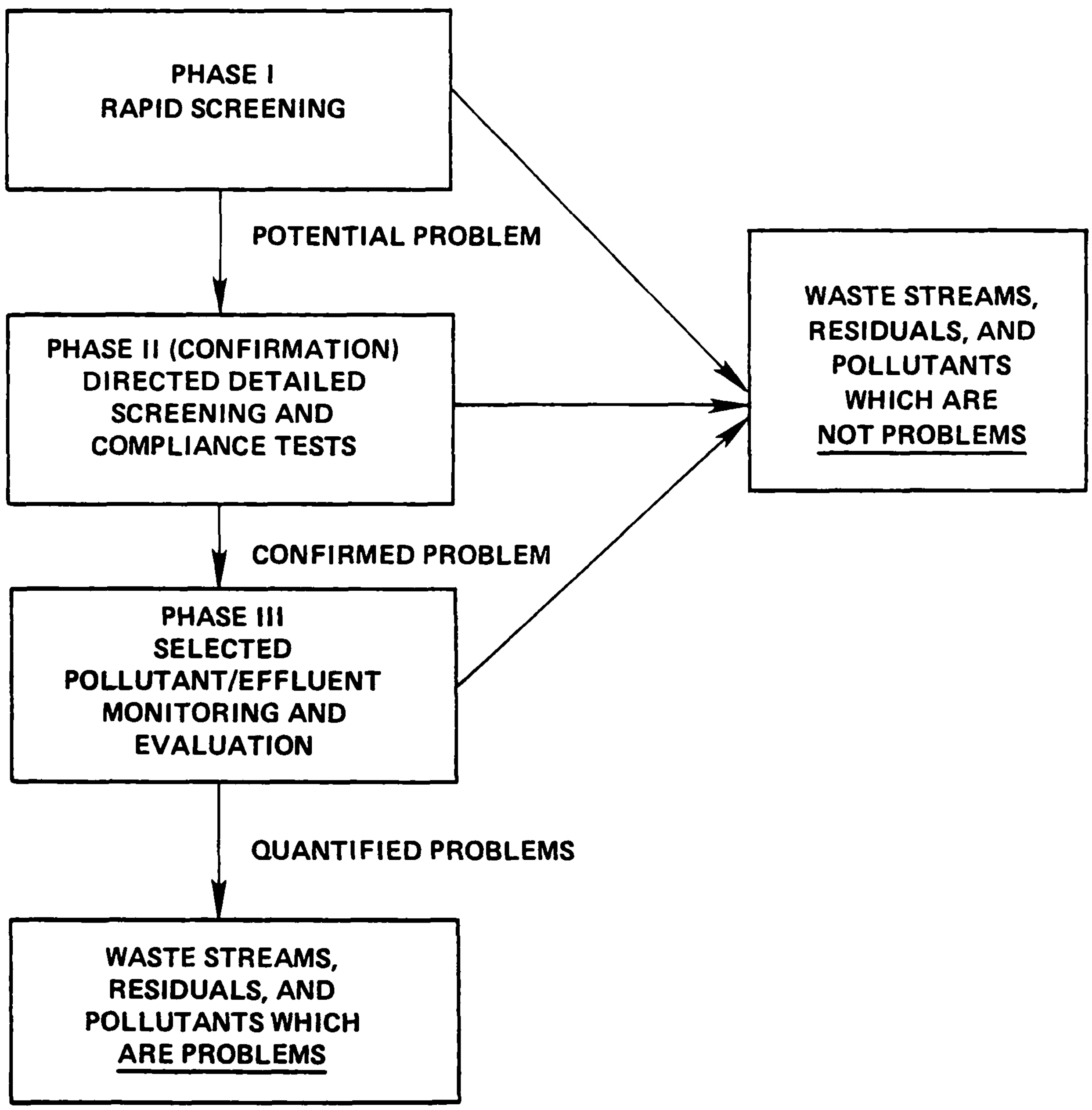


Figure 5. Environmental assessment methodology—a phased approach.

selected inorganic anions, and classes of organic compounds. The particulate matter is further analyzed through size distribution as well as microscopic examination in order to determine gross physical characteristics of the collected material. Biotesting develops information on the human health effects and ecological effects of the sample.

The results of this phase are used to establish priorities for additional testing among a series of energy and industrial sources, streams within a given source, and components within streams. The most important function of Level 1 is the focusing of sampling and analysis programs on specific streams and components for the Level 2 effort. It delineates specific sampling, analysis, and decisionmaking problem areas, and directs and establishes the methodology of the Level 2 effort so that additional information needs can be satisfied. If it can be proven that equivalent Level 1 data exist for all streams of interest, then a Level 1 effort need not be conducted. If partial data exists, Level 1 must be performed on all streams.

Another possible exception to the strict adherence to the Level 1 technique involves the application of slightly more sophisticated procedures where specific pollutants of high current interest are concerned. In this case, the approach would involve a more complex Level 2 sampling and/or analytical strategy in the initial Level 1 plan.

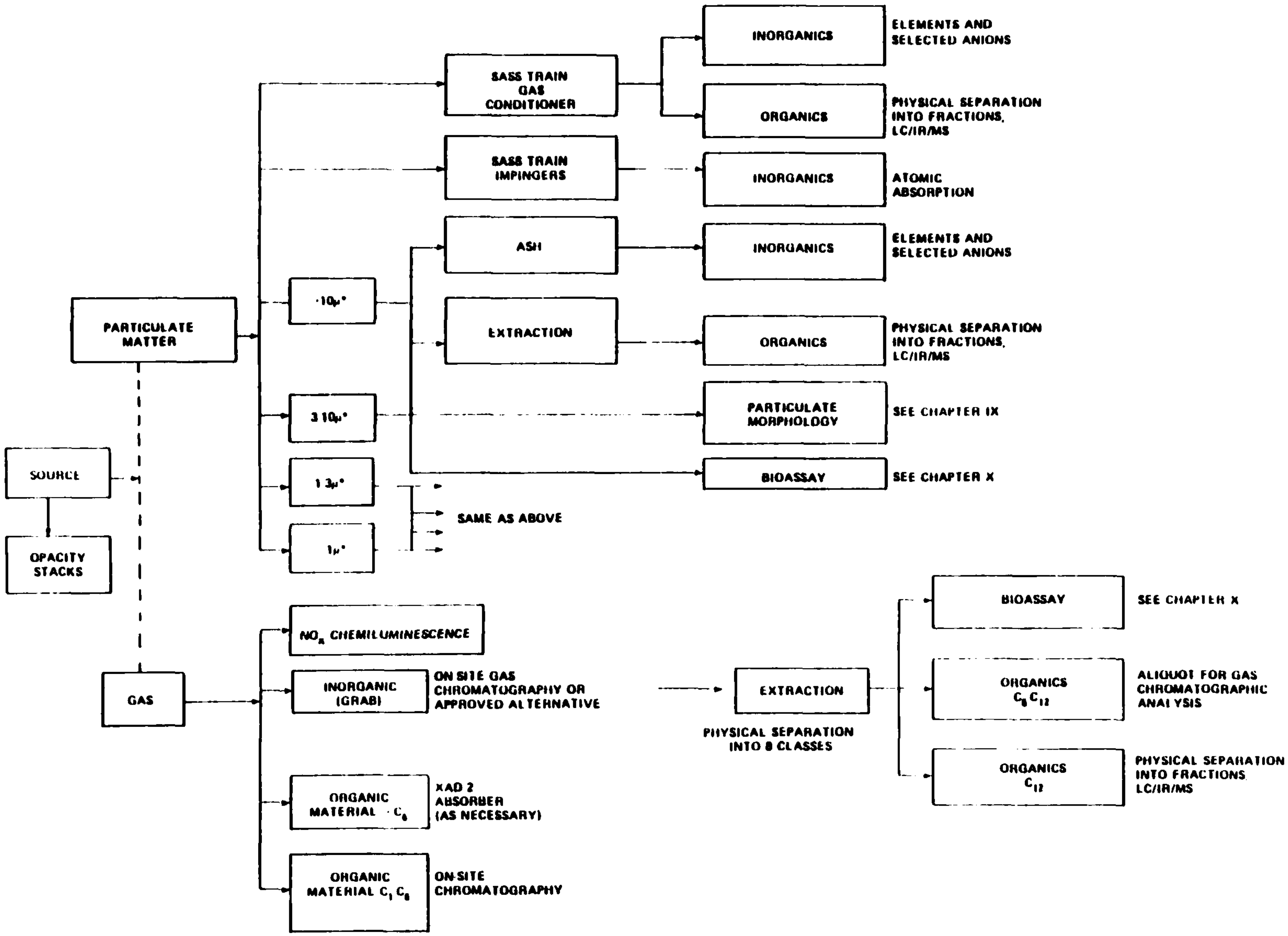
Sampling and analytical schemes developed for Level 1 analysis of particulates and gases are shown in figure 6. Schemes for solids, slurries, and liquids are outlined in figure 7.

In addition to those interactions with other environmental data acquisition projects previously outlined, Level 1 sampling and analysis procedures provide needed input for source assessment methodologies.

Problems and complications related to the field applications of Level 1 sampling and analysis procedures have been identified and are being resolved through the Environmental Assessment Users' Service that is coordinated by the Research Triangle Institute (RTI).

1.3.2 Level 1 Bioassay Procedures

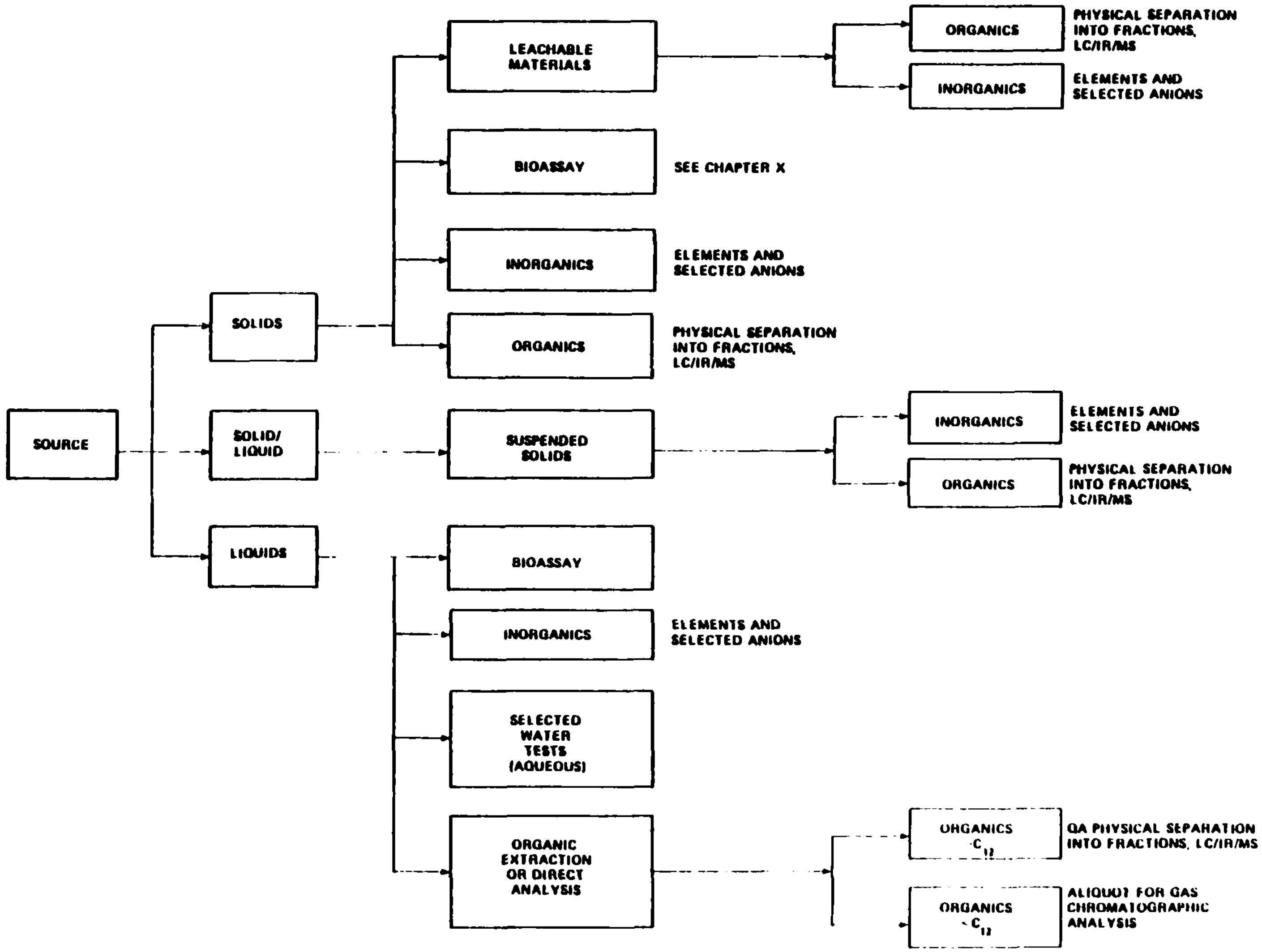
REFERENCE: K. M. Duke, M. E. Davis, and A. J. Dennis, IERL/RTP Procedures Manual: Level I Environmental Assessment Biological Tests for Pilot Studies, EPA-600/7-77-043, April 1977.



*WEIGH INDIVIDUAL CATCHES

SOURCE: J. W. Hamersma, S. L. Reynolds, and R. F. Maddalone, *IERL/RTP Procedures Manual: Level 1 Environmental Assessment*, EPA Report No. 600/2-76-160a, U.S. Environmental Protection Agency, Washington, DC, June 1976.

Figure 6. Basic Level 1 sampling and analytical scheme for particulates and gases.



SOURCE: J. W. Hamersma, S. L. Reynolds, and R. F. Maddalone, *IERL/RTP Procedures Manual: Level 1 Environmental Assessment*, EPA Report No. 600/2-76-160a, U.S. Environmental Protection Agency, Washington, DC, June 1976.

Figure 7. Basic Level 1 sampling and analytical scheme for solids, slurries, and liquids.

These procedures were developed by the Bioassay Subcommittee of the IERL Environmental Assessment Steering Committee. They were refined further in a usable form by the Battelle Columbus Laboratories. The Level 1 bioassay tests include assessments of both health and ecological effects. These analyses are summarized in figure 8.

Health Effects Tests include the following:

- Ames Test

  Salmonella/Microsome Mutagenesis Test is used as a primary screen to determine the mutagenic activity of complex mixtures or component fractions.

- Cytotoxicity Tests

  These assays use mammalian cells in culture to measure quantitatively cellular metabolic impairment and death resulting from exposure *in vitro* to soluble and particulate toxicants. Compared to conventional whole-animal tests for acute toxicity, cytotoxicity assays are more rapid, less costly, and require significantly less sample. However, because the assays employ isolated cells and not intact animals, they provide only preliminary, imprecise information about the ultimate health hazards of toxic chemicals.

- Rodent Acute Toxicity Test

  In vivo tests using whole animals are necessary biological test procedures to complement data from *in vitro* tests and to assist in detecting possible synergisms and antagonisms among the various chemical compounds of a complex effluent or feedstock mixture. The advantages of the *in vivo* tests are (1) the assessment is performed on whole animals rather than individual tissues or organs, and (2) the presence of significant test data on a wide range of toxicants which supply needed information for reliable interpretation of the test results.

Ecological Tests include the following:

- Freshwater and Marine Algal Tests

  These tests are used to quantify the biological response (algal growth) to changes in concentrations of nutrients and to determine whether or not various effluents are toxic or inhibitory to algae.

- Acute Static Bioassays with Marine and Freshwater Fish and Invertebrates

  These tests are conducted by exposing the test organisms to test solutions containing various levels of a toxic agent. These acute toxicity tests are generally used to determine the level of toxic agent that produces an adverse effect on a specified percentage of the test organisms in a short period of time.

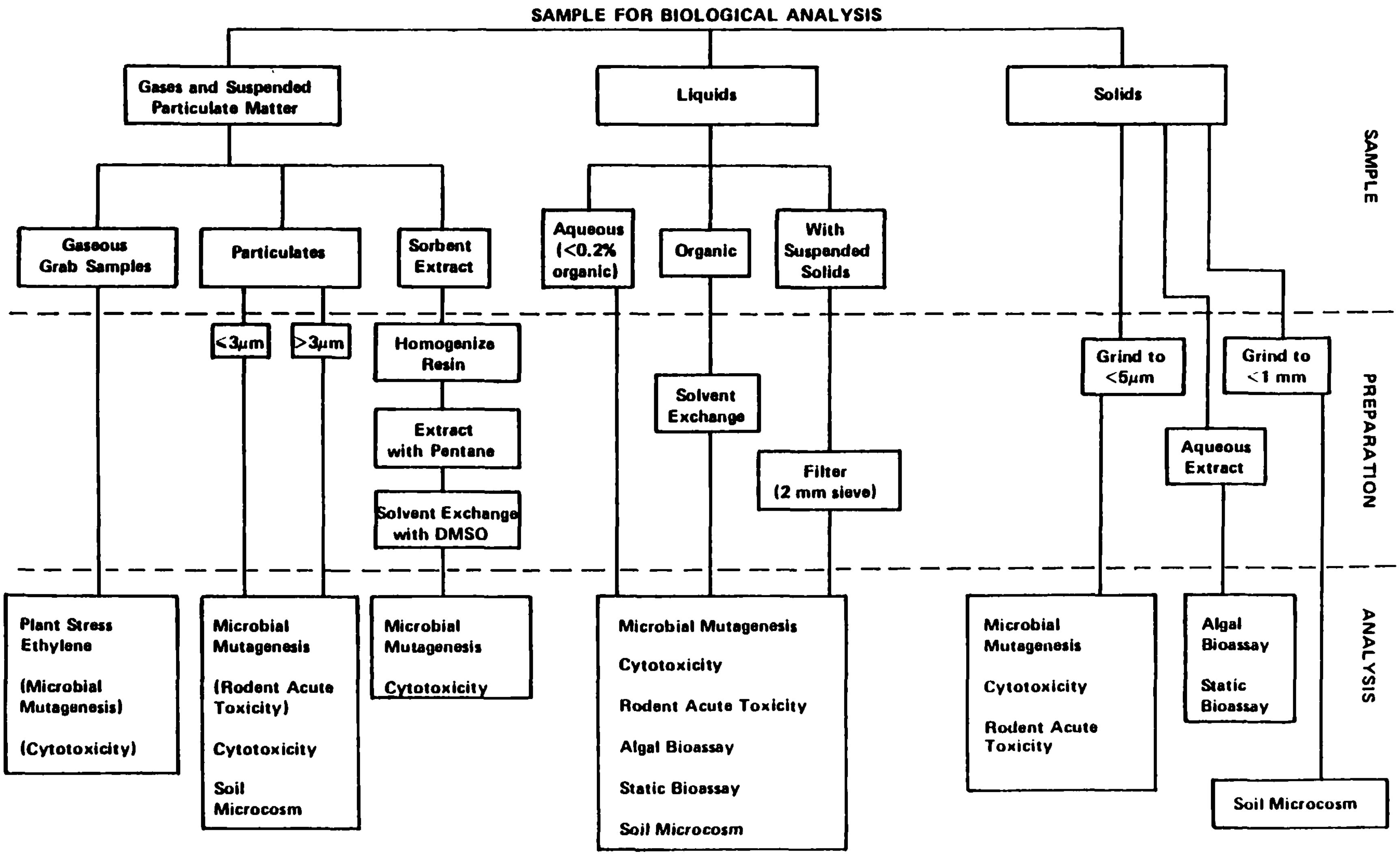


Figure 8. Biological analysis overview.

