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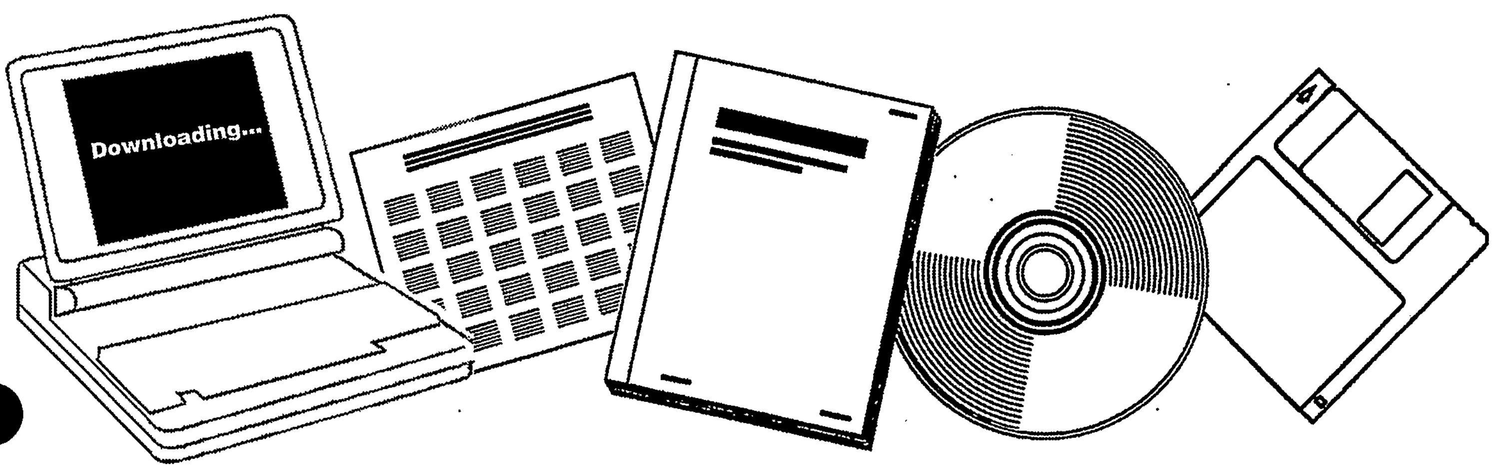

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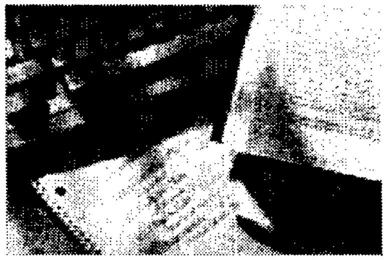

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January 1981

Symposium Proceedings: Environmental Aspects of Fuel Conversion Technology, V (September 1980, St. Louis, MO)

F.A. Ayer and N.S. Jones, Compilers

Research Triangle Institute
P.O. Box 12194
Research Triangle Park, North Carolina 27709

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Office of Environmental Engineering and Technology
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Prepared for

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

PREFACE

These proceedings for the symposium on "Environmental Aspects of Fuel Conversion Technology" constitute the final report submitted to the Industrial Environmental Research Laboratory, U.S. Environmental Protection Agency (IERL-EPA), Research Triangle Park, N.C. The symposium was conducted at the Chase-Park Plaza Hotel in St. Louis, Missouri, September 16-19, 1980.

This symposium served as a colloquium on environmental information related to coal gasification and liquefaction. The program included sessions on program approach, environmental assessment for both direct and indirect liquefaction and for gasification, and environmental control—including the development of the EPA's pollution control guidance documents. Process developers and users, research scientists and State and Federal officials participated in this symposium, the fifth to be conducted on this subject by IERL-RTP since 1974.

Dr. N. Dean Smith, Gasification and Indirect Liquefaction Branch, EPA-IERL, Research Triangle Park, N.C., was the Project Officer and the Technical Chairman. Mr. William J. Rhodes, Synfuel Technical Coordinator for EPA-IERL-RTP, was General Chairman.

Mr. Franklin A. Ayer, Manager, Technology and Resource Management Department, and Mr. N. Stuart Jones, Analyst, Technology and Resource Management Department, Center for Technology Applications, Research Triangle Institute, Research Triangle Park, N.C., were symposium coordinators and compilers of the proceedings.

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16. ABSTRACT The report documents presentations at the fifth EPA-sponsored symposium on the environmental aspects of fuel conversion technology, in St. Louis, MO, 9/16-19/80. The symposium served as a colloquium on environmental information related to coal gasification, indirect liquefaction, and direct liquefaction. The program included sessions on program approach, environmental assessment, and environmental control, including the development of EPA's pollution control guidance documents. Process developers and users, research scientists, and State and Federal officials participated in the symposium.