- Stress Ethylene Test

  This test is based on the response of plants, e.g., the release of elevated amounts of ethylene, to increased environmental stress. It is designed for use with gaseous emissions.

- Soil Microcosm Test

  Various levels of toxicant are applied to the surface of the soil microcosms, which are enclosed systems of soil; its overlying litter; and the macro- and micro-organisms that inhabit this matrix and remineralize organic matter to nutrients that are available to plants. Daily carbon dioxide flux and weekly calcium and dissolved organic carbon in water, which has leached through the cores, are analyzed. Toxic or inhibitory effects are determined using ATP (adenosine triphosphate) analysis and mass balances of nutrient pools and comparing the results with control microcosms.

The only significant problem associated with the development of reliable, inexpensive Level 1 bioassay tests was the difficulty in finding tests that will work with complex mixtures, such as found in process feedstocks and waste streams.

1.3.3 Level 1 Quality Assurance

REFERENCE: Frank Smith, Research Triangle Institute, Research Triangle Park, N.C. 27709.

Quality assurance programs for Level 1 include the following key components.

- Preparation of Guidelines for Environmental Assessment Quality Assurance Programs

A finalized set of Quality Assurance Guidelines contains the following key sections:

A. Definition of Terms

1. Quality - "goodness" of acquired data, a data quality (DQ) program includes the quality control and quality assurance needed to achieve "good" data.

2. Quality Control (QC) - an "internal" system of activities to monitor and maintain a specified quality of data.

3. Quality Assurance (QA) - "external" qualitative and quantitative periodic verifications of quality control.

QA programs are designed to independently assess QC programs, with a comprehensive DQ program embodying both QC and QA. QC components are generally not specific to EA projects.

B. General Guidelines for EA Project QA Programs

C. QA Procedures for Level 1 EA's and for Multi-Level Assessments

D. Reference Tables - These five tables address source gas, ambient air, water, soil, and process measurements. Each table includes information about measurement methods, operating ranges, bias, and precision.

The overall QA document deals primarily with procedures for the verification of secondary standards against primary standards in the lab. IERL is presently working with the National Bureau of Standards (NBS) in an effort to develop standard reference material applicable to environmental assessment projects.

- Interlaboratory Evaluation of Level 1 Environmental Assessment Procedures

  Currently in progress is a program to test both the operation of the Source Assessment Sampling System (SASS) and the use of the analytical scheme outlined in the IERL/RTP Procedures Manual: Level 1 Environmental Assessment. This is essentially an interlaboratory evaluation among Southern Research Institute, Radian Corp., and TRW.

  The first phase consisted of a field evaluation of the SASS for a stable source that was understood to be high in organics.

  Evaluation of Level 1 procedures has included the provision of control samples from actual field tests to the participating laboratories.

- Environmental Assessment Users' Service

  RTI is serving as a central source for IERL Environmental Assessment technical information. A directory of all known IERL EA technology users (over 50) has been prepared. This will assist in the dissemination of updated methodologies, etc., to interested parties, via reviews, bulletins, and telephone contacts.

- Support to Level 1 Environmental Assessment Study

  RTI supported Battelle Columbus Laboratories in the Level 1 Study of the Exxon FBC plant.

- Level 1 Data Compilation

  All data available on IERL-RTP Level 1 EA will be compiled and organized by type of source, type of test, location of testing, time of testing, and the testing contractor. As required, the data will be arranged in several different matrices.

• Revision of Level 1 Procedures Manual

Inputs for the revision are being obtained from contractors and other users of Level 1 procedures. Arthur D. Little has responsibility for the organic sections and TRW for the inorganic sections.

No specific problems were encountered during the development of the QA procedures. The EA users' service will be available to all users of the Level 1 analyses who may have problems and/or questions.

1.3.4 Approach to Level 2 Analysis

REFERENCES: R.I. Beimer, L. E. Ryan, R. A. Maddalone, and M. M. Yamada, Approach to Level 2 Analysis Based on Level 1 Results, MEG Categories and Compounds and Decision Criteria (Draft), Contract No. 68-02-2613, prepared by TRW for U.S. Environmental Protection Agency, IERL/RTP, October 1977.

R.I. Beimer, L. E. Ryan, R. A. Maddalone, and M. M. Yamada, Level 2 Results on Fluidized Bed Combuster Samples (Draft), Contract No. 68-02-2613, prepared by TRW for U.S. Environmental Protection Agency, IERL/RTP, March 1978.

Determination of whether to proceed with a Level 2 analysis depends on inputs from Level 1 analyses, Multimedia Environmental Goals (MEG), and Minimum Acute Toxicity Effluent (MATE) values. The decision logic for a phased Level 1-Level 2 analysis is shown in figure 9.

Level 1 data can be used to prioritize the detailed and specific analysis required in Level 2. Level 1 samples can be broken down into two distinct categories: on-site and home-site. On-site Level 1 samples are reactive and/or volatile and cannot be retained for species specific Level 2 analysis, whereas the home-site samples can be retained. Table 3 lists the Level 1 on-site and home-site samples and the MEG categories found in each.

The Source Assessment Sampling System (SASS) components and the retained water and solid samples can, depending on the total quantities obtained from the Level 1 sampling effort, be retained as neat samples (unadulterated or undiluted) or as Level 1 prepared samples.

Retained Level 1 samples do not contain some of the MEG compounds of interest. In some cases MEG compounds have not been included in the on-site sample activity (e.g., ozone) or they have reacted with the SASS construc-

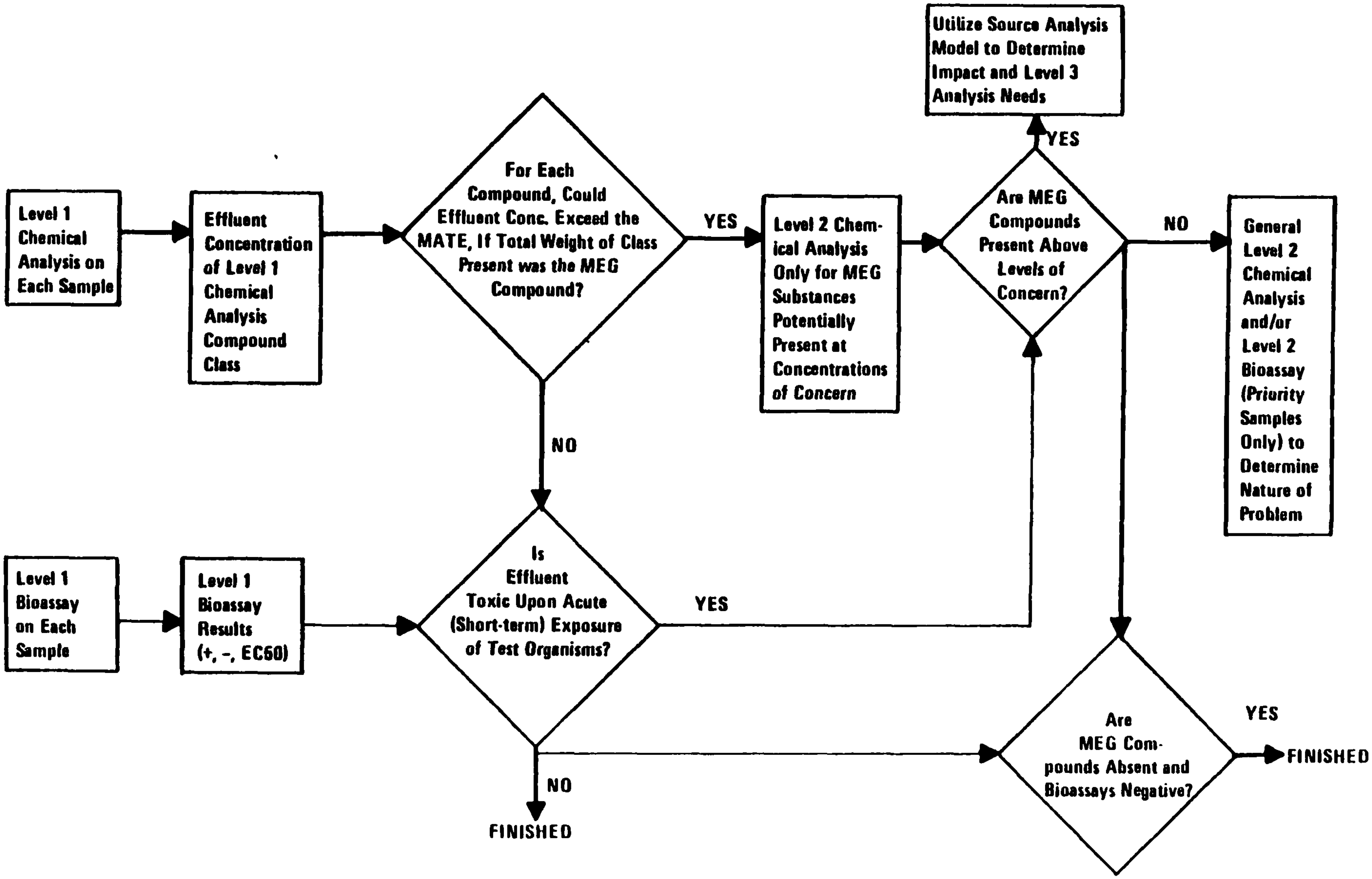


Figure 9. Decision logic for phased Level 1—Level 2 analysis.

TABLE 3. LEVEL 1 SAMPLES

Level 1 General Category	On-Site	MEG Category (Environmental Impact)
Air	NO_x	47
	C_1 - C_6	1, 2, 4, 5, 7, 8, 9, 10, 11, 13, 15, 24, 25, 26
	CO_2, CO, O_2, N_2, H_2O, SO_2, H_2S	42, 47, 52, 53
	H_2S, SO_2, COS, CH_3SH, CH_3CH_2SH, etc.	13, 53
	Total particulate, $\mu g/m^3$	(General information – effluent guidelines)
Water	pH, acidity, alkalinity, BOD, COD, dissolved oxygen, conductivity, dissolved and suspended solids, specific anions	(General information – effluent guidelines)
Solids	Total output, kg/hour	(General information – effluent guidelines)

Level 1 General Category	Home-Site	MEG Categories (Environmental Impact)
Air	SASS components	All categories
Water	Retained aqueous sampling, e.g., evaporation pond, cooling tower, etc.	All categories
Solids	Retained bulk solid samples, e.g., feed materials, overflow bed materials, etc.	All categories

tion materials and are not sampled (e.g., HF); and in other cases, they have been sampled but altered in composition, and their compound origin can no longer be distinguished (e.g., AsH_3).

These problematic MEG compounds not retained in Level 1 samples are as follows:

- C_1-C_6 compounds, e.g., methane;
- Reactive organic and inorganic compounds, e.g., acrolein and hydrogen fluoride;
- Volatile inorganic compounds, e.g., phosgene;
- Sampled but altered inorganic compounds, e.g., stibene.

Two suggested approaches exist for analyzing C_1-C_6 compounds: (1) integrated Tedlar bag (glass sample bomb) Level 2 resampling and (2) solid absorbent method.

Compounds detected in the C_1-C_6 range are best analyzed by direct GC/MS (gas chromatography/mass spectrometry). Samples will need to be collected specifically for this purpose, and shipment and storage should not exceed 24 hours.

The reactive organic compounds are best analyzed on-site as they are emitted. Category 1 reactive compounds may be detectable in the integrated bag sample. Tests for the reactive organic compounds cannot be discussed in generalized terms. In the phased approach when a category is implicated in a presite literature search, choice of analytical method and presite analytical check-out should be conducted. In these cases, as well as in some inorganic areas, the Federal Register may contain specific test methods.

Generally, any Level 1 reporting point (organic or inorganic) that exceeds the most conservative MATE concentration value in a given category will require Level 2 analysis on the particular Level 1 sample aliquot representative of the reporting point data.

The inorganic or organic compounds listed in MEG charts are not sought by the Level 1 scheme. However, should an inorganic element or inorganic class exceed a concentration guideline as defined by the MEG's, then in the phased approach to environmental assessment, a Level 2 analysis assessment would be required to identify and quantify the compound forms of the inorganic element and organic classes of environmental concern. Level 2 would be conducted to specifically detect quantitatively the MEG compounds.

The MATE values take into consideration a variety of factors, including the biological data, half-lives, cumulative tendencies, and relationships between human and animal toxicity data. The MATE levels are aimed at minimizing induced effects of any type due to short-term direct exposure to a waste stream. Levels exceeding the MATE would be of environmental concern.

Decision to conduct a Level 2 analysis can now be made based on Level 2 data and MATE concentrations and their presences in a specific MEG category.

The MEG compounds at MATE concentrations are the basis for the Level 1 data presentation and decision charts developed. These charts list MEG compounds with their MATE in order of decreasing toxicity in each of the MEG categories. A decision to conduct Level 2 tests for a specific MEG is triggered if the Level 1 report point exceeds the most toxic MATE for that category.

1.3.5 Level 2 Inorganic Analysis

REFERENCE: R. I. Beimer, L. E. Ryan, R. A. Maddalone, and M. M. Yamada, Approach to Level 2 Analysis Based on Level 1 Results, MEG Categories and Compounds and Decision Criteria (Draft), Contract No. 68-02-2165, prepared by TRW for U.S. Environmental Protection Agency, IERL/RTP, October 1977.

Level 2 inorganic analysis is primarily concerned with compound identification.

The analysis and identification scheme for inorganic compounds in solid materials consists of:

- Initial Sample Characterization - elemental composition sample stability and bulk morphological structure are determined.
- Bulk Composition Characterization - qualitative and quantitative anion, valence state, and X-ray diffraction information are derived.
- Individual Particle Characterization - single particle elemental composition, X-ray diffraction pattern and morphology are measured.

Figures 10 through 12 describe a logic path for identification of inorganic compounds in a solid matrix. A similar approach for liquid samples is described in figure 13. In both approaches emphasis is placed on an accurate elemental mass balance for the MEG compounds that exceed MATE values.
After a method or series of methods has been applied, a comparison of lists of identified to potential MEG compounds for elements that exceed their

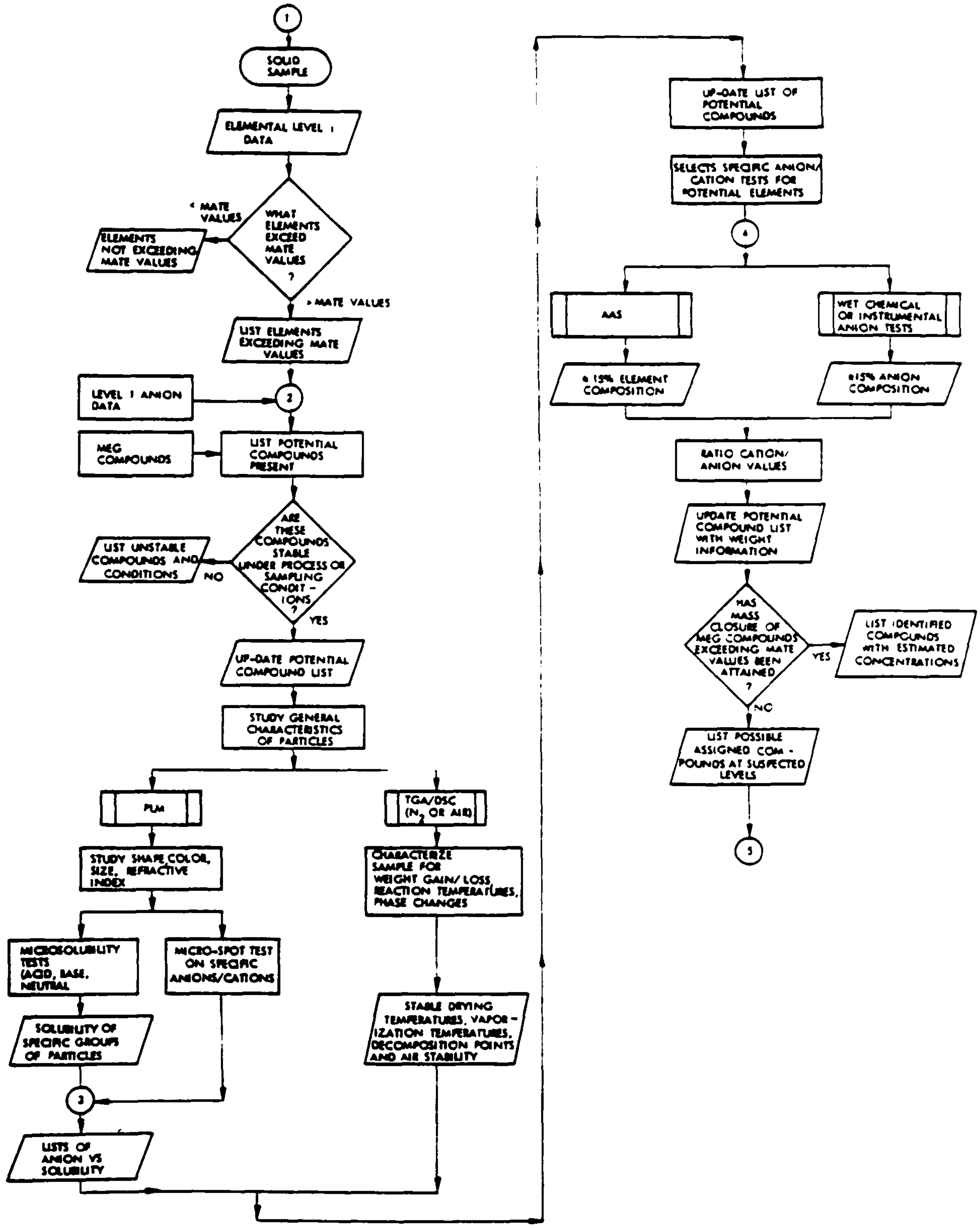


Figure 10. Logic flow chart for initial sample characterization.