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OPENING SESSION

KEYNOTE ADDRESS

by

KURT W. RIEGEL, Ph.D.

Associate Deputy Assistant Administrator

Office of Environmental Engineering and Technology

U. S. Environmental Protection Agency

Good morning. On behalf of the Environmental Protection Agency, I welcome you to our Fifth Symposium on the Environmental Aspects of Fuel Conversion Technology. Since our Fourth Symposium in Hollywood last year, much has happened, but two things in particular now inspire our research efforts: First, the price of imported oil has continued to skyrocket. For example, from June 1979 to June 1980, the price increased from an average of $18.90 to $31.60 per barrel--not counting spot market surcharges. Second, the President has signed into law the Synthetic Fuels Corporation Bill authorizing up to $20 billion to encourage the growth of a synthetic fuels industry in the United States. These two stimuli--among others--appear to me to insure that the synthetic fuels industry will be real--established and thriving--well before the end of the century.

As environmental protection scientists and technologists, we have had a unique opportunity to study the various synthetic fuels processes <u>in embryo</u> and to lay the basis for sound environmental development of the industry. This is in sharp contrast to the situation we have faced with countless other industries, where after-the-fact environmental regulations have been resented and challenged, either legally or politically. After the oil embargo in late 1973, we prepared to respond to the environmental challenge of a rapidly growing synthetic fuels industry that, according to the Project Independence Blueprint, loomed large on the horizon. That shadow has been looming and receding through many cycles in the past six years. As you all know, we have suffered on-again, off-again funding in response, but we have somehow managed to sustain a core effort through all of these gyrations.

Perhaps it is just as well that our day of reckoning has been delayed. We have learned a great deal more about the processes and pollutants and have seen the evolution of more comprehensive Federal environmental laws. New acronyms and areas of concern have appeared since 1974: TOSCA, RCRA, priority pollutants, hazardous solid wastes, etc. Each new law has broadened our perception of our task to characterize the waste streams from synthetic fuels technologies, to find appropriate environmental control technologies, and to formulate a comprehensive data base for the use of EPA's Program Offices, as they put together effective, economically feasible regulations.

Another important gain during this period has been the refinement of the communications channels between DOE and EPA through interagency programs. In response to President Carter's directive of May 23, 1977, that EPA and DOE jointly develop procedures for establishing environmental standards for all new energy technologies, a Memorandum of Understanding between DOE and EPA has been executed. This formalizes the many fruitful contacts that have been developed at the various working levels between these organizations.

Further, within the Agency the Alternate Fuels Group and the Priority Energy Project Group have been established by Doug Costle to consider the environmental policy issues involved in implementing the National Energy Program and to coordinate EPA activities for appropriate responses to these issues.

This morning I would like to briefly review the course of our odyssey over the past six years and then discuss with you what I believe will be done in the near future.

The EPA's Synthetic Fuels Program was initiated in the early 1970's but received a boost in 1974, following OPEC's import embargo and in parallel with the preparation of President Nixon's Project Independence Blueprint. The schedules that were originally laid out for our assessments were based upon the apparent national schedules for synfuel commercialization in the 1976 time period. However, private investors balked at putting capital into plants to produce liquids or high BTU gas which could not compete in price with natural fossil fuels then or in the foreseeable future. As ERDA's (now DOE's) Synthetic Fuels Commercialization Program had failed to gain Congressional approval, there was no basis for expecting any major Federal support of commercialization activity, and the EPA therefore targeted the completion of the synfuels program for the 1984-86 time period, which would allow time for application of our results to plant designs.

So, the EPA's program started rolling in needed data, ERDA/DOE's program started rolling out development concepts, and--what nobody had anticipated--OPEC continued rolling up crude oil prices at an ever-increasing rate. Oil which had cost us $3.50 per barrel in mid-1973 was over $12.00 per barrel in mid-1977. It rose to over $18.00 per barrel in mid-1979 and was almost $32.00 per barrel in June of this year. This escalation has had two major effects: the Federal government, seeing the continually climbing monthly cost of supporting our crude oil demands through imports and recognizing the damage being done to both our domestic and foreign economic positions, made a decision not only to support synfuels commercialization, but also to establish a means of speeding permit and regulation compliance by developers. The organization proposed to handle these tasks was the Synfuels Corporation.