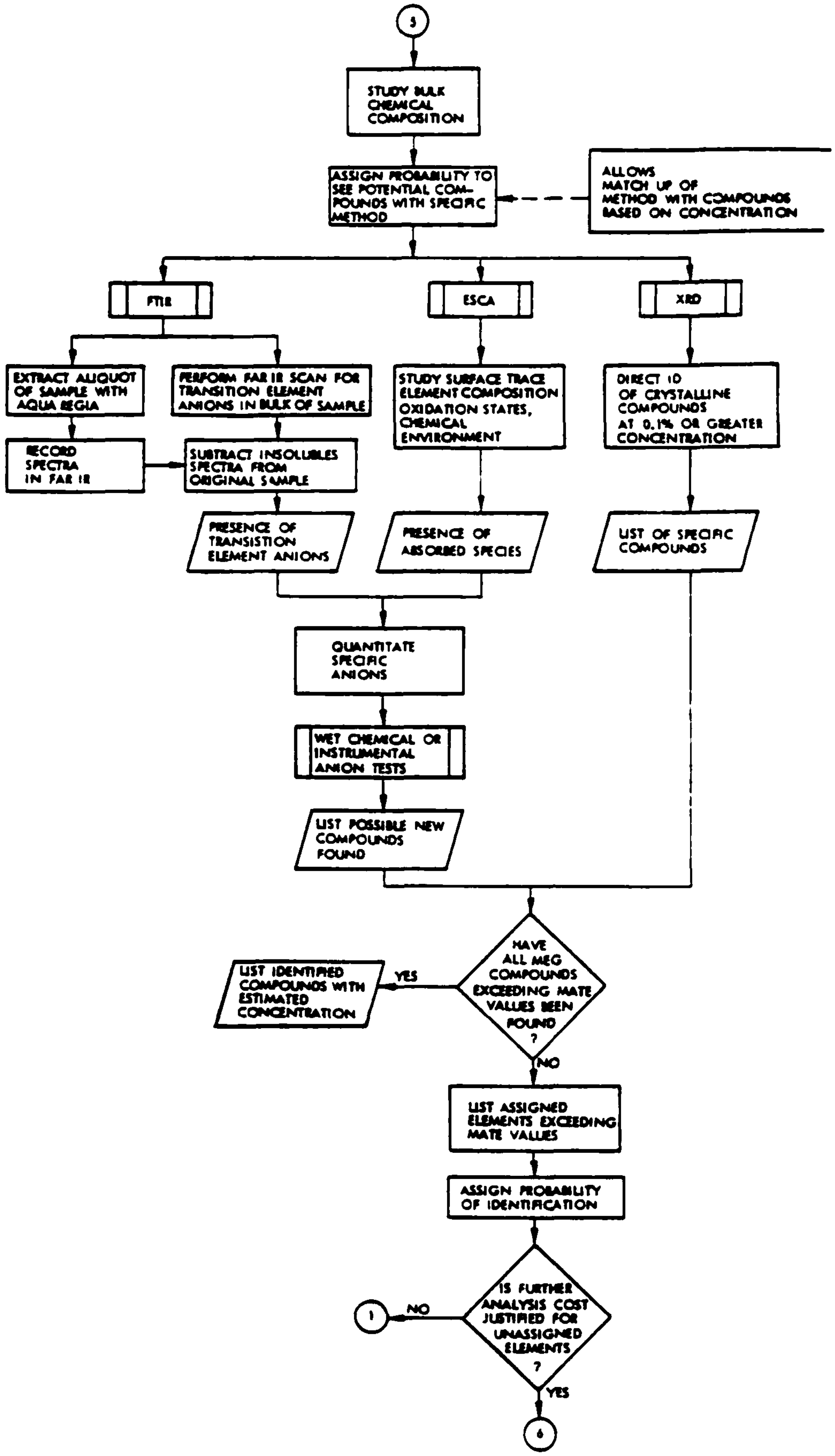


Figure 11. Logic flow for bulk composition characterization.

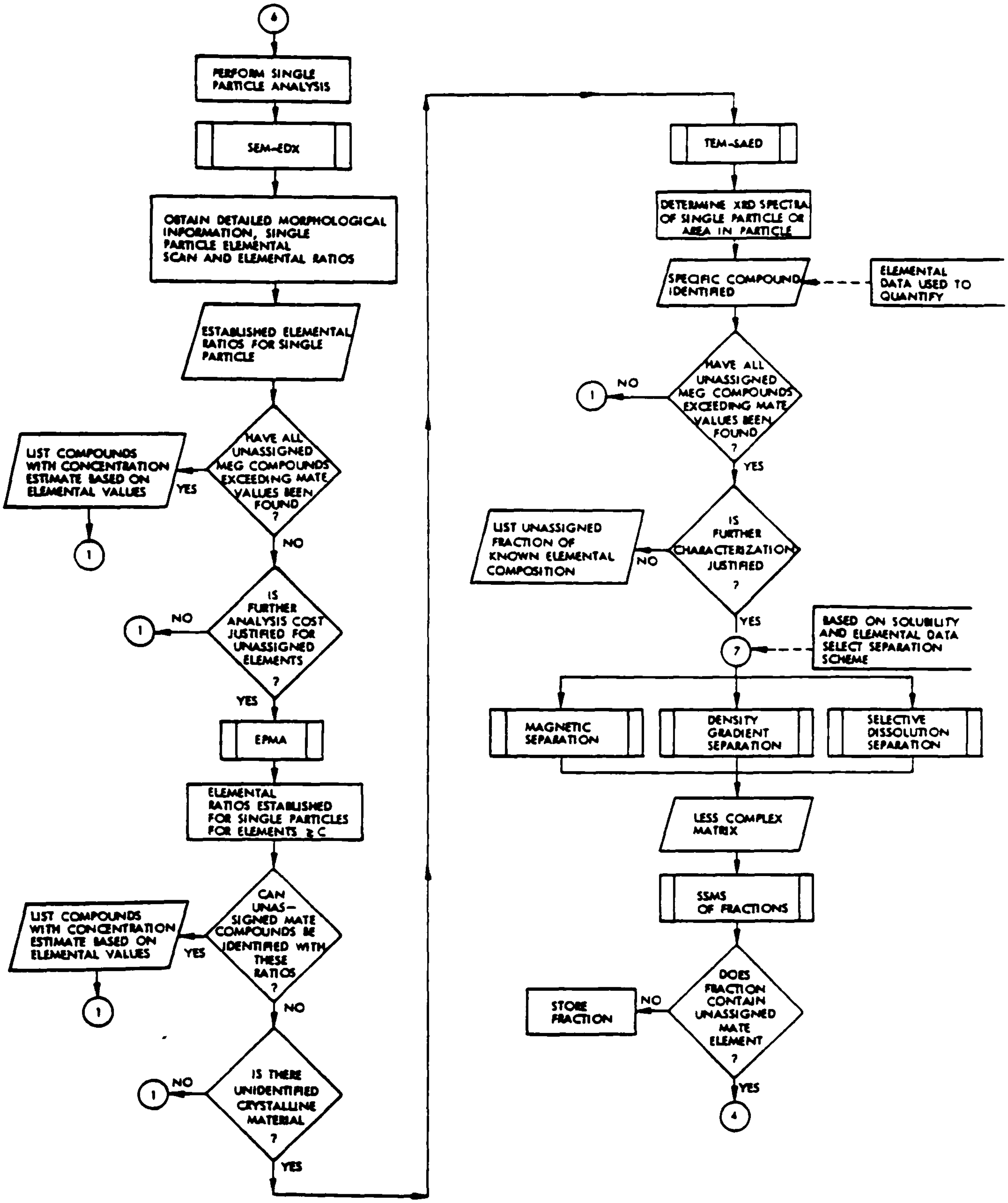


Figure 12. Logic flow for individual particle characterization.

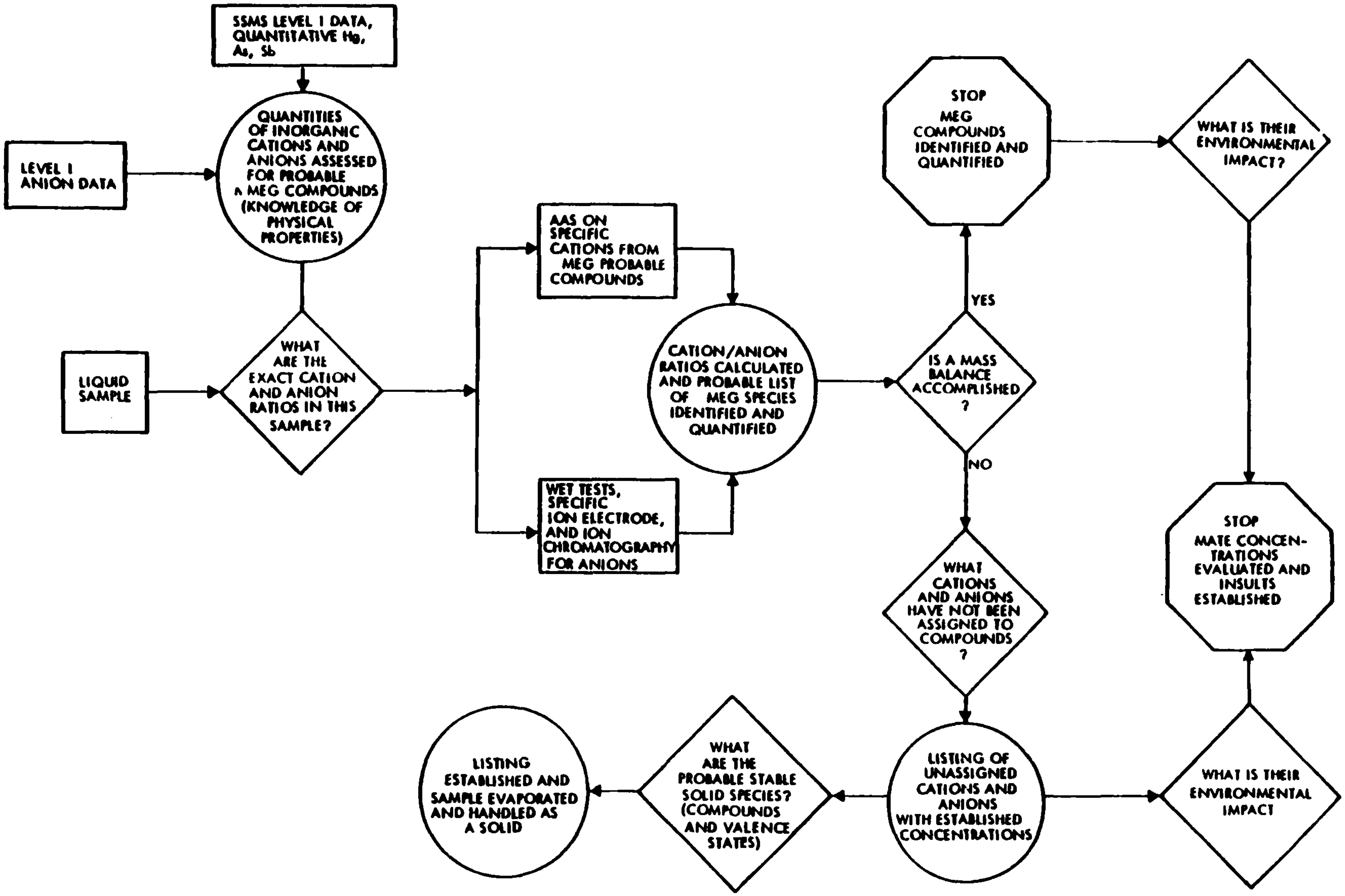


Figure 13. Level 2 liquid sample compound analysis scheme.

MATE values is made. A satisfactory analysis will depend on a variety of factors: (1) number of compounds identified versus MEG compounds exceeding MATE values; (2) interest in identifying compounds for unknown elements that exceed MATE values; and, (3) the cost/availability of necessary equipment.

1.3.6 Level 2 Organic Analysis

REFERENCE: J. C. Harris and P. L. Levins, EPA/IERL-RTP Interim Procedures for Level 2 Sampling and Analysis of Organic Materials Guidelines, EPA-600/7-78-016, February 1978.

The Level 1 samples - mostly extract solutions - are conveniently available for more comprehensive organic analytical characterization using all of the techniques discussed later. However, before proceeding to more detailed analysis of these Level 1 samples to answer the Level 2 question, the appropriateness of the sample for study must be carefully evaluated.

The types of samples to be collected specifically for Level 2 studies will still come from the same basic gas, liquid/slurry, and solid groups as to the Level 1 samples. Specific samples will be defined by the procedure used for a particular analysis. Many of the sample types may be the same as for the Level 1 samples, but they may be subjected to different treatment procedures, such as alternative solvents for extraction. In addition, there will be new samples collected to allow a better qualitative, as well as quantitative, measurement of some species such as the low molecular weight compounds in the C_1-C_6 range. Other species-specific samples may be collected also, as in bisulfite impinger solution sampling for aldehyde determination.

Sampling methods for use in Level 2 may in many cases be the same as those used in Level 1. It may be possible in some cases where a specific measurement is sought to use simpler procedures than those prescribed for Level 1. In some cases, alternative procedures will be desirable to measure species not represented well by the Level 1 scheme and/or especially reactive compounds, such as certain reactive olefins, hydrazines, etc. Table 4 summarizes Level 2 sampling methods by MEG category.

Two basically different types of Level 2 studies may be carried out. In most cases, results from the Level 1 study will have provided chemical class information to direct attention to specific compound categories. In

TABLE 4. LEVEL 2 SAMPLING AND ANALYSIS METHODS BY MEG CATEGORY

No.	MEG Category/Subcategory	Sampling Method: Air	Sampling Method: Water	Analysis Method
1	Aliphatic Hydrocarbons			
	$C_1 - C_7$	gas bulb	purge and trap	GC/ms or GC/FID on Porapak Q
	$> C_7$	SASS	pentane extract	GC/ms or GC/FID on SP-2250 (or OV-17)
2	Alkyl Halides			
	b.p. < 100°C	gas bulb	purge and trap	GC/ms or GC/ECD (isothermal) on Porapak Q
	b.p. > 100°C	SASS	CH_2Cl_2 extract	GC/ms or GC/ECD (isothermal) on SP-2250 (or OV-17)
3	Ethers	SASS	CH_2Cl_2 extract	GC/ms on SP-1000
4	Halogenated Ethers			
	b.p. < 100°C	gas bulb	purge and trap	GC/ms or GC/ECD (isothermal) on SP-1000
	b.p. > 100°C	SASS	CH_2Cl_2 extract	GC/ms or GC/ECD (isothermal) on SP-1000
5	Alcohols			
	b.p. < 100°C (< C_4)	gas bulb	purge and trap	GC/ms on SP-1000
	b.p. > 100°C	SASS	resin adsorption or ether extract	GC/ms on SP-1000
6	Glycols, epoxides	SASS	direct analysis of aqueous solution or Et_2O extraction	GC/ms on Porapak P (direct aqueous injection)

TABLE 4. LEVEL 2 SAMPLING AND ANALYSIS METHODS BY MEG CATEGORY (con.)

No.	MEG Category/Subcategory	Sampling Method Air	Sampling Method Water	Analysis Method
7a	Aldehydes			
	b.p. $< 100°C$ ($< C_5$)	Bisulfite impingers	purge and trap	Iodometric titration of bisulfite impingers or GC/ms on SP-1000
	b.p. $> 100°C$	SASS	Et_2O extraction	Iodometric titration of bisulfite impingers or GC/ms on SP-1000
7b	Ketones			
	b.p. $< 100°C$ ($< C_4$)	gas bulb	purge and trap	GC/ms on SP-1000
	b.p. $> 100°C$	SASS	CH_2Cl_2 extraction	GC/ms on SP-1000
8a,b	Carboxylic Acids			
	formic, acetic	SASS	purge and trap	Reverse phase HPLC or GC/ms on SP-1000 after derivative formation
	$C_3 - C_5$	SASS	direct analysis of aqueous solution	Reverse phase HPLC or GC/ms on SP-1000 after derivative formation
	$> C_5$	SASS	extract at pH 2	Reverse phase HPLC or GC/ms on SP-1000 after derivative formation
8c	Amides			
	$< C_9$	SASS	direct analysis of aqueous solutions	Normal or reverse phase HPLC or GC/ms on SP-1000
	$> C_9$	SASS	ether extract	Normal or reverse phase HPLC or GC/ms on SP-1000
8d	Esters	SASS	CH_2Cl_2 extract	Normal or reverse phase HPLC or GC/ms on SP-1000

TABLE 4. LEVEL 2 SAMPLING AND ANALYSIS METHODS BY MEG CATEGORY (con.)

No.	MEG Category/Subcategory	Sampling Method: Air	Sampling Method: Water	Analysis Method
9	Nitriles			
	b.p. < 100°C (C_2)	gas (reactive)	purge and trap	GC/ms on SP-1000
	< C_6	SASS	direct analysis of aqueous solution	GC/ms on SP-1000
	> C_6	SASS	CH_2Cl_2 extract	GC/ms on SP-1000
10	Amines			
	b.p. < 100°C	gas bulb	direct analysis of aqueous solution	GC/ms on Carbowax 20M-0.8% KOH
	b.p. > 100°C (< C_6)	SASS	direct analysis of aqueous solution	GC/ms on Carbowax 20M-0.8% KOH
	(> C_6)	SASS	CH_2Cl_2 extract at pH 11	GC/ms on Carbowax 20M-0.8% KOH
11	Azo compounds, hydrazine, etc.	special impinger reagents	direct analysis of aqueous solution or CH_2Cl_2 extraction at pH 11	GC/ms on Carbowax 20M-0.8% KOH
12	Nitrosamines	SASS	direct analysis of aqueous solutions or CH_2Cl_2 extraction at pH 11	Normal phase HPLC or Gel Permeation Chromatography or GC/ms on SP-1000 or Tenax
13a	Mercaptans	gas bulb and on-site GC	direct injection	GC/FPD on Teflon/polyphenyl ether/ H_3PO_4 (in field for reactive species) or GC/ms on OV-17 or SP-1000

TABLE 4. LEVEL 2 SAMPLING AND ANALYSIS METHODS BY MEG CATEGORY (con.)

No.	MEG Category/Subcategory	Sampling Method		Analysis Method
		Air	Water	
13b	Sulfides, Disulfides			
	b.p. < 100°C (< C_4)	gas bulb	purge and trap	GC/FPD on Teflon/polyphenyl ether/ H_3PO_4 (in field for reactive species) or GC/ms on OV-17 or SP-1000
	b.p. > 100°C	SASS	CH_2Cl_2 extract	GC/FPD on Teflon/polyphenyl ether/ H_3PO_4 (in field for reactive species) or GC/ms on OV-17 or SP-1000
14	Sulfonic Acids, Sulfoxides	SASS	direct analysis of aqueous solution	Ion-pair HPLC (sulfonic acids) or Normal or reverse phase HPLC (sulfoxides)
15	Benzene, Substituted Benzene Hydrocarbons			
	b.p. < 100°C	gas bulb	CH_2Cl_2 extract	GC/ms or GC/FID on SP-2250 (or OV-17)
	b.p. > 100°C	SASS	CH_2Cl_2 extract	GC/ms or GC/FID on SP-2250 (or OV-17)
16	Halogenated Aromatics	SASS	CH_2Cl_2 extract	GC/ms or GC/ECD (isothermal) on SP-2250 (or OV-17)
17	Aromatic Nitro Compounds	SASS	CH_2Cl_2 extract	Reverse phase HPLC or GC/ms on SP-1000 or SP-2250

TABLE 4. LEVEL 2 SAMPLING AND ANALYSIS METHODS BY MEG CATEGORY (con.)

		Sampling Method		
No.	MEG Category/Subcategory	Air	Water	Analysis Method
18	Phenols	SASS	direct analysis of aqueous solution or resin adsorption or ether extract at pH 2 ($>C_{10}$ only)	Reverse phase HPLC or GC/ms on Tenax (direct aqueous injection) or GC/ms on SP-1000 after derivative formation
19	Halophenols	SASS	direct analysis of aqueous solution or resin adsorption or ether extract at pH 2 ($>C_{10}$ only)	Reverse phase HPLC or GC/ms on Tenax (direct aqueous injection) or GC/ms on SP-1000 after derivative formation
20	Nitrophenols	SASS	direct analysis of aqueous solution or resin adsorption or ether extract at pH 2 ($>C_{10}$ only)	Reverse phase HPLC or GC/ms on Tenax (direct aqueous injection) or GC/ms on SP-1000 after derivative formation
21	Fused Polycyclic Hydrocarbons	SASS	CH_2Cl_2 extract	GC/ms on Dexsil 400 or Reverse or normal phase HPLC
22	Fused Non-alternant Polycyclic Hydrocarbons			GC/ms on Dexsil 400 or Reverse or normal phase HPLC
23	Heterocyclic Nitrogen Compounds	SASS	CH_2Cl_2 extract at pH 11	GC/ms on SP-1000 or SP-2250 or Normal phase HPLC

TABLE 4. LEVEL 2 SAMPLING AND ANALYSIS METHODS BY MEG CATEGORY (con.)

No.	MEG Category/Subcategory	Sampling Method: Air	Sampling Method: Water	Analysis Method
24	Heterocyclic Oxygen Compounds			
	b.p. $<$ 100°C (Furan)	gas bulb	purge and trap	GC/ms on SP-1000 or SP-2250 or Normal phase HPLC
	b.p. $>$ 100°C	SASS	CH_2Cl_2 extract	GC/ms on SP-1000 or SP-2250 or Normal phase HPLC
25	Heterocyclic Sulfur Compounds			
	b.p. $<$ 100°C (Thiophene)	gas bulb	solvent extract	GC/ms on SP-1000 or SP-2250 or Normal phase HPLC
	b.p. $>$ 100°C	SASS	solvent extract	GC/ms on SP-1000 or SP-2250 or Normal phase HPLC
26	Organometallics			

those cases a specific sampling and analysis procedure may be selected. In other cases, a need for Level 2 studies may be indicated by criteria such as a set of positive biotest results, rather than chemical composition data. The biotest results would not target specific chemical categories for study in Level 2. In these cases a comprehensive set of Level 2 studies will be required using procedures with lower detection limits than Level 1. It may also be neccessary to analyze for species that may originally have gone undetected because of the procedural constraints imposed by the Level 1 economic considerations.

It is expected that most Level 2 organic analyses will be directed towards one or more specific classes of chemical compounds that were indicated by Level 1 analysis to exceed their respective decision-level (or MATE) concentration(s).

Table 4 summarizes the particular choices of sampling and analysis methods, respectively, that are recommended for Level 2 analyses by MEG category. The appropriate methods will, in some cases, be described in somewhat more detail in the final Level 2 Procedures Manual. However, because each Level 2 study is likely to be unique, it is necessary to allow for flexibility and to leave exact details--sample size, GC temperature program, etc.--to the discretion of the analyst.

Samples to be analyzed at Level 2, for which Level 1 failed to provide a more directed analysis, will generally have to be analyzed by methods that have greater compound detection sensitivity than those used in Level 1 and deal better with those areas for which Level 1 procedures are least well suited--for instance, gases and high molecular weight species. It is difficult to devise a specific scheme that will be appropriate for all process streams to be analyzed in this manner.

In addition, or alternatively, it is likely that Level 2 bioassay procedures that combine chemical fractionation will be developed and utilized to zero in an appropriate chemical analysis.

1.3.7 Environmental Assessment Data Systems (EADS)

REFERENCES: FPEIS Reference Manual, EPA-600/8-78-005, June 1978.

FPEIS User Guide, EPA-600/8-78-006, June 1978.

The Environmental Assessment Data Systems (EADS) are a group of independent computerized data bases that are interlinked to provide common accessibility to data produced by IERL/RTP environmental assessment projects. These data bases will store data pertaining to emissions from gaseous, liquid, and solid waste streams, as well as data on site-specific ambient conditions and data describing specific processes. The environmental assessment (EA) projects now underway will produce large volumes of waste stream data that must be analyzed in order to ascertain the total environmental impact of various processes. The EADS provides a cost-effective means of storing and retrieving these data for ongoing analysis. The development of useful analytical techniques to aid the user will enhance his ability to derive meaningful results from his analysis.

The Fine Particle Emissions Information System (FPEIS), which is now operational on the EPA computer at Research Triangle Park, N.C., is the first component of the EADS to be implemented. Work has been initiated that will provide for the development and implementation of the three remaining waste stream components of the EADS (Gaseous Emissions Data System, Liquid Effluents Data System, Solid Waste Effluents Data System) and for ancillary software to accomplish routine editing, loading, and retrieval of data in a basic report format. These new data bases are expected to be available in 1979.

The FPEIS contains data on primary fine particle emissions to the atmosphere from stationary point sources as well as detailed information on applied control systems. All the data pertaining to a source and control device combination obtained during a certain testing period are given a unique Test Series Number that may be used to identify the particular test activity. Each Test Series, in turn, consists of a number of subseries, which represent all the data pertaining to a given combination of source and control device operating parameters, or to data taken at either the inlet or outlet of the control device. The subseries connects different sampling activities together and gives a complete description of the gas stream for the various operating conditions of the source and control device.

The test run is any measurement of fine particle emissions from a source or control device combination for a specified length of time using a single particle size measuring equipment or method. The test run is the cornerstone of the data base structure of the FPEIS. Test runs are grouped into test subseries according to the situation existing during the period of the test.

Figure 14 details the organization of FPEIS data by Test Series, subseries, and run levels. The data are grouped into five general categories of information that are listed below.

- Source and Test Series Related Information - Identifies the stationary source that was tested, the source location, and literature references for the test series. The FPEIS will accept the entry "CONFIDENTIAL" for any source whose identity cannot be disclosed.

- Control Device Characteristics and Design Parameters - Control devices are characterized by category, class, generic type, commercial name, and manufacturer. Specification types are provided as standard nomenclature for the electrostatic precipitator, cyclone, wet scrubber, and fabric filter.

- Test Characteristics and Control Device Operating Parameters - Data include test date and time, sampling location description, and specific source and control device operating parameters.

- Biological and Chemical Analysis Data - Bioassay data will be reported at a later date in a form consistent with EA data analysis requirements. Chemical species may be reported using the SOTDAT particulate pollutant codes, the MEG numbers, the Chemical Abstracts Services Registration Numbers, or as the appropriate Level I fraction.

- Particle Size Measurement Equipment and Data - Data include sampling flow rate, temperature, pressure, and duration. Particle sizes may be expressed in terms of Stokes', Aerodynamic, or Impaction diameters.

The FPEIS is currently operational on the UNIVAC 1110 computer at EPA's National Computer Center, Research Triangle Park, North Carolina. Users may access the data base either through their own data communications terminal or via the EPA Project Officer. Direct access is presently restricted to a few users who have a working knowledge of the UNIVAC and the data base management system used to implement the data base. As new user features are added to the FPEIS, the user interface will be expanded.

FPEIS has two standard data output programs that are being used to process data requests. The SUMMARY REPORT produces a listing of the entire contents of the data base in order of source category. (Due to high paper usage this program is only rarely used.) The SERIES REPORT lists the data

TEST SERIES LEVEL

A. SOURCE CHARACTERISTICS
- Source Category (SCC I)
- Type of Operation (SCC II)
- Feed Material Class (SCC III)
- Operating Mode Class (SCC IV)
- Site and Source Name
- Source Address (Street, City, State, Zip Code)
- UTM Zone Location and Coordinates
- Test Series Start and Finish Date
- Tested By and Reference

B. TEST SERIES REMARKS

C. CONTROL DEVICE(S) CHARACTERISTICS
- Generic Device Type
- Device Class and Category
- Device Commercial Name
- Manufacturer
- Description
- Design Parameter Type and Value

SUBSERIES LEVEL

D. TEST CHARACTERISTICS
- Test Date, Start, and Finish Time
- Source Operating Mode
- Percent Design Capacity
- Feed Material and its Composition
- Sampling Location and its Description
- Volume Flow Rate, Velocity Temperature and Pressure
- Percent Isokinetic Sampling
- Orsat Gas Analysis and Trace Gas
- Composition
- Control Device(s) Operating Parameter and Value Remarks

E. PARTICULATE MASS TRAIN RESULTS
- Front Half and Total Mass Concentration
- Mass Train Comments

F. PARTICULATE PHYSICAL PROPERTIES
- Density
- Resistivity
- Others

G. BIOASSAY DATA
- (Format to be determined later)

H. CHEMICAL COMPOSITION
- Particle Boundary Diameters
- Sizing Instrument Calibrated or Calculated
- Chemical Entry Code
- Chemical and Analysis Method ID
- Concentration in Filter/Total
- Concentration in Ranges 1 through 8

RUN LEVEL

I. MEASUREMENT PARTICULATE
- Measurement Instrument/Method Name
- Size Range Lower and Upper Boundary
- Collection Surface
- Dilution Factor
- Measurement Start Time and Period
- Sample Flow Rate
- Sample Temperature, Pressure, and Moisture Content
- Comments

J. PARTICULATE SIZE DISTRIBUTION
- Particle Diameter Basis (Classic Aerodynamic, Stokes, or Aerodynamic Impaction)
- Boundary Diameter
- Concentration Basis (Mass or Number)
- Concentration

Figure 14. Organization of FPEIS data.

for one complete test series for which the user has supplied the unique test series number as program input. New report software are being developed to aid the user with specialized data presentations. Among these is a program to calculate the fractional efficiency of particulate control devices. This program will be available in mid-1978.

The FPEIS contains data from over 1,000 sampling runs which represent tests conducted over 50 source/collector combinations. Additional data acquisition activities have been conducted to identify, encode, and enclose more data on fine particle sampling into the FPEIS. These activities will raise the number of sampling runs to more than 2,500 and the number of sources to over 100 by mid-1978. The routine entry of data from future control technology development and environmental assessment sampling will ensure the growth of the data base. Detailed documentation on the FPEIS, consisting of a comprehensive REFERENCE MANUAL and USER GUIDE, are available to users from the EPA Project Officer.

1.4 CURRENT ENVIRONMENTAL BACKGROUND

In order to facilitate the development of environmental objectives, the current environmental background must be adequately described. The three approaches summarized here include: (1) a summary of key Federal regulations that specify control levels, (2) the development of a noncriteria ambient baseline data base, and (3) the construction of process technology environmental scale models.

1.4.1 Summary of Key Federal Regulations That Specify Control Levels

REFERENCE: J. G. Cleland and G. L. Kingsbury, Summary of Key Federal Regulations and Criteria for Multimedia Environmental Control (Draft), Contract No. 68-02-1325, prepared by RTI for U.S. Environmental Protection Agency, IERL, June 1977.

The following Federal regulations have been summarized:

- National Primary and Secondary Ambient Air Quality Standards
- Occupational Safety and Health Administration (OSHA) Standards for Air Contaminants
- National Emission Standards for Hazardous Air Pollutants (NESHAP)
- New Stationary Source Performance Standards (NSSPS)
- Emissions Standards for Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines
- National Interim Primary Drinking Water Regulations and U.S. Public Health Service Regulations on Drinking Water
- EPA Effluent Standards
- EPA Toxic Effluent Standards (Proposed)
- EPA Pesticide Regulations
- Standards for Protection Against Radiation
- Criteria for the Evaluation of Permit Applications for Ocean Dumping of Materials

A partial list of additional items reviewed includes:

- Summary Listing of Significant Regulations Promulgated by EPA in Implementing the Clean Air Act
- EPA Water Quality Criteria (Proposed)
- Prevention of Significant Deterioration

- EPA Hazardous Substances
- Guideline Series: Control of Emissions from Lurgi Coal Gasification Plants

1.4.2 Noncriteria Ambient Baseline Data Base

REFERENCE: Robert Handy, Research Triangle Institute, Research Triangle Park, N.C. 27709.

A computer search of four files has been initiated. Files include: APTIC, WRA, NTIS, and Pollution Abstracts. Over 100 reprints covering 350 chemicals have been ordered. These will serve as the basis for input into the data base being developed by RTI with assistance from MRI Systems.

Computer input forms have been designed in a format that is a modification and extension of that originally suggested by Wagoner of RTI. The first compilation of the data base was available for review in August 1978.

1.4.3 Environmental Siting Scale Models for Technologies

Engineering data were obtained by reviewing EPA reports and contractor reports and by discussing the program with knowledgeable individuals. Engineering drawings were made illustrating the land use and environmental impact on air quality and on surface and ground water resources due to the air, water, and solid wastes discharged from a large coal-cleaning facility. Following consultation with appropriate EPA personnel, a model of the basic features of the coal processing facilities and the environmental impacts depicted was constructed. A brochure describing the coal cleaning model has been prepared and is available from IERL/RTP.

1.5 ENVIRONMENTAL OBJECTIVES DEVELOPMENT

By utilizing input from current environmental background projects and additional research, RTI is developing Multimedia Environmental Goals (MEG's). The MEG's provide reference levels including standards, estimated permissible concentrations, minimum acute toxicity effluent values, natural background levels, where available for chemical contaminants and for selected nonchemical contaminants. The MEG information is presented in a format designed to facilitate its use in the quantitative evaluation of environmental impact.

1.5.1 Development of Multimedia Environmental Goals

REFERENCE: J. G. Cleland and G. L. Kingsbury, Multimedia Environmental Goals for Environmental Assessment, Volumes I and II, EPA-600/7-77-136a and -136b, November 1977.

Multimedia Environmental Goals (MEG's) are levels of contaminants or degradents (in ambient air, water, or land or in emissions or effluents conveyed to ambient media) that are judged to be (1) appropriate for preventing certain negative effects in the surrounding populations or ecosystems or (2) representative of the control limits achievable through technology. The project's central purpose is to derive MEG's as estimates of desirable levels of control for those chemical contaminants and nonchemical degradents included in a master list.

This Master List of over 600 chemical substances and physical agents has been compiled using the following selection factors prescribed by EPA.

Primary Factor - The pollutant is associated with fossil fuels processes.

Secondary Factors -

(1) Federal standards or criteria exist or have been proposed.
(2) A TLV has been established or an LD_{50} has been reported.
(3) The substance is a suspected carcinogen.
(4) The substance appears on the EPA Consent Decree List.

Tertiary Factors (optional) -

(1) The substance is present as a pollutant in the environment.
(2) The substance is highly toxic.