Meanwhile, entirely separate from these legislative activities, a number of commercial interests noted that the economics of operating large-scale, coal-to-gasoline or methanol plants became favorable and indicated a reasonable return on investment at retail unit prices of $1.00 to $1.25 for gasoline at the pump. As a consequence, a series of completely independent, privately financed synfuel projects were announced, ranging over the major coal seams of the country, and with schedules indicating operation in the 1984-88 time period.

I said earlier that our programs were targeted for completion in about the same time period. It follows that there is no way that a plant that starts operating at the time that our program is completed could possibly utilize our input or data, and the controls on that plant's waste streams would probably be based upon best engineering judgement. Furthermore, neither our regional permit offices nor the local state and county offices would have had a sound basis for evaluating the permit applications submitted for that plant. Again, best engineering judgement would have been applied in the evaluation process. It was, therefore, very clear that the EPA needed both a means of dealing with accelerated projects and a basis for rationally and objectively evaluating forthcoming plant permit applications.

Both of these needs represented areas in which the "traditional" EPA approaches could not be applied. Simply stated, our data acquisition and analysis program was not complete, and, therefore, we were not in a position to write firm "traditional" regulations covering waste discharges to all media. Furthermore, the EMB charter contained the option of selecting and recommending certain environmental and other regulations for executive branch set-aside, and we really didn't have sufficient data to effectively argue all of the set-asides.

To address both of these needs, the EPA administrator created operational arms for the use of the existing, formerly advisory, EPA Energy Policy Committee. The first of these, the Priority Energy Project Group focused on the development of a working relationship with the EMB and had four major objectives:

First, the Group would draft EPA procedures and guidance for developing regulations in support of the EMB and for performing as an accelerator of designated priority energy projects. Second, it would be responsible for the development of a system for tracking permit processing information, from submittal through approval or rejection. Third, it would provide information on EPA permitting procedures, thereby influencing the development of EMB procedures and assisting both the applicants and the permitting agencies in understanding the total process. Finally, the Group would serve as EPA's principal liaison with the EMB.

The second recently created working arm of the EPC is the Alternate Fuels Group (or AFG), which has a longer listing of responsibilities involving the Agency's regulatory, permitting, and research strategy for synthetic and other alternate fuels. This group addresses all synfuels, and its overall goal is to deal with our assessment data gap, both as a current problem and in terms of eliminating it as a problem in the near future. The Group's work plan logically divides into three areas: First, defining where we are and what the Agency position on the major issues is right now. This will be accomplished through publication of our Agency environmental summary paper, which we plan to update periodically.

Second, the group will prepare Agency guidance, in advance of our traditional regulations, on the best available controls for application to synfuel plant waste streams. This will lead to direct input to the EPA regulatory offices in support of their later development of standards for the synfuels industry.

And third, the group will prepare an R, D&D plan for the overall synthetic fuel program under the Office of Research and Development. This plan, to cover approximately a 5-year period, will address the options, priorities, and means of filling the data gaps and supporting the expeditious development of regulations.

I'd like to drop back to the second element of the AFG's work plan. Since this area--that is, the early guidance--is in current demand, I think it's worthwhile describing where we are in more detail.

To assist in accomplishing its work assignments, the AFG has defined four Working Groups, covering the major synfuel product areas. The areas are Gasification/Indirect Liquefaction, Direct Liquefaction, Oil Shale, and Biomass. Each of these Working Groups is drafting guidance in its particular area; all are working to virtually the same outline and format requirements; and all are treating the shared or common technology areas in the same fashion. For example, the impact on plant costs and operating economics is being handled in basically the same way by all groups.

The product guidance will be Agency guidance and will cover all media plus toxic substances and radiation. It will be approved for release by all of the responsible EPA Program Offices as Pollution Control Guidance Documents, or PCGD's. There are three principal target of this guidance. First are the permit reviewers, both in the EPA regional offices and in the comparable State government agencies. Second are the process developers or permit applicants who want to construct synfuel plants: And third are the regulatory offices, which will utilize the data base as an input for standards preparation.

The technical approach being taken by all Working Groups is, in brief, to collect and analyze all available environmental and process data in order to synthesize Agency positions on the best available control approaches achievable at a reasonable cost. The PCGD's will present the available process characterization and control data and the analyses utilized in formulating guidance as an appendix. The presentation of the data base will enable the regulatory offices to evaluate issues (such as how to handle discharges of potentially dangerous but presently unregulated pollutants) and aid them in deciding how and when to develop standards. It should also serve to convince system developers that all reasonable control options have been considered and to show interested environmental groups that the permitting offices have the tools needed to protect the environment through the recommendation of specific controls. Additionally, through the implementation of a multicycle review process, the comments and criticism of key industry personnel are being obtained as the PCGD's evolve through several draft stages. This direct participation will, we hope, further serve to convince industry of the thoroughness of our approach and that it is in their best interest to use the PCGD recommendations and guidance in their designs and permit applications.