A total of 85 categories (26 organic and 50 inorganic), shown in tables 5 and 6, are used to organize the substances in the Master List. Substances are categorized based on chemical functional groups for organic compounds

TABLE 5. ORGANIC CATEGORIES ADDRESSED BY MEG'S

1	Aliphatic Hydrocarbons
2	Halogenated Aliphatic Hydrocarbons
3	Ethers
4	Halogenated Ethers
5	Alcohols
6	Glycols, Epoxides
7	Aldehydes, Ketones
8	Carboxylic Acids and Derivatives
9	Nitriles
10	Amines
11	Azo Compounds, Hydrazine, and Derivatives
12	Nitrosamines
13	Mercaptans, Sulfides and Disulfides
14	Sulfonic Acids, Sulfoxides
15	Benzene, Substituted Benzene Hydrocarbons
16	Halogenated Aromatic Hydrocarbons
17	Aromatic Nitro Compounds
18	Phenols
19	Halophenols
20	Nitrophenols
21	Fused Aromatic Hydrocarbons
22	Fused Non-Alternant Polycyclic Hydrocarbons
23	Heterocyclic Nitrogen Compounds
24	Heterocyclic Oxygen Compounds
25	Heterocyclic Sulfur Compounds
26	Organophosphorus

TABLE 6. INORGANIC CHEMICAL SUBSTANCES CATEGORIES ADDRESSED BY MEG's

Group	Category	Element	Group	Category	Element
IA	27	Lithium	VIIA	57	Chlorine
	28	Sodium		58	Bromine
	29	Potassium		59	Iodine
	30	Rubidium	IIIB	60	Scandium
	31	Cesium		61	Yttrium
IIA	32	Beryllium	IVB	62	Titanium
	33	Magnesium		63	Zirconium
	34	Calcium		64	Hafnium
	35	Strontium	VB	65	Vanadium
	36	Barium		66	Niobium
IIIA	37	Boron		67	Tantalum
	38	Aluminum	VIB	68	Chromium
	39	Gallium		69	Molybdenum
	40	Indium		70	Tungsten
	41	Thallium	VIIB	71	Manganese
IVA	42	Carbon	VIII	72	Iron
	43	Silicon		73	Ruthenium
	44	Germanium		74	Cobalt
	45	Tin		75	Rhodium
	46	Lead		76	Nickel
VA	47	Nitrogen		77	Platinum
	48	Phosphorus	IB	78	Copper
	49	Arsenic		79	Silver
	50	Antimony		80	Gold
	51	Bismuth	IIB	81	Zinc
VIA	52	Oxygen		82	Cadmium
	53	Sulfur		83	Mercury
	54	Selenium	IIIB	84	Lanthanides
	55	Tellurium		85	Actinides
VIIA	56	Fluorine			

and principal elements for inorganics. An alphabetical list of substances is not used because it would provide no way of associating related compounds.

A six-digit number has been assigned to each MEG compound addressed. These MEG numbers indicate the category, subcategory, and position within the subcategory for any compound. Consequently, structurally similar compounds will be assigned similar numbers. This association of structurally similar compounds is a powerful tool in environmental assessment, especially in the absence of complete profile data for many substances.

For each substance a MEG chart is prepared (216 have been published and drafts are completed for an additional 200). This chart, shown in table 7, has two interrelated tables: Emission-Level Goals and Ambient-Level Goals.

Emission-Level Goals are based on technological or ambient factors and pertain to gaseous emissions to the air, aqueous effluents to water, and solid waste to be disposed of in or on land. Technological factors refer to limitations on control levels due to existing or developing technology.

Ambient factors included in the MEG's chart as criteria for Emission Level Goals are:

(1) Minimum Acute Toxicity Effluents (MATE's) - pollutant concentrations in undiluted emission streams that would not adversely affect those persons or ecological systems that are exposed for short periods of time.

(2) Ambient-Level Goals - estimated permissible concentrations (EPC's) of pollutants in emission streams which, after dispersion, will not cause the level of contamination in the ambient receiving medium to exceed a safe continuous exposure concentration.

(3) Elimination of Discharge (EOD) - concentrations of pollutants in emission streams which, after dilution, will not cause the level of contamination to exceed levels measured as "natural background."

Technology-based Emission-Level Goals are considered highly source-specific; goals based on ambient factors can be considered applicable universally to any industry's discharge streams.

Ambient-Level Goals are based on the following: (1) current or proposed Federal ambient standards or criteria, (2) toxicity (acute and chronic effects considered), and (3) carcinogenicity and/or teratogenicity (for zero threshold pollutants). "Zero threshold" is used to distinguish contam-

TABLE 7. SAMPLE MEG CHART

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		4.0E1		
Water, $\mu g/l$ (ppm Wt)			2.5E3	1.0E2	6.0E0	5.0E-1	
Land, $\mu g/g$ (ppm Wt)			5.0E0	2.0E-1	1.2E-2	1.0E-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)			5.9E1		4.0E-1
Water, $\mu g/l$ (ppm Wt)			2.91E2	5.0E1	6.0E1
Land, $\mu g/g$ (ppm Wt)			6.0E-1	1.0E-1	1.2E-2

inants shown to be potentially carcinogenic or teratogenic; goals specified for these pollutants imply acceptable risk levels.

A Background Information Summary Sheet, shown in table 8, will accompany each MEG chart.

In delineating MEG's, applicable Federal standards, criteria, or recommendations are specified. For those substances not addressed by current guidelines, consideration in arriving at MEG's was given to the following.

(1) Established or estimated human threshold levels
(2) Acceptable risk levels for lifetime exposure to suspected carcinogens and/or teratogens
(3) Degrees of contamination considered reasonable for the protection of existing ecosystems
(4) Potential for accumulation and biological magnification in aquatic organisms, livestock, and vegetation
(5) Hazards to human health or to ecology resulting from short-term exposure to emissions.

The development of MEG's methodology has been approached from three distinct aspects so far. These are listed below.

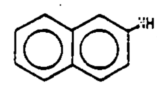
(1) Investigation of Federal Guidelines produced MEG's for only a small percentage of the substances on the Master List but yielded insight into the variety of approaches that have been utilized for standard setting so far.
(2) Generation of two types of EPC's. Toxicity-based EPC's are based on empirical data concerning the effects of chemical substances on human health and ecosystems. Another set of EPC's is supplied by a system relating carcinogenic or teratogenic potential to media concentrations considered to pose an acceptable risk. Both types of EPC's are calculated on the background information summaries. A total of 22 models are used for translating empirical data into EPC's. Only the most stringent value for a given media/criteria combination will appear on the MEG chart for a given substance.
(3) Minimum Acute Toxicity Effluents (MATE's) refer to concentrations appropriate for short-term exposure whereas EPC's consider lifetime continuous exposure. At present, 14 different kinds of MATE values have been defined in the methodology.

TABLE 8. BACKGROUND INFORMATION SUMMARY SHEET

CATEGORY: 10C

WLN: L66J CZ

STRUCTURE:



2-AMINONAPHTHALENE: $C_{10}H_9N$ (2-naphthylamine, β-naphthylamine). 10C220
White crystals that darken on exposure to light and air; volatile with steam.

PROPERTIES:

Molecular wt: 143.19; mp: 113; bp: 306; d: 1.0614_4^{98}; 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. 1). 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. 1). 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. 6).

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.

β-Naphthylamine was the subject of a NIOSH Hazard Review Document (ref. 11).

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. 12).

MINIMUM ACUTE TOXICITY CONCENTRATIONS:

Air, Health: $7 \times 10^4/423.8 = 165$ μg/m³
Water, Health: $15 \times 165 = 2.5 \times 10^3$ μg/ℓ
Land, Health: $0.2 \times 2.5 \times 10^3 = 500$ μg/g

Air, Ecology:
Water, Ecology: $100 \times 1 = 100$ μg/ℓ
Land, Ecology: $0.2 \times 100 = 20$ μg/g

ESTIMATED PERMISSIBLE CONCENTRATIONS:

$EPC_{AH2} = 0.107 \times 727 = 78$ μg/m³
$EPC_{AH3} = 0.081 \times 727 = 59$ μg/m³
$EPC_{WH1} = 15 \times 59 = 885$ μg/ℓ
$EPC_{WH2} = 0.4 \times 727 = 291$ μg/ℓ
$EPC_{LH} = 0.2 \times 291 = 58.2$ μg/g
$EPC_{AC2} = 10^3/(6 \times 423.8) = 0.4$ μg/m³
$EPC_{WC} = 15 \times 0.4 = 6$ μg/ℓ
$EPC_{LC} = 0.2 \times 6 = 1.2$ μg/g

$EPC_{WE1} = 50 \times 1 = 50$ μg/ℓ
$EPC_{LE} = 0.2 \times 100 = 20$ μg/g

The primary problem associated with the development of MEG's has been lack of data or other information needed to generate certain MEG's; e.g., natural background concentrations, biological half-lives, and absorption factors. Problems associated with chemical nomenclature have complicated efforts to compile useful information on polycyclic organic compounds.

1.5.2 Integration of Nonchemical Pollutant Goals and Nonpollutant Goals Into the MEG Concept

REFERENCE: B. W. Cornaby, D. A. Savitz, M. E. Stout, G. E. Pierce, and A. W. Rudolph, Development of Environmental Goals for Nonchemical and Nonpollutant Factors in Fluidized-Bed Combustion (Draft), prepared by Battelle Columbus Laboratories for the U.S. Environmental Protection Agency, IERL, December 1977.

The MEG chart was originally designed to evaluate chemical emissions in air, water, and land, and it is now felt that the MEG concept can be extended to both nonchemical and nonpollutant factors.

These factors include: noise, heat, microorganisms, bioassay tests on complex effluents, and land- and water-related physical factors.

1.5.2.1 MEG for Noise

Current and proposed noise standards or regulations were reviewed for the occupational environment (8 hours at 90dB(A) set by OSHA) and the community at large (55dB(A) proposed by EPA). No ambient standards for noise exposures of nonhuman organisms were discovered. After a review of pertinent literature, a level of 60dB(A) was judged to be a reasonable environmental objective.

1.5.2.2 MEG for Heat

Direct human health effects of heat are limited to the medium of air. The most appropriate value for an ambient criterion is thought to be 30° C (86° F) (Wet Bulb Globe Temperature). This is based on physiological parameters and assumes continuous light work. The suggested value for moderate work is 26.7° C (80° F) and 25° C (77° F) for heavy work.

For man, the media of greatest interest is air, but for other forms of life and ecosystems it is water. The Illinois standard is suggested for MEG use--no change greater than 5° F above the ambient temperature.

1.5.2.3 MEG for Microorganisms

The MEG format will accommodate microorganisms in the air and water media with less emphasis on the soil media.

1.5.2.4 MEG for Bioassay Tests on Complex Effluents

These MEG's are intended to be simple decision levels for each bioassay, which define it as having no detectable effect, low effect, medium effect, and high effect.

1.5.2.5 MEG for Land and Water Physical Factors

These are intended to be land- and water-related physical factors. One example is the use of appropriate physical property measurements on a solid waste material to place it in an equivalent soil classification category, which would actually be the MEG in this case.

In this example, a solid waste material found to fall into a high MEG classification would be suitable if disposed of over large areas of land that have high enough stability to support high load-bearing land uses such as large building construction.

1.6 CONTROL TECHNOLOGY ASSESSMENT

1.6.1 Control Assay (CA) Development

REFERENCE: Preliminary CA Development Draft submitted to EPA in March 1978 by Catalytic, Inc., under contract no. 68-02-2167.

Control assays identify the best potential control techniques based on Level 1 evaluation of effluent samples before and after treatment by combinations of laboratory procedures that simulate control processes.

The CA approach can be most useful under circumstances where control technology has not been defined, or where environmentally satisfactory interim methods are being used that may not represent best technology/economic practice on a commercial scale. Pilot plants and development units for new coal conversion technologies are examples of these situations. In such cases, CA pretreatment operations will be employed to remove large quantities of pollutants, thereby rendering the waste test sample more typical of the discharge from the commercial facility.

CA protocols will include special field analyses that aid in the selection of appropriate control assay operations. Level 1 chemical and bioassay procedures will be used to provide test data for evaluating the effectiveness of the treatment schemes employed.

A phased approach requires two separate levels of CA effort. The first phase (CA 1) utilizes Level 1 procedures, which assume no previous knowledge of waste characteristics except process background.

The second phase (CA 2) effort (with the benefit of CA 1 and Level 1 S/A results) will concentrate on those streams previously found by CA 1 to be exceeding effluent decision criteria limitations. These problem streams will be re-examined using additional, different control assay operations more specifically designed to remove particular pollutant constituents.

The procedure to gather raw samples for the CA Phase 1 and 2 efforts will be the same as the Level 1 and Level 2 sampling schemes. However, sample sources and quantities needed for CA will be different from those specified by Level 1 procedures.

The quantity of raw waste required from an individual source for CA purposes cannot be specified on a generalized basis because the sample size is dependent upon a number of variables including:

- Number of raw waste sources
- Type of pretreatment
- Type of control assay operation
- Number of each type of control assay operation
- Level 1 laboratory testing volume requirements
- Flow rates of individual raw wastes.

For every raw sample processed under CA protocols, a number of treated effluent samples will be produced. Therefore, judgment should be applied in selecting raw samples. If it is known from previous experience that some of the samples may not be harmful, or that their treatment schemes and ultimate fate are well established, then they should not be included in the CA program.

Before the actual CA effort is initiated, data needs must be established and used to help identify test requirements as well as any anticipated problems. These requirements are similar to those identified under the Level 1 analytical schemes.

- Process data such as temperature and pressure must be known.
- A pretest site survey must be made to verify process data and tentative sample points selected.
- Pretest site preparation must be specified to have sample points accessible and outfitted with appropriate nozzles, valves, etc.
- Electrical, water, and other services must be provided, where needed.

The raw samples and the treated effluent samples will be analyzed by the Level 1 protocols. Some of these analyses will be performed in the field and some in the home laboratory. A test plan must identify field analyses so that the appropriate equipment can be assembled and the mobile laboratory outfitted.

A proposed control assay methodology has been prepared for wastewaters. Key components include: (1) wastewater characteristics and pollutant parameters, (2) type of treatment technology required, (3) pretreatment unit operation, (4) basic unit operations, (5) selection of unit operations for CA work, and (6) test sequence for the wastewater CA.

Figure 15 details the control assay development test sequence for wastewaters.

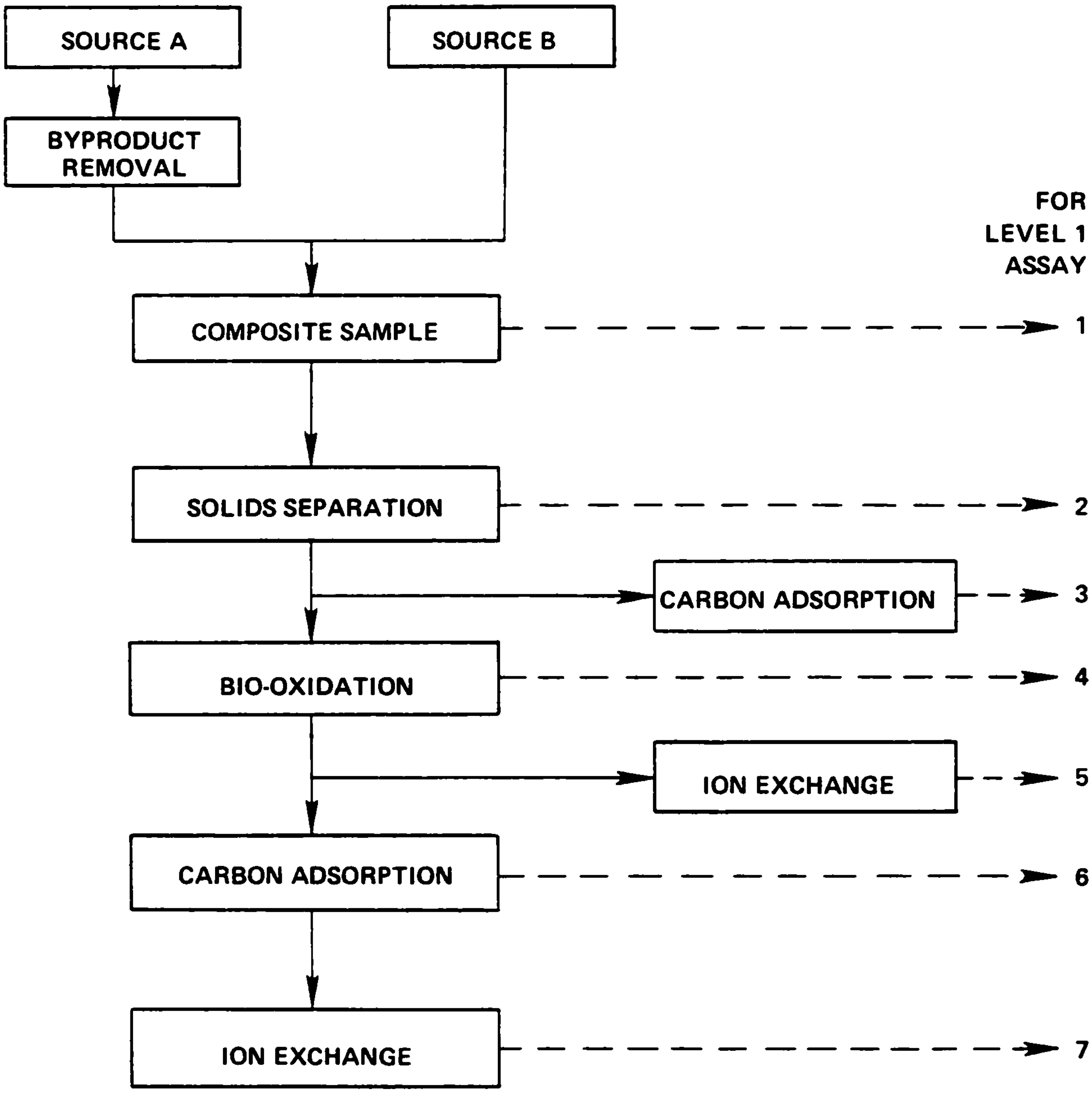


Figure 15. Control assay development test sequence for wastewater.

1.6.2 Development of the Multimedia Environmental Control Engineering Handbook (MECEH)

REFERENCES: Cameron Engineers, Inc., Development of the Multimedia Environmental Control Engineering Handbook (Draft), Contract No. 68-02-2152, October 1977.

Cameron Engineers, Inc., Table of Contents for Multimedia Environmental Control Engineering Handbook (Draft), Contract No. 68-02-2152, January 1978.

The Multimedia Environmental Control Engineering Handbook (MECEH) has four major sections: (1) a Table of Contents, (2) a Secondary Entry System, (3) data sheets, and (4) a general index.

The Table of Contents will categorize each specific control device or process by the general technology and the generic device involved. Table 9 details the classification system used in the handbook. To date, the Table of Contents has been developed for the entire handbook down to the generic device level, third order headings. Fourth order headings have been developed for four of the nine general technology classifications shown in table 9.

The Secondary Entry System allows a user to approach the MECEH from a problem-oriented viewpoint. The user will be able to locate the best available control technology using only the information that he has available on the problem itself. The system will allow entry by any of the following means:

- Media (air, land, water)
- Industry
- Pollutant stream
- Pollutant species present
- General technology
- Applicable generic devices

For example, an MECEH user would evaluate his specific problem and determine the media to which the pollutant is discharged. Turning to that specific section of the index, he would then select the industry involved and the pollutant stream of concern. Technologies that can be used for control will be listed under the pollutant stream according to the general class of pollutant.