I don't want to give the impression that we are rapidly constructing some boxes and at the same time trying to convince a number of interested groups that they'll be happy in them--not so at all.

The PCGD's will provide detailed guidance on the best control practice (a single control) for each stream, plus provide information on other approaches relative to cost, energy requirements and residuals. In additional, for those streams considered to be significant environmental problems or whose control can have major cost impacts, one or more options for achieving greater pollutant content reductions or lesser cost will be presented.
Options which combine controls between process segments or utilize waste materials (both gases and liquids) as plant fuel will be included. And for everyone's benefit, a detailed "How-to-use-the-PCGD" section, with examples, will be provided.

So, as you can see, the boxes are designed to be comfortable for everyone and to cover everyone's needs as best we can at this point in time. Naturally, we'll update the PCGD's as additional data are developed and analyzed in our research program, until firm standards and regulations are promulgated.

As you all know, the provision of the Energy Security Act which would have set up the Energy Mobilization Board was cut out of the Act by an overwhelming majority in the House. The Act, as signed by President Carter, does create a Synthetic Fuels Corporation and does provide for up to $20 billion to fund synthetic fuels projects, but the "fast track" and environmental set-asides have been eliminated.

However, the Agency has been pleased by the responsiveness of the Priority Energy Project Group and Alternate Fuels Group and their various affiliates. We may no longer be under pressure to "fast track," but we have benefited greatly from the effort to look ahead and to coordinate research with regulatory activity and the generators of the emerging synthetic fuels technologies. The interchanges that have occurred over the past several months have given each participant a keener appreciation of the pressures and, sometimes subtle, details that must be mastered, which each of the other participants brings to the table. Having gained this, we are loathe to let it go.

Therefore, although the pace may not be quite as frantic as it was the first six months in 1980, we do intend to continue with the work we have started, work which has been well done.

Now that I have retraced with you the zig-zag path of legislation and administration, I can direct your attention to the much more interesting technical program that will be presented over the next four days. Thank you for coming. I am sure that you will enjoy it.

Session I: GENERAL APPROACH

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IERL-RTP PROGRAM FOR GASIFICATION AND INDIRECT LIQUEFACTION

by

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The synfuels program being conducted by the Fuel Process Branch of EPA's Industrial Environmental Research Laboratory at Research Triangle Park, North Carolina, addresses the potential environmental impacts and control needs of coal gasification and indirect liquefaction technologies.

The purpose of this program is to support EPA's regulatory responsibilities to prevent adverse health or ecological impacts when these technologies reach commercial practice. The overall goal of this effort is to aid in the achievement of an environmentally sound and viable commercial synfuels industry.

At the start of this program, it was recognized that certain program objectives would have to be accomplished if this goal of an environmentally sound synfuels industry was to be achieved; namely:

- The characterization of the multimedia discharges from these technologies,
- The assessment of the discharges' potential health and ecological effects,
- The determination of the degree of control required to avoid adverse impacts,
- The evaluation and applicability of existing control techniques,
- The identification of new control technology needs,
- The development and/or support in the development of these new needed control processes.

In 1974, the initial program effort was directed to the development of evaluation approaches and identification of potential opportunities for data acquisition. Due to the complexity of the technologies being addressed, the lack of facilities and information, and the need to undertake broad multimedia evaluations, it was decided to develop contractual "centers of expertise." These centers would provide the technical expertise that could not be developed in-house due to limitation of personnel.

Since coal conversion technologies were only in the development stage in the U.S., and since the chemical breakdown of the coal structure results in the generation of aromatic organic compounds among which are known carcinogens, the program was based on obtaining sufficient data to identify and evaluate the total environmental effects of the discharges rather than to focus on EPA's currently regulated pollutants only.

The program was organized into four major areas:

- Environmental Assessment,
- Control Technology Development,
- Control Research Facilities,
- Methodology Development.

Environmental Assessment involves the evaluation of technologies, data acquisition, interpretation of results, projection of environmental effects, and identification of control needs.

Control Technology Development involves the evaluation of the availability and applicability of existing control technologies to meet the requirements identified by the Environmental Assessment. Additionally, operational information, reliability, and modification capabilities are evaluated. This effort has been dropped as a responsibility in the federal sector for control technology development, and demonstration was shifted to the Department of Energy.

Control Research Facilities were developed to provide information concerning the viability of control technologies and to characterize their multimedia discharges. These facilities also offer capabilities to evaluate modification of control techniques and the testing of new approaches. To date two such facilities have been constructed and are operating:

- Gasifier with gas cleaning and acid gas removal capabilities. This facility is modular and flexible in design, allowing evaluation of different systems.
- Water treatability facility to evaluate methods for treating the various wastewaters that would be generated by synfuels plants.

Methodology Department provides uniform procedures that result in consistent, cost-effective data gathering and interpretation. These procedures range from sampling/analytical techniques through data interpretation to report format. The procedures as originally developed by the

Laboratory and other EPA organizations are continually reviewed and refined.

During this initial phase of the program, considerable effort was spent in identifying availability and viability of sites for future data acquisition efforts. Due to lack of commercial U.S. facilities, plants in England, Poland, Yugoslavia, Turkey, and South Africa were surveyed for potential interest in future evaluations. These sites included the Lurgi, Koppers-Totzek, and Winkler gasification technologies.

The second phase of this program involved the actual data acquisition, interpretation of results, and identification of projected control needs. Domestically, various low Btu gasifiers were evaluated including Chapman-Wilputte, Wellman-Galusha, and Stoic. Foreign sites included a Lurgi plant in Yugoslavia and a Koppers-Totzek plant in South Africa. Results from these evaluations will be presented during this symposium. The Yugoslavian evaluation was by far the largest effort and was jointly supported and conducted by U.S. and Yugoslav experts.

The third phase of this effort which we are now well into is the compilation of data acquired to date into a data base to support EPA's guidance and regulatory activities. The Agency is now actively developing Pollution Control Guidance Documents (PCGDs) under the direction of EPA's Alternate Fuels Group. The Fuel Process Branch is involved in the PCGDs relating to low Btu gasification, medium Btu gasification, substitute natural gas, and indirect coal liquefaction.

The PCGDs will provide guidance to protect the environment during the periods preceding regulations promulgation and to avoid costly delays in the commercialization of synfuels processes due to uncertainties regarding environmental control requirements.

The primary purpose of each PCGD is to provide guidance to both system developers and permitting authorities on control approaches which are available at a reasonable cost for the technologies under consideration. The PCGDs are also intended to provide the public with the EPA's best current assessment of the environmental problems posed by the different synfuels technologies and the effectiveness and costs of available controls. This information should (a) assist system developers at the outset in their efforts to design facilities incorporating best available control technologies, and (b) aid permit reviewers in their decision making by delineating likely pollutants and their concentrations as well as available control options. The Agency intends these PCGDs to provide guidance only. The documents have no legal authority, contain no new regulations of any kind, and include nothing that is mandatory.

IERL-RTP efforts to date have shown that many data gaps still exist. Specifically, future work should address the following points:

- There is a tremendous lack of information on the effectiveness, operability, and reliability of control techniques for coal conversion plants. Information of this type needs to be gathered for the whole spectrum of potential pollutants from these plants, not just for those species for which standards or criteria exist.

- There is a need not only to demonstrate existing control techniques for their applicability to coal conversion processes, but also to initiate development of improved methods.

- There is a definite need to develop more information on the health effects of the compounds generated by the breakdown of the coal structure during gasification or liquefaction and to investigate the effects of entire discharge streams upon human health and ecological systems.

EPA/IERL-RTP PROGRAM FOR DIRECT LIQUEFACTION AND SYNFUEL PRODUCT USE

by
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The direct liquefaction program at EPA/IERL-RTP covers those synfuel processes which add hydrogen to coal and form liquid hydrocarbon products directly. The processes currently under study include SRC-II, Exxon Donor Solvent, and H-Coal. SRC-I is also included in the program because of its similarity to SRC-II even though the main product from that process is a solid. The synfuels use program covers products from coal and shale synfuel processing systems.

DIRECT LIQUEFACTION OF COAL

IERL-RTP's work in direct liquefaction of coal includes both the preparation of pollution control guidance documents, as well as involvement in support of EPA Regional Offices.

Preparation of Pollution Control Guidance Documents

Laboratory-prepared EPA pollution control guidance documents are intended to be used by EPA Regions as they evaluate permits, by EPA regulatory offices as they prepare formal regulations, and by process developers as an indication of the extent of pollution control EPA considers appropriate for the evolving synfuel industry.

The documents contain extensive descriptions of the processes and pollutants discharged, and detailed descriptions of control devices that might be applied to various sources. Where appropriate, process design modifications are proposed if they would result in an environmentally and economically more attractive system.

The range of pollutants considered for control includes those currently regulated, as well as those unregulated where chemical and bioassay test data indicate control would be prudent. Synfuel products are also considered in the document to the extent that their on-site storing and handling impacts on the local environment.