TABLE 9. CLASSIFICATION SYSTEM FOR THE CONTROL ENGINEERING HANDBOOK

1. GAS TREATMENT
   - 1.1 Mechanical Collection
   - 1.2 Electrostatic Precipitators
   - 1.3 Filters (fabric, granular, etc.)
   - 1.4 Liquid Scrubbers/Contactors
   - 1.5 Condensers
   - 1.6 Solid Sorbents (mol sieves, activated carbon)
   - 1.7 Incineration (direct and catalytic)
   - 1.8 Chemical Reaction

2. LIQUIDS TREATMENT
   - 2.1 Settling, Sedimentation
   - 2.2 Precipitation, Flocculation
   - 2.3 Flotation
   - 2.4 Centrifugation and Filtration
   - 2.5 Evaporation and Concentration
   - 2.6 Distillation, Flashing
   - 2.7 Liquid-Liquid Extraction
   - 2.8 Gas-Liquid Stripping
   - 2.9 ph Adjustment
   - 2.10 Biological Processes
   - 2.11 Oxidation Processes
   - 2.12 Activated Carbon and Other Absorbents
   - 2.13 Ion Exchange Systems
   - 2.14 Cooling Towers and Ponds
   - 2.15 Chemical Reaction and Separation
   - 2.16 Water Intake Structures

3. SOLIDS TREATMENT
   - 3.1 Fixation
   - 3.2 Recovery
   - 3.3 Processing/Combustion
   - 3.4 Chemical Reaction and Separation
   - 3.5 Oxidation/Digestion
   - 3.6 Physical Separation (specific gravity, magnetic, etc.)

4. FINAL DISPOSAL
   - 4.1 Pond Lining
   - 4.2 Deep Well Injection
   - 4.3 Burial and Landfill
   - 4.4 Sealed - Contained Storage
   - 4.5 Dilution (water)
   - 4.6 Dispersion (air, land)

5. PROCESS MODIFICATIONS
   - 5.1 Feedstock Changes
   - 5.2 Stream Recycle
   - 5.3 Process Design Improvements

6. COMBUSTION MODIFICATION
   - 6.1 Furnace Modifications
   - 6.2 Optimum Burner/Furnace Design
   - 6.3 Alternate Fuels/Processes
   - 6.4 Fuel Additives

7. FUEL CLEANING
   - 7.1 Physical Separation
   - 7.2 Chemical Refining
   - 7.3 Carbonization/Pyrolysis
   - 7.4 Treatment of Liquid Fuels
   - 7.5 Fuel Gas Treatment

8. FUGITIVE EMISSIONS CONTROL
   - 8.1 Surface Coatings/Covers
   - 8.2 Vegetation
   - 8.3 Miscellaneous Methods of Control
   - 8.4 Leak Prevention
   - 8.5 Vapor Recovery Systems
   - 8.6 Ballast Water Treatment

9. ACCIDENTAL RELEASE TECHNOLOGY
   - 9.1 Spill Prevention in Storage
   - 9.2 Spill Prevention in Transportation
   - 9.3 Spill Prevention in Oil & Gas Production
   - 9.4 Flares
   - 9.5 Spill Cleanup Techniques

The largest section of the MECEH will include a data sheet for each control technology listed in the Table of Contents.

The general index will list devices, manufacturers, specific pollutants, and other key words.

The only significant complications were associated with developing the standardized specific device data sheet and the preparation of a Table of Contents that contains all commercially available control technologies.

1.6.3 Baseline Methodology for Effluent Control Options: Textile Industry Example

REFERENCE: Monsanto Research Corporation, Source Assessment: Textile Plant Wastewater Toxics Study: Phase I, EPA-600/2-78-004H, March 1978.

The Chemical Processes Branch (CPB) of IERL/RTP wanted to generate data to be used to determine the best available technology economically achievable (BATEA) for wastewaters from the textile industry. To this end, CPB implemented two projects: (1) a jointly funded project with the American Textile Manufacturer's Institute (ATMI) and (2) a special project on CPB's source assessment program. The objective of the EPA/ATMI grant study is to provide assistance in determining the BATEA for criteria water pollutants. This project is divided into two parts: a technical study to determine the best available technology, and an economic study to determine the costs of various technologies.

The objectives of the second project are to evaluate the toxicity of textile secondary effluents, the removal of toxicity by the BATEA systems, the removal of the 129 priority pollutants established by EPA from the consent decree, and the new wastewater sampling and analysis protocols established by EPA.

This summary deals primarily with the implementation and evaluation of new EPA sampling, chemical analysis, and bioassay protocols (Level 1). This evaluation was conducted by the Monsanto Research Corporation (MRC) for EPA and is summarized in figure 16.

Several pilot-scale BATEA systems are being evaluated to determine their performances. The units are located in a mobile unit to enable various wastewaters from a variety of point sources to be treated. The impact of each treatment system can then be evaluated for a standard plant waste stream.

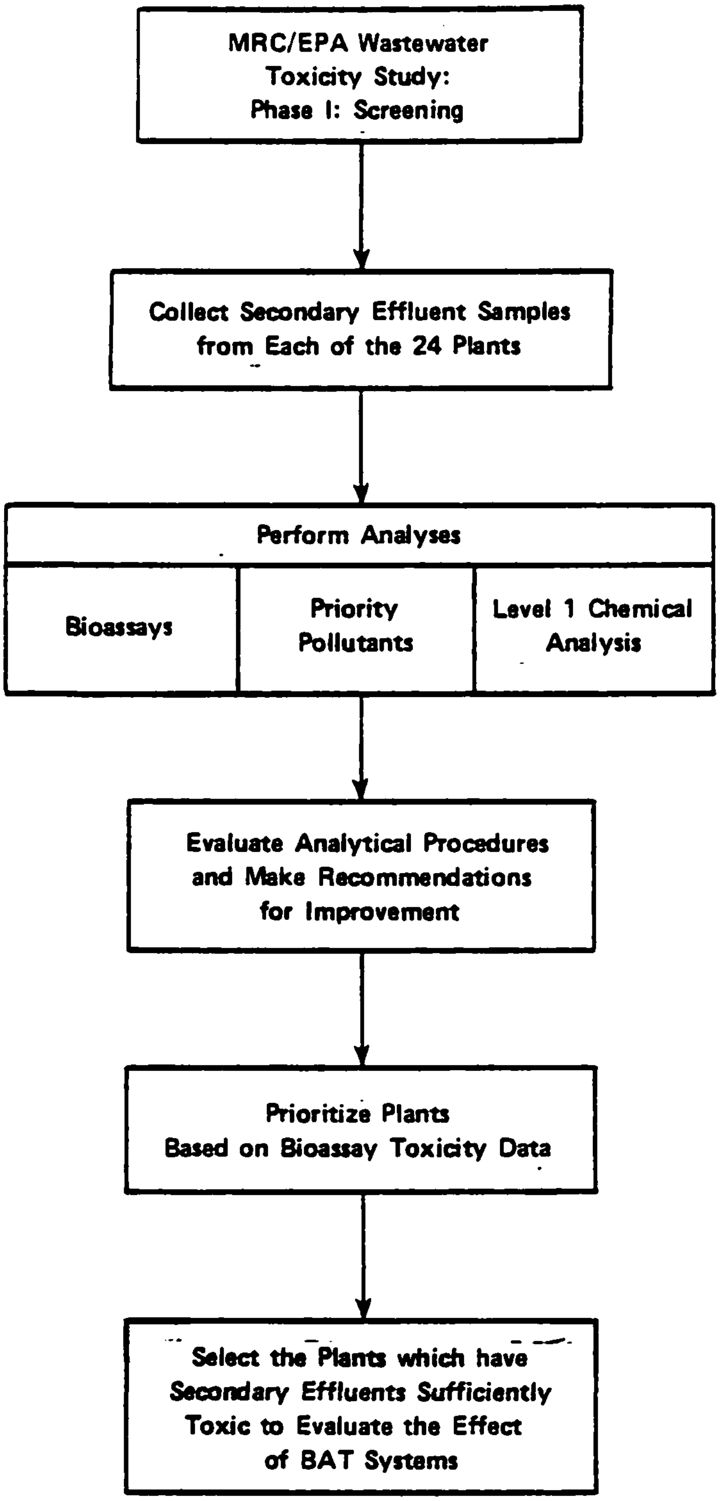


Figure 16. MRC/EPA wastewater toxicity study plan.

Raw wastewater and secondary effluent samples were collected from each of 24 selected textile plants. Each sample was analyzed using the following tests:

- Microbial Mutagenicity (Ames Test)
- Terrestrial Ecology-Soil Microcosm
- Freshwater or Marine Bioassays
- Acute Toxicity Tests on Rats

After performing the analyses, MRC evaluated Level 1 analytical procedures and made its final recommendations in December 1977.

Based on bioassays, Level 1 chemical analyses, and analyses for the 129 priority pollutants, the textile plants were prioritized. Using this ranking, MRC and EPA selected the plants which have secondary effluents that are sufficiently toxic to justify additional testing. The objective of this testing was the determination of whether or not BAT processes remove the toxic character of the waste.

1.7 ENVIRONMENTAL ALTERNATIVES ANALYSIS

1.7.1 Source Analysis Models (SAM's)

REFERENCES:

L. M. Schalit and K. J. Wolfe, SAM/IA: A Rapid Screening Method for Environmental Assessment of Fossil Energy Process Effluents, EPA-600/7-78-015, February 1978.

L. B. Anderson, M. A. Herther, and R. J. Milligan, SAM/I: An Intermediate Screening Method for Environmental Assessment of Fossil Energy Process Effluents (Draft), Contract No. 68-02-2160, prepared by Acurex Corp. for U.S. Environmental Protection Agency, IERL, June 1978.

Three different models are being developed: SAM/IA for rapid screening, SAM/I for screening, and SAM/II for regional site evaluation.

SAM's can be used to do one or more of the following:

- rank sources and effluent streams
- establish Level 2 and Level 3 sampling and analysis priorities
- determine problem pollutants and pollutant priorities
- determine which control technology options are the most effective
- determine the need for control/disposal technology development

Workbook formats and standard forms will be generated for each model. The Multimedia Environmental Goals (MEG's) being developed by RTI are employed. The primary use of the models will be in environmental assessment source evaluations that are conducted by the Energy Assessment and Control Division (EACD) of IERL. Figure 17 details key characteristics and relationships of the models. At present the models utilize only chemical data; later ones may utilize bioassay data, also.

1.7.1.1 SAM/IA

SAM/IA is based on effluent concentrations, uses only one potential assessment alternative (the MATE, Minimum Acute Toxicity Effluent), does not include transformation analysis, and includes only degree of hazard and toxic-unit discharge calculations.

Development of applications for SAM/IA will emphasize: (1) interpretation of Level 1 results by determining maximum potential "degree of hazard" and "toxic unit discharge rates (TUDR)," utilizing only the MATE's for the most hazardous substance in each MEG compound category, primary emphasis

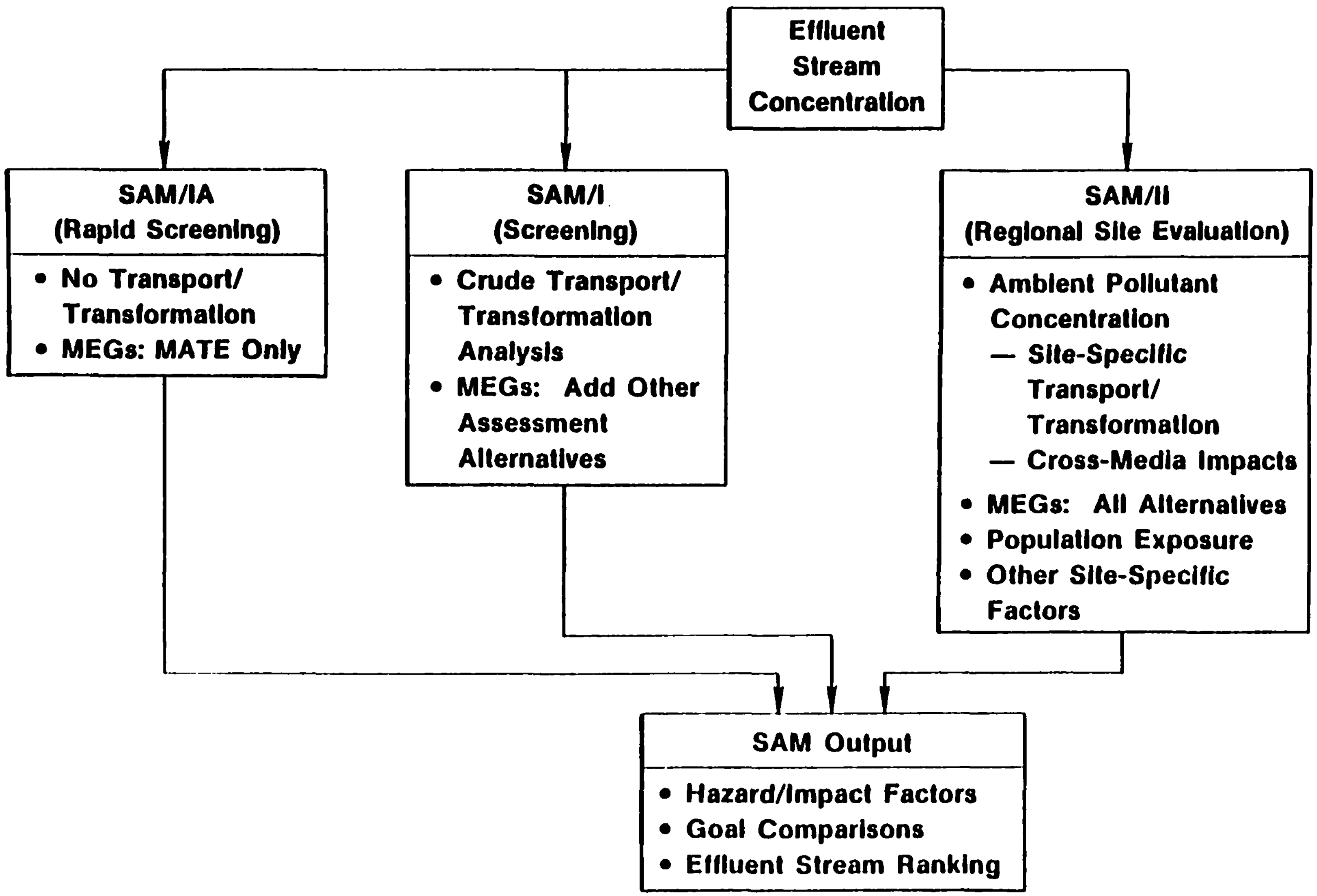


Figure 17. Relationship of various SAM's to SAM output.

being on guidance for further sampling and analysis; and (2) interpretation of Level 2 results to determine potential "degree of hazard" and TUDR. Comparability with bioassay results should only be attempted when Level 2 chemical data are available.

The key steps of the SAM/IA procedure are shown in figure 18 and are outlined below:

1. Identify specific sources within the overall system or process.
2. Identify the various effluent streams from each source.
3. Determine the concentration of each pollutant to be considered in each effluent stream.
4. Each pollutant concentration in a given stream is divided by the health-based MATE(s) for that pollutant. This quantity is referred to as "degree of hazard (H)". This is also done for the ecological MATE.
5. Flags are noted on the form for all H's that exceed unity.
6. The final calculation for each pollutant in each stream takes the product of its H and effluent stream flow rates to establish health (or ecological) toxic unit discharge rates (TUDR) for each pollutant in the stream.
7. The total stream hazard is calculated as the sum of the H's for each pollutant in the stream. The total TUDR is also calculated as a sum over all pollutants.
8. Steam hazards and TUDR's are grouped and summed by discharge media.

Ordinarily, SAM/IA will be used for rapid screening of the difference between an uncontrolled process and the results of the application of various control options. Consequently, it will be applied to confined or ducted sources.

In order to make the most efficacious use of SAM/IA it is important that users understand the following assumptions:

- The substances on the MEG list that are potential components of an effluent stream are the only ones that need to be included.
- It is assumed that such dispersion from the source to a receptor would, in almost all cases, be equal to, or greater than, the

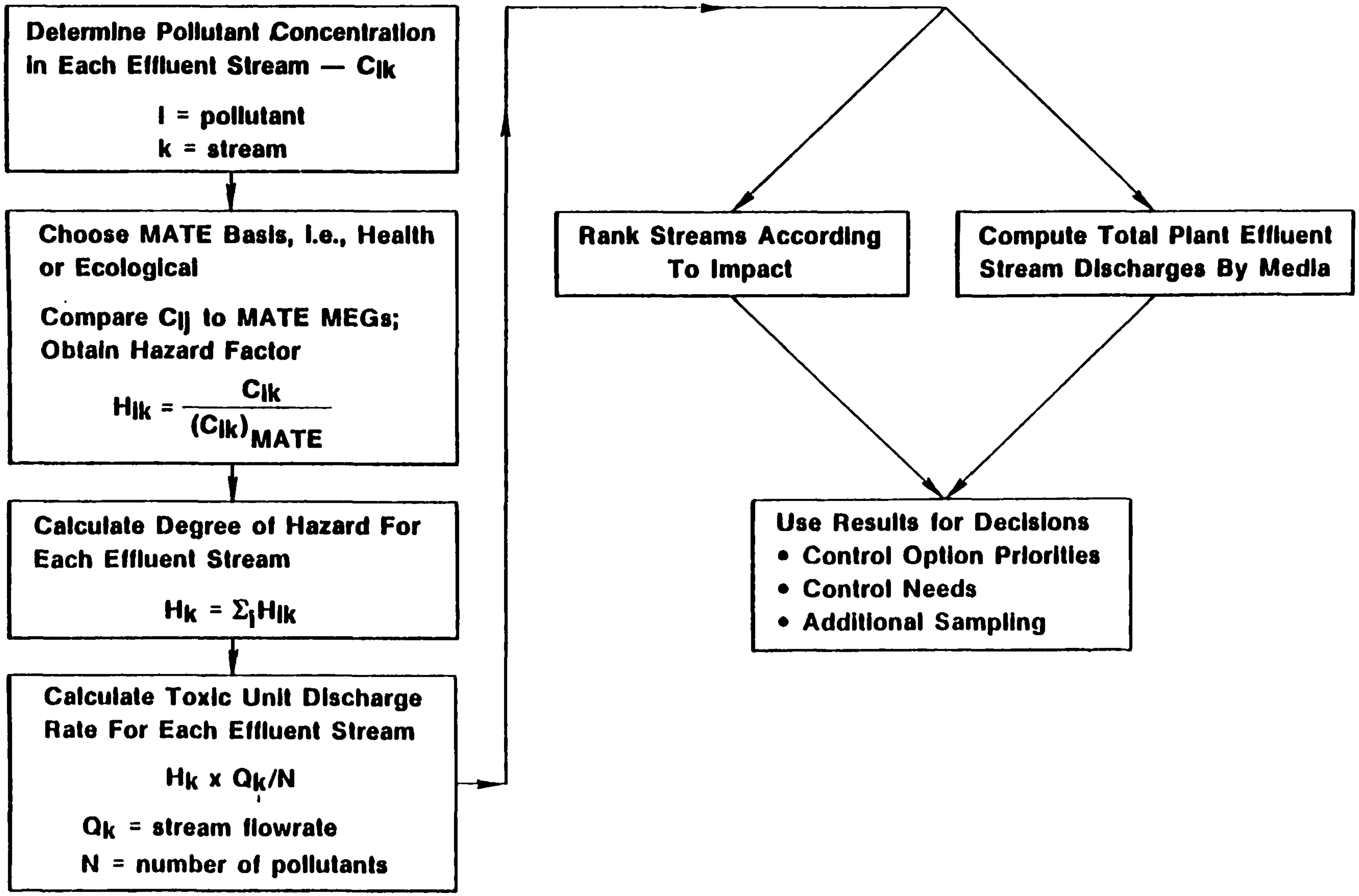


Figure 18. SAM/IA procedure.

safety factors normally applied to acute (short-term exposure) toxicity data to convert them to estimated safe, low-level, longer-term chronic ambient exposure levels.