IERL-RTP is making every effort to ensure that the best information available is contained in the guidance documents. A work group has been established which has representatives from all EPA's regulatory offices. The Regions are also represented. Representatives from DOE and the process developers in industry participate by providing data and a critical technical review of the accuracy of the technical components of the guidance documents. Extensive reviews, both internal and external to EPA, are planned. Participants will include all regulatory offices, the EPA Science Advisory Board, environmental groups, industry, DOE, and the general public.

The schedule of activities for the next 2 years is shown in Figure 1. The first version of the guidance document will be heavily slanted toward SRC-II. This emphasis is the result of a paucity of data available from the H-Coal and Exxon Donor Solvent (EDS) pilot plants. The guidance document is expected to be updated to reflect up-to-date information on EDS and H-Coal.

Regional Support Activities

The second important use of guidance documents is as an aid to EPA Regional Offices as they evaluate permit applications. Regions III and IV have, or will shortly receive, Prevention of Significant Deterioration (PSD) applications for SRC-II and SRC-I, respectively. They also have received and been asked to comment on Environmental Impact Statements for these two processes. Since the guidance documents are not yet available to the Regions, IERL-RTP is providing ad-hoc assistance in the evaluation of permit applications and the review of impact statements.

Inputs provided to date have been mainly identification of data deficiencies in the applications or impact statements. In limited cases, where specific control technologies have been identified by DOE, sufficient background material has been pulled together to make an analysis of the appropriateness of the DOE selection. Evaluation of specific control systems has generally not been the

FIGURE 1

DIRECT LIQUEFACTION POLLUTION CONTROL GUIDANCE

DOCUMENT SCHEDULE

ACTIVITY MILESTONES	Date
Program Kickoff	6/12/80
Draft chap. on Source Assessment	10/31/80
Draft chap. on Control Technology Options	1/15/81
Draft chap. on Environmental Impacts	2/27/81
Draft chap. on Recommended Control Practices	2/27/81
Vol. III Draft	2/27/81
Draft, Vol. II & Vol. III revised to DLWG, OEET, DOE, IRC review	4/15/81
First Draft, Vol. I to DLWG, OEET, DOE, IRC review	4/15/81
Receive review comments	6/ 8/81
Review with OEET & contractors	6/15/81
Review with OAQPS, OWPS, OSW, DOE, IRC, etc.	6/15-29/81
Review with AFG	6/29/81
Second Draft Vol. I-III to DLWG, OEET	8/24/81
Second Draft Vol. I-III to AFG, SAB, DOE, IRC	9/ 7/81
Receive comments on 2nd Draft	10/26/81
Review AFG/SAB/DOE comments with DLWG	11/ 6/81
Third Draft Vol. I-III to DLWG/AFG/SAB	1/15/82
Third Draft Vol. I-III to EPC	1/31/82
Revise Third Draft, to DLWG/AFG	3/ 1/82
Federal Register Notice of Public Forum	3/15/82
Public Forum	5/15/82
Receive Public Comments	6/15/82
Review Public Comments with DLWG	7/ 1/82
Recommend Comment Incorporation to AFG	7/15/82
EPA approval of comment incorporation	8/ 1/82
Final PCGD to OEET/DLWG/AFG/DOE/EPC	9/ 1/82
Transmit to printer with EPC approval	9/15/82

Abbreviations:

- DLWG - Direct Liquefaction Working Group
- OEET - Office of Environmental Engineering & Technology
- IRC - Industrial Review Committee
- AFG - Alternate Fuels Group
- SAB - Science Advisory Board
- EPC - Energy Policy Committee

prime task, however, because DOE has not progressed very far with detailed specifications for control technology components of the SRC-II system.

West Virginia personnel are being assisted in their evaluation of a construction permit request from DOE. The same problem occurs here: it is difficult, if not impossible, to estimate the effectiveness of the environmental control system when it has not been specified in sufficient detail. These ad-hoc support activities are expected to continue indefinitely. As a matter of routine, all inputs to Regions and States are channeled to EPA's regulatory offices for comment.

IERL-RTP expects to continue its direct liquefaction assessment program for several years. Major items of concern which have been identified and will be investigated include the nature and toxicity of emissions from heavy ends processing, the feasibility of zero discharge water systems, the determination of the toxic and leachability characteristics of gasifier solid wastes, and factors which affect stream time for sulfur cleanup systems. IERL-RTP expects to spend about $2 million per year in this assessment and control technology evaluation area.