- The MATE values (or the basic data they were developed from) are adequate.
- No synergistic effects occur.

1.7.1.2 SAM/I

Characteristics of SAM/I relative to other SAM's include the following:

- Based on simple, non-site-specific relationships between ambient concentration and effluent concentrations using a dilution factor approach
- Allows several potential assessment alternatives based on the different MEG's
- Includes simple models for transformation analysis that are not site-specific
- Includes degree of hazard/TUDR calculations.

SAM/I can be used to calculate the allowed effluent concentrations of each pollutant species in a stream from ambient MEG values and to compare actual effluent concentrations to the acceptable concentrations to calculate a degree of hazard (H).

Required input data are the same as with SAM/IA: source type, effluent concentrations, and effluent stream flow rates. However, in SAM/I a dilution factor, F, is chosen as appropriate to the source category. This dilution factor is used to relate ambient concentration-based MEG values to allowed effluent concentrations, and thereby allow calculating pollutant species' degrees of hazard:

$$H = \frac{\text{effluent concentration}}{\text{MEG x F}} \quad .$$

The toxic unit discharge rate for a given pollutant in a given stream is defined (as in SAM/IA) as the product of H and the effluent stream flow rate.

This procedure applies to all effluent stream types--gaseous, liquid, and solid--with stated decision criteria for choosing appropriate dilution factors. For gaseous streams source type and source size, determine F. For liquid and solid discharges the dilution factor is specified by the type of interaction between the effluent stream and the receiving body (e.g., discharge to surface water, ground water, or deep well injection).

It should be emphasized that the SAM/I methodology is still undergoing development and refinement in both approach and detailed procedures. Thus, the above discussion should be considered only qualitatively descriptive of the final model form.

1.7.1.3 Extended SAM/I

A SAM/I-like model is being refined to include background ambient concentrations in hazard factor calculations. In this case the hazard factor is equal to the ratio of maximum ground level pollutant concentrations from a source plus background concentration to the MEG for the particular pollutant. This extended SAM/I model will also include impact factor calculations and urban/rural source density and population exposure differences.

1.7.1.4 SAM/II

The needs for a regional site evaluation SAM are being evaluated, and available techniques are being compiled. The Source Assessment Methodology discussed in Section 1.7.2 may be utilized directly or adapted for SAM/II. Currently, only a preliminary outline of the form of the SAM II model has been prepared.

1.7.2 Source Assessment Methodology

REFERENCE: R. W. Serth, T. W. Hughes, and R. E. Opferkuch, Source Assessment: Analysis of Uncertainty, Volume I: Principles and Applications, EPA-600/2-77-107, November 1977.

A "source" is defined as an entire industry or commercial operation that is national in scope. An "assessment" of that source determines the extent and potential hazard of industry emissions based on all available process, emissions, and control technology information.

Figure 19 details the steps in performing a source assessment. The final Source Assessment Document (SAD) includes sampling and analysis results, engineering information, health effects data, and atmospheric dispersion information.

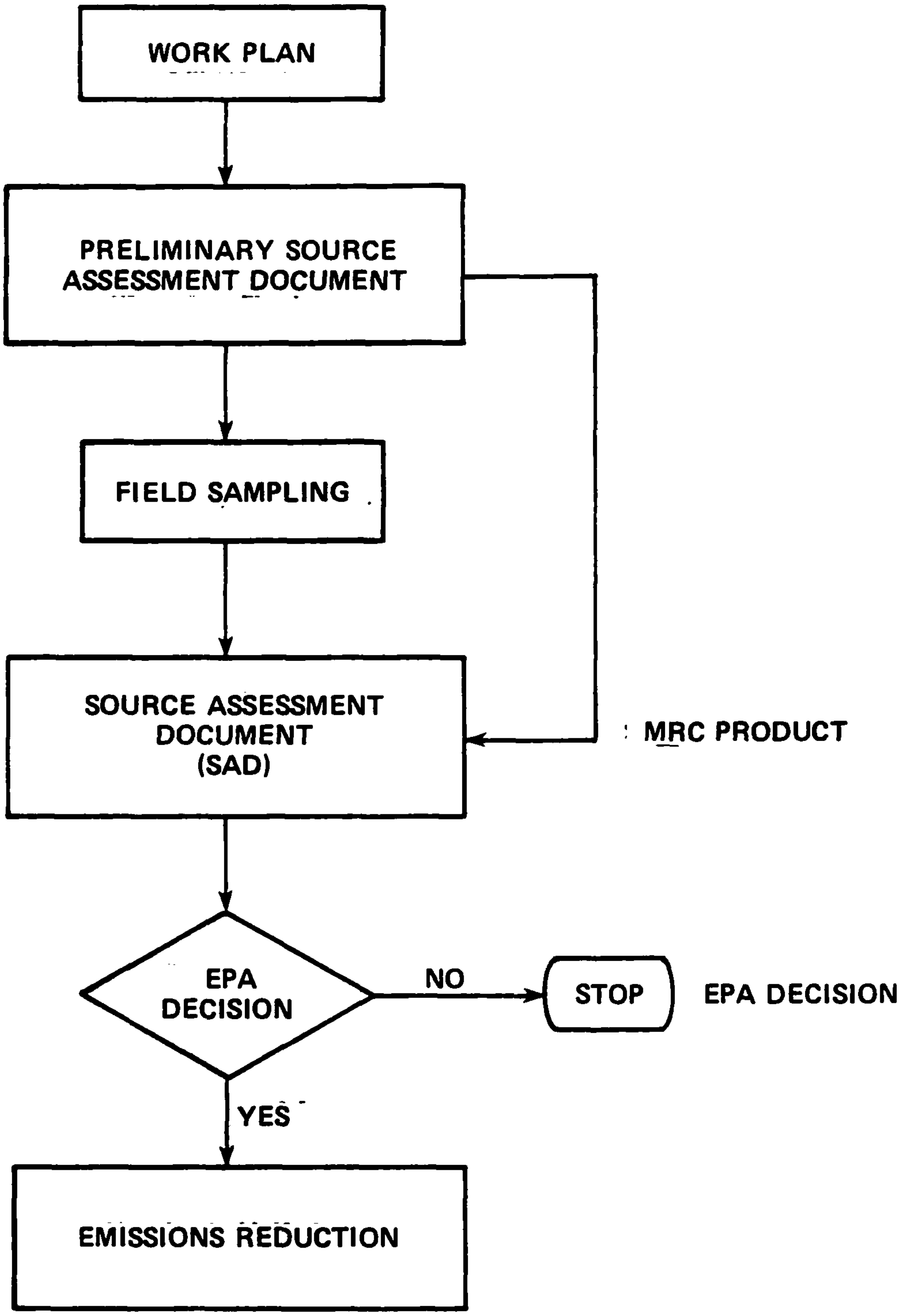


Figure 19. Steps in performing a source assessment.

EPA makes a decision on the need for development of additional pollution control technology based on the SAD. In arriving at a decision, EPA has the following concerns:

- Is the decision correct?
- What impact does data quality have on the correctness of the decision?
- Which information areas have the greatest impact on correct EPA decisions?
- What can be done to improve the decision criteria?

EPA's criteria for determining the best decision that will achieve emissions reduction include the following:

Major Decision Criteria	Minor Decision Criteria
• Source Severity	• Emissions Growth Trends
• National Emissions Burden	• Affected Population
• States' Emissions Burdens	• Affected Population

These criteria are discussed in the following paragraphs.

1.7.2.1 Source Severity

The source severity is based on the resultant maximum time-averaged ground level concentration for each pollutant, which is calculated from Gaussian plume dispersion theory for a continuously emitting elevated point source.

$$S \equiv \frac{\text{Exposure Concentration}}{\text{Potentially Hazardous Concentration}} \equiv \frac{\overline{X}_{max}}{F}$$

$\overline{X}_{max}$ = maximum time-averaged ground level pollutant concentration.

F = An "acceptable" pollutant concentration (This may be a Primary Ambient Air Quality standard for criteria pollutants or an equivalent value for noncriteria pollutants utilizing threshold limit values and appropriate conversion factors.)

If $S \equiv \frac{\overline{X}_{max}}{F} \geq 0.05$, there is sufficient cause to develop additional pollution control technology.

If $S \equiv \frac{\overline{X}_{max}}{F} < 0.05$, there is insufficient cause to develop additional pollution control technology.

1.7.2.2 National Emissions Burden

For a given source and given criteria pollutant, the national emissions burden, N_B, is defined as follows:

$$N_B \equiv \frac{M_p}{M_n}$$

M_p = annual mass emissions of given criteria pollutant from the given source type

M_n = annual mass emissions of given pollutant from all stationary sources nationwide

In practice, the above equation is calculated as follows:

$$N_B = \frac{(CAP_T)(EF_R)}{M_{NEDS}}$$

CAP_T = total production capacity of source type

EF_R = representative emission factor for source type

M_{NEDS} = estimate of M_n obtained from the 1972 National Emissions report

If $N_B \equiv \frac{\Sigma M_p}{\Sigma M_n} \times 100 \geq 0.1$, then additional pollution control technology should be developed. If $N_B \equiv \frac{\Sigma M_p}{\Sigma M_n} \times 100 < 0.1$, then no further pollution control technology development is required.

1.7.2.3 States' Emissions Burdens

For states' emissions burdens,

$$S_B \equiv \frac{\text{Mass of An Industry's Emissions in a State}}{\text{Mass of All Industries' Emissions in a State}} = \frac{\Sigma M_{ps}}{\Sigma M_s}$$

If $S_B \equiv \frac{\Sigma M_{ps}}{\Sigma M_s} \times 100 \geq 1.0$, additional pollution control technology is needed.

If $S_B \equiv \frac{\Sigma M_{ps}}{\Sigma M_s} \times 100 < 1.0$, no further development is needed at this time.

1.7.2.4 Minor Decision Criteria

Emissions Growth Trends (G) are defined as the ratio of future emission rates to present emission rates. The affected population is the number of people exposed to a potentially hazardous environment. These factors are used to determine priorities only where a problem source has been established from the major decision criteria.

1.7.3 Defined Research Data Base for Standards

REFERENCE: R. P. Hangebrauck, Director, Energy Assessment and Control Division, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. 27711.

Figure 1 illustrates the relationships of IERL/RTP Standards Development Support R&D to the steps the EPA program offices take in developing standards. Three key information transfer documents will be generated by IERL for the Administrator and all Program Offices:

- A Standards Support Plan for each energy technology (e.g., synthetic fuels from coal), outlining the schedule for producing a Pollution Control Guidance Document for technology areas and Environmental Assessment Reports on each of several specified energy technologies for use by all EPA Program Offices and taking into consideration mutual schedules. Information covered includes a definition of the technologies covered, projected development and application, requirements of the EPA Acts, EPA plans for regulatory activities, EPA research and development activities, and EPA Program Offices' views on R&D data needs.
- A Pollution Control Guidance Document for each energy technology area or subarea (e.g., low-Btu coal gasification) summarizing EPA's predicted regulatory mechanisms and control requirements plus a description of pollutants and process sources, effects of

known pollutants, existing pollution control technology and suggested discharge limits, and applicable monitoring technology. The identification of anticipated regulatory mechanisms and statement of preliminary discharge limitations require input, participation, and concurrence by the EPA Program Offices.

- An Environmental Assessment Report for each specified energy technology at the commercial or demonstration stage (e.g., Lurgi systems for low and medium Btu gas from coal), covering in depth all environmental assessment information relevant to existing or needed standards development summarized for each EPA Program Office. The report will also include a description of processes/systems that can make up the technology, the status of development and projected national application; process areas of environmental concern, and the present and proposed environmental requirements. The major sections of the report will generally be organized to cover each Program Office area separately, as well as multimedia integration. Major sections will include characterization of input materials, products, and waste streams; performance and cost of control alternatives; identification of the most effective control alternatives; analysis of regulatory requirements and environmental impacts; and a summary of needs for additional data to support standards development, enforcement, effects R&D, and control technology R&D.

Figure 20 shows an illustration of the approach for synthetic fuels from coal-based energy technologies. Table 10 gives an example of a Standards Support Plan (SSP) outline for technologies that produce synthetic fuels from coal. Table 11 is an outline of an Environmental Assessment Report (EAR) for Lurgi systems for producing low- and medium-Btu gas from coal.

A *Standards Support Plan* summarizes and integrates the status of all EPA media standards development for the Synthetic Fuels from Coal Technology Area and outlines EPA's schedule for producing Environmental Assessment Reports on each of several priority Synfuel energy technologies for use by all Program Offices, taking into consideration mutual schedules. Examples of priority Synfuel technologies which would be specified for generation of individual Environmental Assessment Reports are as follows:

- Coal Gasification Technologies
  - Lurgi Systems for Low- and Medium-Energy Gas from Coal
  - Wellman Galusha Systems for Low- and Medium-Btu Gas
- Coal Liquefaction Technologies
  - Koppers Totzek/Fisher Tropsch for Producing Synthetic Petroleum
  - Solvent-Refined Coal

Environmental Assessment Report for Lurgi Systems for Low- and Medium-Energy Gas from Coal

Provides the Administrator, Program Offices, and Policy and Planning with a recognized, authoritative document representing OR&D's environmental assessment research input on standards (supporting data, needs, alternatives) for a given energy technology. The report provides a comprehensive, multimedia, multipollutant data base and checklist of environmental facts concerning the technology covered. Recognizing the evolutionary state of the technologies and of environmental assessment methodology, the report will be expanded, refined, and updated every 1 or 2 years as needed for Agency purposes. Some key outputs are as follows:

- Process description of the Systems making up the technology
- Characterization of Input Materials, Products, and Waste Streams
- Performance and Cost of Control Alternatives
- Analysis of Regulatory Requirements and Environmental Impacts by Media, with Regional Considerations
- Summary of the Needs for Additional Data to Support Standards Development, Enforcement Health and Ecological Effects Research, and Control Technology R&D

Figure 20. Illustration of approach for synthetic fuels from coal-based energy techniques.

TABLE 10. STANDARDS SUPPORT PLAN FOR TECHNOLOGIES FOR PRODUCING SYNTHETIC FUELS FROM COAL

1.0 INTRODUCTION (2-3 pages)

- *1.1 Purposes of the Standards Support Plan
- *1.2 Mechanisms for Preparing and Updating the Plan
- 1.3 Relationship to the Synfuels Environmental Assessments

2.0 DEFINITION OF THE TECHNOLOGIES (5-10 pages)

- 2.1 Coal Gasification Technologies
  - 2.1.1 Overview and Generalized Flow Diagram
  - 2.1.2 Coal Pretreatment Operations
  - 2.1.3 Coal Gasification Operations
  - 2.1.4 Gas Purification Operations
  - 2.1.5 Conventional Technologies for Pollution Control
- 2.2 Coal Liquefaction Technologies
  - 2.2.1 Overview and Generalized Flow Diagram
  - 2.2.2 Coal Preparation Operations
  - 2.2.3 Coal Liquefaction Operations
  - 2.2.4 Products Separation Operations
  - 2.2.5 Hydrotreating Operations

3.0 THE STANDARDS SUPPORT SCHEDULE (2-3 pages)

- 3.1 Description of the Schedule
- *3.2 The Schedule

4.0 DISCUSSION OF THE STANDARDS SUPPORT SCHEDULE (10-15 pages)

- *4.1 Projected Development of Synthetic Fuels Processes
  - 4.1.1 Utility Applications
  - 4.1.2 Non-Utility (Industrial/Commercial) Applications
- *4.2 Requirements of EPA Acts
  - 4.2.1 Clean Air Act
  - 4.2.2 Federal Water Pollution Control Act
  - 4.2.3 Resource Conservation and Recovery Act
  - 4.2.4 Toxic Substances Control Act
- *4.3 EPA Plans for Regulatory Activities
  - 4.3.1 Office of Air Quality Planning and Standards
  - 4.3.2 Office of Water Planning and Standards
  - 4.3.3 Office of Solid Waste Management Programs
  - 4.3.4 Office of Toxic Substances
  - 4.3.5 Office of Enforcement
  - 4.3.6 Regional Offices
  - 4.3.7 Radiation, Noise, and Other EPA Offices
  - 4.3.8 Relationships to Other Regulatory Activities (NIOSH, Mine Safety, etc.)