SYNFUELS USE PROGRAM

EPA's Synfuels Use Program has been underway for approximately 6 months. For the past few years much emphasis has been placed on determining the environmental impact of synfuel production facilities. That is certainly a worthwhile objective but it is clear that, at least in the near term, the most significant human exposure to synfuel related materials will come from the transport, storage, and use of the products. Very little attention has been given to this important aspect of the evolving synfuels industry. The major objective of the program is to estimate the human exposure associated with various uses of synfuels and to estimate the toxicity of the materials to which people are exposed. These estimates are of considerable importance to EPA's Office of Pesticides and Toxic Substances as they make decisions related to the application of the Toxic Substances Control Act to the synthetic fuels industry.

To date IERL-RTP has completed a rough-cut market penetration projection for the various synthetic fuels. The study was limited to coal and shale oil products because of their nearer term probability for development and uncertain environmental status. This market penetration projection is complemented by a summary of all completed and on-going human effects research programs which deal with synthetic fuels. An analysis of these two studies, planned for this Fall, will result in a specification of the types of data still needed to allow estimation of the risk associated with exposure resulting from synfuels use. Priorities for completing the effects work will be established based on the exposure estimates and estimates of the toxicity of the materials in question: materials of higher exposure or higher toxicity will be given top priority. These data requirements and priorities will be sent to DOE, synfuels developers, and EPA research laboratories with recommendations for implementation. All the effort on risk estimation has been closely coordinated with EPA's regulatory offices. It is very important that the data generated be of the quality and type that is directly useable for the formulation and promulgation of regulations.

EPA's Synfuels Use Program over the next few years will continue to evaluate the evolving synfuels industry especially from the view of risk to human health from new uses of the products or new ways of incorporating synfuels into the existing production system; for example, blending of synthetic and natural crude oil in refineries. One current major deficiency is that very little effects work is underway to evaluate the toxicity of synfuel combustion products. As these problems become more well defined, IERL-RTP will be conducting research to reduce the severity of the impact of the use of these products. IERL-RTP will also begin to look at other environmental impacts such as ecological effects, regulatory options that are available for dealing with the problems of synfuel use, and synfuels that are preferable for development from social, economic, and environmental points of view. IERL-RTP's budget for this program is approximately $1 million per year for the next 5 years.

UPDATE OF EPA/IERL-RTP ENVIRONMENTAL ASSESSMENT METHODOLOGY

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Abstract

EPA's IERL-RTP has developed a systematic approach for performing each aspect of environmental assessment to allow for consistent data gathering and interpretation. Environmental assessment requires the determination of contaminant levels associated with point source discharges and comparison of those determinations with target control levels. Procedures for conducting phased environmental assessments involving Level 1 and Level 2 chemical analyses and bioassays have been formalized. Multimedia Environmental Goals (MEGs) reflecting potential toxicity of specific chemicals provide the target values used for comparison. Source Analysis Models (SAMs) delineate discharge stream severities based on the components present and mass flow rates. The Level 1/Level 2 chemical analysis approach has been coupled with the categorical system for organizing chemicals addressed by MEGs.

The computerized Environmental Assessment Data System (EADS) at IERL-RTP is used to store environmental assessment data and to provide links between characterization and target goals. Eventually, EADS will be used to automate large portions of the assessment data analysis.

UPDATE OF EPA/IERL-RTP ENVIRONMENTAL ASSESSMENT METHODOLOGY

INTRODUCTION

In support of the Environmental Protection Agency's standards-setting and regulatory functions, information is needed in response to the question, "To what extent does a particular industrial source cause pollution damage to the environment?" Answers to this question involve a complex mix of information from numerous scientific and engineering disciplines. To provide a structured and cost-effective approach to assembling and interpreting this information, the concept of an environment assessment has been developed and procedures established for its implementation.

An assessment of the pollution potential of an industrial source is necessarily complex because it addresses many types of industrial discharges into all environmental media (air, water, land). The approach to environmental assessment developed by the EPA's Industrial Environmental Research Laboratory at Research Triangle Park, N.C., is to divide the work to be accomplished into discrete steps with the results of each completed phase providing guidance for succeeding efforts. Four main advantages of such a formal approach are that:

1. Thorough screening ensures coverage of potential problems identifiable on the basis of the existing effects data.
2. Attention is focused on the chemical constituents of highest concern.
3. Many unnecessary samples and analyses are eliminated by virtue of the guidance provided by the results of previous phases.
4. Results obtained from different sources by different investigators are directly comparable.