*See Notes

TABLE 10. STANDARDS SUPPORT PLAN FOR TECHNOLOGIES FOR PRODUCING SYNTHETIC FUELS FROM COAL (con.)

*4.4 EPA Research and Development Activities
    4.4.1 Data Gathering
        4.4.1.1 Tests at Government-Supported Facilities
        4.4.1.2 Tests at Private Facilities
    4.4.2 Environmental Reviews of Synfuels Technologies
        4.4.2.1 Government-Supported Projects
        4.4.2.2 Private Projects
    4.4.3 Description of IERL/RTP Environmental Assessment Reports
*4.5 Program Offices' Views of R&D Data Needs

5.0 APPENDICES (1-2 pages)

5.1 References for Further Detail on Technologies

5.2 References for Further Detail on Regulatory Plans

5.3 EPA Persons Involved in Synfuels Assessment, Standards, and Enforcement

NOTES

1.1 This section should describe the purposes briefly; for example, as follows:

- to briefly describe the technical and economic information that ORD (IERL/RTP) can provide to support standards that may result from any of the EPA legislative Acts;
- to establish a time schedule for transmitting this information to the standards-setting and enforcement offices in EPA;
- to serve, at least initially, as a negotiating document between IERL/RTP and the program and regional offices for determining what information is to be developed by OR&D for standards support, and in what time frame. Eventually, the Agency may want to publicize the plan for the benefit of developers and users of synthetic fuels technologies.

1.2 The proposed mechanism is as follows: IERL/RTP would prepare the first version of the plan. It would reflect OR&D feelings on priorities among the various technologies; OR&D's understanding of the data needs of the program offices; and OR&D's understanding of the various offices' (including regional offices') plans for standards and enforcement. This first version of the Standards Support Plan would then be circulated to the program offices (or perhaps to a committee that includes their representatives) for comment. Several iterations of the plan (each prepared by IERL/RTP, or jointly with the committee members) may be required before final agreement. Thereafter, periodic revisions would undoubtedly be needed to accommodate changes in policies or technology development trends.

3.2 This section would consist of a fold-out time chart showing:

- estimated timing of the development, demonstration, and commercialization of various synthetic fuels processes

TABLE 10. STANDARDS SUPPORT PLAN FOR TECHNOLOGIES FOR PRODUCING SYNTHETIC FUELS FROM COAL (con.)

- requirements of EPA Acts that may apply to synthetic fuels plants
- major ORD milestones and transmittals of key data to the program offices
- best current estimates of the type and timing of EPA standards for various types of synthetic fuels technologies

4.1 This section would present IERL/RTP's best estimates of the rate of development and commercialization of various coal gasification and liquefaction processes. To the extent possible, distinctions would be made between developments for gas or electric utilities, industrial or commercial fuels, and industrial chemical feedstock applications.

4.2 A very brief explanation of key requirements of the EPA Acts that may influence the nature or timing of standards, as depicted on the schedule in Section 3.2.

4.3 Very brief explanations of milestones for standards shown on the schedule; information based on discussions between the various program offices and IERL/RTP (or IERL contractors).

4.4 Brief but explicit discussions of the ORD milestones and data shown on the standards support schedule.

4.5 Brief but explicit guidance on the kinds of data needed from IERL/RTP to support standards. Prepared in the same manner as Section 4.3.

TABLE 11. ENVIRONMENTAL ASSESSMENT REPORT—LURGI SYSTEMS FOR PRODUCING LOW- AND MEDIUM-Btu GAS FROM COAL†

Abstract
List of Figures
List of Tables
*Nomenclature

*1.0 SUMMARY

1.1 Overview of Lurgi Gasification Systems
1.2 Waste Streams and Pollutants of Major Concern
1.3 Status of Environmental Protection Alternatives
1.4 Data Needs and Recommendations

2.0 PROCESS DESCRIPTION OF LURGI GASIFICATION SYSTEMS

2.1 Technical Overview of Lurgi Systems
2.1.1 Status of Development
*2.1.2 Industrial Applicability of Lurgi Systems
2.1.3 Input Materials, Products, and By-products
2.1.4 Energy Efficiencies
2.1.5 Capital and Operating Costs
2.1.6 Commercial Prospects

*2.2 Description of Processes
2.2.1 Generalized Process Flow Diagram
2.2.2 Coal Pretreatment
2.2.3 Coal Gasification
2.2.4 Gas Purification
2.2.5 Auxiliary Processes

*2.3 Process Areas of Current Environmental Concern
2.3.1 Coal Pretreatment
2.3.2 Coal Gasification
2.3.3 Gas Purification
2.3.4 Auxiliary Processes

*3.0 CHARACTERIZATION OF INPUT MATERIALS, PRODUCTS, AND WASTE STREAMS

*3.1 Summary of Sampling and Analytical Activities
3.1.1 IERL/RTP Environmental Assessment Activities
3.1.2 Non-IERL/RTP Site Evaluations

*3.2 Input Materials
3.2.1 Coal Pretreatment and Handling
3.2.2 Coal Gasification
3.2.3 Gas Purification
3.2.4 Auxiliary Processes

*3.3 Process Streams (same format as Section 3.2)

† See footnotes at end of Table
*See Notes

TABLE 11. ENVIRONMENTAL ASSESSMENT REPORT–LURGI SYSTEMS FOR PRODUCING LOW- AND MEDIUM-Btu GAS FROM COAL† (con.)

*3.4 Toxic Substances in Products and By-products (same format as Section 3.2)

*3.5 Waste Streams to Air (same format as Section 3.2)

*3.6 Waste Streams to Water (same format as Section 3.2)

*3.7 Waste Streams to Disposal Sites (same format as Section 3.2)

4.0 PERFORMANCE AND COST OF CONTROL ALTERNATIVES

*4.1 Procedures for Evaluating Control Alternatives

*4.2 Air Emissions Control Alternatives
- 4.2.1 Coal Pretreatment and Handling
- 4.2.2 Coal Gasification
- 4.2.3 Gas Purification
- 4.2.4 Auxiliary Processes

*4.3 Water Effluent Control Alternatives (same format as for Section 4.2)

*4.4 Solid Waste Control Alternatives (same format as for Section 4.2)

*4.5 Toxic Substances Control Alternatives

*4.6 Summary of Most Effective Control Alternatives
- 4.6.1 For Emissions Control
- 4.6.2 For Effluents Control
- 4.6.3 For Solid Wastes Control
- 4.6.4 For Toxic Substances Control

*4.7 Multimedia Control Systems

4.8 Regional Considerations Affecting Selection of Alternatives

4.9 Summary of Cost and Energy Considerations

5.0 ANALYSIS OF REGULATORY REQUIREMENTS AND ENVIRONMENTAL IMPACTS

*5.1 Environmental Impact Methodologies
- 5.1.1 Multimedia Environmental Goals
- 5.1.2 Source Analysis Models
- 5.1.3 Bioassay Interpretations

5.2 Impacts on Air
- *5.2.1 Summary of Air Standards and Guidelines
- *5.2.2 Comparisons of Waste Streams with Emissions Standards
- *5.2.3 Impacts on Ambient Air Quality
- *5.2.4 Evaluation of Unregulated Pollutants and Bioassay Results

5.3 Impacts on Water
- 5.3.1 Summary of Water Standards
- 5.3.2 Comparisons of Waste Streams with Effluent Standards
- 5.3.3 Impacts on Ambient Water Quality
- 5.3.4 Evaluation of Unregulated Pollutants and Bioassay Results

†See footnotes at end of Table
*See Notes

TABLE 11. ENVIRONMENTAL ASSESSMENT REPORT—LURGI SYSTEMS FOR PRODUCING LOW- AND MEDIUM-Btu GAS FROM COAL† (con.)

5.4 Impacts of Land Disposal
  5.4.1 Summary of Land Disposal Standards
  5.4.2 Comparisons of Waste Streams with Disposal Standards
  5.4.3 Evaluation of Unregulated Pollutants and Bioassay Results

5.5 Product Impacts
  5.5.1 Summary of Toxic Substances Standards
  5.5.2 Comparisons of Product Characterization Data with Toxic Substances Standards
  5.5.3 Evaluation of Unregulated Toxic Substances and Bioassay Results

5.6 Radiation and Noise Impacts

5.7 Summary of Major Environmental Impacts
  5.7.1 Air Impacts
  5.7.2 Water Impacts
  5.7.3 Impacts of Solid Wastes
  5.7.4 Impacts of Toxic Substances
  5.7.5 Other Impacts (Noise, Radiation, Land Use)

5.8 Siting Considerations for Gasification Plants

6.0 SUMMARY OF NEEDS FOR ADDITIONAL DATA

6.1 Data Needs
  6.1.1 To Support Standards Development and Enforcement
  6.1.2 To Support Effects and Control Technology R&D

6.2 Data Acquisition by Ongoing Environmental Assessment Activities

7.0 APPENDICES

*7.1 Glossary of Environmental Assessment Terms

7.2 References

7.3 Etc. Other Appendices as Appropriate

†These reports will be prepared for selected energy systems, and updated to reflect significant changes in status of development or knowledge of environmental impacts. Lurgi low- and medium-BTU systems have been used as an example to illustrate the general outline of EA reports.

*NOTES

Nomenclature. A short (e.g., one-page) section defining key terms. Reference to Section 7.1 for an expanded set of definitions.

1.0 An "executive" summary, aimed primarily at EPA regulatory offices, but presented in a manner to also inform educated laymen in all fields having potential interest in energy and the environment. Emphasis on objectives, key findings and conclusions, and need (if any) for further environmental assessment work. Limited to about 20-30 pages. Liberal use of graphics; more sophisticated layout than for the remainder of the report. Available as a separate document, perhaps with multi-colored printing.

TABLE 11. ENVIRONMENTAL ASSESSMENT REPORT–LURGI SYSTEMS FOR PRODUCING LOW- AND MEDIUM-Btu GAS FROM COAL† (con.)

2.1.2 In addition to discussing where Lurgi systems might be used in industry, this section should identify any EPA industrial source categories that would apply to Lurgi installations.

2.2 Engineering descriptions of production and auxiliary processes, with sufficient detail for evaluation of waste stream control alternatives. Less detail for descriptions of auxiliary processes involved in wastewater control and solids disposal. Master flow diagram in Section 2.2.1 identifies all processes and waste streams, and serves as a reference for the rest of the report.

2.3 Highlights of major known environmental problems. This section intended to balance the process engineering discussions with a broad environmental perspective.

3.0 This chapter serves as a "hard-copy" data base, summarizing the best available information on the physical, chemical, and biological effects characteristics of materials, products, and waste streams associated with Lurgi gasification systems. Detailed data from specific tests are to be stored in Environmental Assessment Data Systems (EADS), and in limited-copy reports in project officer files.

3.1 This section describes sites and equipment (including operating conditions) sampled by IERL/RTP and other organizations, but does not discuss the results (data) from these activities.

3.2-3.7 These sections present the physical, chemical, and biological effects (bioassay) data on a material-by-material, product-by-product, or stream-by-stream basis. Data generated by both IERL/RTP and other organizations are compiled. Data on both controlled and uncontrolled waste streams are presented; fugitive discharges are covered as waste streams. All materials, products, and waste streams are tied back to the master flow diagram in Section 2.2.1.

4.1 "Control alternatives" to include material changes, process modifications, and waste stream treatment options. Evaluations to consider factors such as pollutant reduction/prevention efficiency, cost, operating reliability, stage of development, and results of analyses from Chapter 5.

4.2, 4.3, 4.4, 4.5 Control alternatives to be evaluated should include: (a) those that have been demonstrated on gasification plants; (b) those that have been demonstrated on similar sources; and (c) those that are emerging (undemonstrated).

4.6 This section to summarize the results of Sections 4.2-4.5 for the control alternatives that show the best balance of performance and cost, on a media-by-media basis.

4.7 This section intended for evaluation of plant-wide systems capable of controlling waste streams to more than one medium.

5.1 A brief review of IERL/RTP environmental assessment methodologies, with reference to basic reports.

5.2.1 Very brief review of existing or proposed standards that may be applicable to Lurgi gasifiers.

5.2.2, 5.3.2, 5.4.2, 5.5.2 Comparisons of waste stream rates and compositions with applicable discharge standards. Comparisons may be on a stream-by-stream basis, or a plant-wide, as appropriate.

TABLE 11. ENVIRONMENTAL ASSESSMENT REPORT—LURGI SYSTEMS FOR PRODUCING LOW- AND MEDIUM-Btu GAS FROM COAL† (con.)

5.2.3, 5.3.3 Projections of incremental ambient loadings by simplified environmental transport models; and comparison with air, water, and land quality standards or criteria.

5.2.4, 5.3.4, 5.4.3, 5.5.3 Interpretations of the degree of hazard presented by various waste streams, using chemical composition data for unregulated pollutants and results of bioassays.

7.1 An expanded glossary, covering all environmental assessment terms.

SECTION 2.0

RECOMMENDATIONS

Based on (1) consultation with IERL/RTP personnel, (2) contractor suggestions, (3) the October 14-15, 1977, "Environmental Assessment Methodology Meeting" held at EPA, Research Triangle Park, North Carolina, and (4) the February 13-14, 1978, meeting of the Environmental Assessment Steering Committee, the following discussion of additional research and/or coordination that might be useful to the IERL environmental assessment methodology program has been developed. These suggested approaches may not necessarily reflect the opinion of the Industrial Environmental Research Laboratory or of EPA.

- Current Process Technology Background

  Expand efforts to develop a comprehensive set of nomenclature to be utilized by all contractors in describing all energy technologies and environmental components.

  Develop a uniform set of methods for defining capital and operating costs. These methods or guidelines should allow selection of an approach based on the degree of accuracy desired and resources available to develop the cost estimates.

- Current Environmental Background

  Update Summary of Key Federal Regulations and Criteria for Multimedia Environmental Control and add similar information for individual states.

  Collect more extensive information on the toxicological characteristics of substances emitted from fossil energy process.

  Speed up work to complete noncriteria ambient baseline data base. Utilize IUPAC nomenclature to be compatible with MEG's.

  Further fossil energy process data are needed for preparation of environmental scale models of energy facilities. Consider a center for study and comparison of facility siting models of the various energy technologies for use by the interested public, environmental scientists, and engineers.

- Environmental Objectives Development

  Expand coverage on substances of concern on the MEG list.

  Refine MEG EPC models to enhance effective utilization. This applies especially to those related to carcinogenicity, land, etc.

  Set up means for automatically flagging data needs from the EPA health and ecological research labs to support MEG's development.

  Accelerate application of the MEG concept to microorganism, noise, nonionizing radiation, radionuclides, water-related physical factors, and land-related physical factors.

  Define relationship of bioassay protocol results to MEG models.

  Apply a number coding system to all MEG substances.

- Environmental Data Acquisition

  Concentrate efforts on means of reducing Level 2 analytical load and cost by taking advantage of existing toxicity data for substances of concern.

  Do more Level 1 to Level 2 test cases.

  Consider and test out methods for integrating bioassays and chemical analysis procedures; for example, fractionation of sample before applying bioassay.

  Accelerate efforts to refine the Level 1 bioassay protocol and define and develop a Level 2 bioassay protocol.

  Develop specific auxiliary Level 1 or Level 2 procedures for evaluating the presence of certain classes of compounds not presently covered by Level 1.

  Continue to develop the Environmental Assessment Data System (EADS) including integration of the to-be-developed Gaseous Emissions Data System (GEDS), the Liquid Effluents Data System (LEDS), and the Solid Waste Effluent Data System (SWEDS) with the already developed Fine Particle Emissions Information System (FPEIS).

- Control Technology Assessment

  Accelerate development of standardized laboratory procedures that simulate control processes (control assays) and their use in connection with Level 1 evaluation procedures.

  Complete development of the Multimedia Environmental Control Engineering Handbook. Review and refine technology classification and prepare specific device data sheets for priority control approaches first.

- Environmental Alternative Analyses

  Further refine and develop the Source Analysis Models (SAM's).

  Integrate bioassay interpretation into SAM/IA: A Rapid Screening Method for Environmental Assessment of Fossil Energy Process Effluents.

For SAM II, consider the applicability/comparability of the Source Assessment Model as a means of regional site evaluation.

- General

  Increase level of effort being devoted to development of environmental assessment methodology.

  Provide specific contract support to assist in this area, especially for overall systems approaches related to the entire EA area.

  Maintain and increase a participatory involvement among all laboratory personnel who have an interest in environmental assessment methodology development to help gain utilization and acceptance of preferred approaches.

  Initiate an Environmental Assessment Methodology Quarterly Review to keep all parties both within and outside EPA better informed of the latest sources of information on approaches, changes in approaches, dissemination of results from application, etc.

  Conduct frequent meetings for project officers and contractors involved in environmental assessment methodology development and application.

  Develop a comprehensive glossary of terms associated with environmental assessment.

SECTION 3.0

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/7-78-151		

4. TITLE AND SUBTITLE	5. REPORT DATE
Status of IERL-RTP Environmental Assessment Methodologies for Fossil Energy Processes	July 1978
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
John L. Warren	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Research Triangle Institute P.O. Box 12194 Research Triangle Park, North Carolina 27709	EHE623A
	11. CONTRACT/GRANT NO.
	68-02-2612, Tasks 22 and 62
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711	Final; 7/77-6/78
	14. SPONSORING AGENCY CODE
	EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is Walter B. Steen, Mail Drop 61, 919/541-2825.

16. ABSTRACT The report summarizes the status of the following environmental assessment (EA) methodologies: current process technology background, environmental data acquisition, current environmental background, environmental objectives development, control technology assessment, and environmental alternatives analysis. After discussing the mechanism used to prepare the report, it reviews the need for additional research in: basic research, analytical methods, environmental models, and multimedia environmental goals. It suggests improvement in: contractor/EPA coordination, coordination of EA methodology development with health effects research, multimedia environmental goal coordination, dissemination of results, and interaction with other agencies. It includes a bibliography of all published reports and drafts of IERL-RTP's EA methodology program.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Assessments	Stationary Sources	14B
Fossil Fuels	Environmental Assessment	21D
Energy Conversion Techniques	Health Effects	10A
Environmental Biology		06F

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Unlimited	Unclassified	105
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	

EPA Form 2220-1 (9-73)