IERL-RTP began to develop this structured approach to environmental assessment about 5 years ago. By then, the need for a common methodology was recognized clearly, for experiences since 1969 with Environmental Impact Statements (required under the National Environmental Policy Act) had already demonstrated the wide variation of outputs that could occur in assessing possible environmental impacts. Predictably, when the first specific procedures and practices to be followed in environmental assessment were spelled out in an IERL-RTP report in 1976[1], the approach was met with considerable resistance from contractors. Some of that continues, but the advantages of a common methodology are becoming more apparent as the volume of collected data grows. Over the last 4 years, numerous modifications and additions have been made in the various segments of the methodology as a result of continuous research and in response to comments from the users. In many cases, those applying the procedures are also the methodology developers since the development of the methodology has proceeded concurrently with its implementation in the preliminary environmental assessments conducted by IERL-RTP. Although the evolution of the methodology continues, the overall approach appears to be accomplishing its initial objectives.

Many of the conclusions that will be presented in papers at this symposium will be expressed in terms defined by the IERL-RTP environmental assessment methodology. Because of the common approach, results from the different studies are comparable, even though certain specific procedures vary to accommodate unique problems encountered in each assessment program. This paper describes briefly the IERL-RTP environmental assessment methodology and its various components at their present level of development. It is hoped that this presentation will contribute to a better understanding of the specific technology assessments.

APPROACH

There are five major components of the IERL-RTP environmental assessment methodology:

- Technology background development
- Sampling and analysis
- Environmental goals
- Impact analysis
- Control technology evaluation

Three levels of effort are defined for data acquisition involving sampling and analysis. Level 1 was designed for initial screening or survey of potential pollutants, and its goal is the comprehensive survey via chemical and bioassay analyses of all discharges to the environment. Chemical analyses at this level are primarily directed toward the identification and semiquantitation of categories of compounds present in the discharge streams. Level 2 focuses on the streams and compound classes found to be of major concern in Level 1. Analyses are aimed at identifying and quantifying the specific chemicals present. Level 3 is presently in the conceptual planning stage, and will involve selectively monitoring the pollutants of concern identified in Levels 1 and 2 and determining their variation with time and process operating conditions. Evaluation of the effectiveness of pollution control devices in place at the test site would be a product of Level 3 data collection.

TECHNOLOGY BACKGROUND DEVELOPMENT

Much can be learned about probable pollution problems associated with a given process or technology by reviewing existing information and applying scientific and engineering experience. Consequently, the first step in an environmental assessment is to obtain all the pertinent literature available. Attention is given to the current and projected status of the commercial development of the technology, the varieties of process units applicable, the process chemistry, and the nature, quantities and points of discharge of waste streams and fugitive emissions (leaks, spills, etc.). Such literature reviews usually reveal information gaps that render difficult or impossible an adequate determination of the pollution potential of the technology and associated environmental damage. Both the selection of the facilities to be tested and the determination of the amount and types of data to be collected are directed by the information derived from the literature review.

Once a particular facility has been selected as a test site, a detailed engineering evaluation of existing data for that facility is made, and tentative sampling points are selected. Plant layout, temperatures, pressures, flow rates, and other plant operation data are obtained in a pretest site survey. The final test plan states what, how, and when required sampling and analysis activities will be performed. It informs the sampling crew of optimum sampling locations and conditions and of unusual circumstances that may be encountered during the sampling process. Sample preservation techniques and procedures for handling and shipment of samples are also discussed.

SAMPLING AND ANALYSIS--LEVEL 1

Sampling and analysis procedures for Level 1 environmental assessments are set forth in the second edition of the IERL-RTP Procedures Manual.[2] This manual supersedes the 1976 manual. Although the overall approach to sampling and to organic and inorganic analysis at Level 1 remains unchanged since 1976, incremental changes in the procedures have vastly improved their effectiveness and reliability. In accordance with a guideline issued by IERL-RTP, all IERL-RTP contractors and grantees performing environmental assessments are required to use the procedures in the revised manual. The manual addresses quality control/quality assurance as well as the specific analytical and sampling techniques to be used. New developments in the areas of sampling, analysis, and quality control are reported in a quarterly report called "Process Measurements Review." This widely circulated publication of the Process Measurements Branch of IERL-RTP announces revisions in the procedures manual as they are adopted.

It should be emphasized that the objective of Level 1 data acquisition is to provide a data base to allow prediction of the pollutants and streams of concern. Once this data base is in place, as it is presently for coal-fired power plants, it is appropriate to pursue Level 2 investigations. Thus, a complete site-specific Level 1 study need not precede every Level 2 effort. However, even for well-developed bases, occasional Level 1 or partial Level 1 surveys can prove informative[3].

Level 1 Sampling

Level 1 sampling programs are designed to permit efficient collection of all substances in a stream, making maximum use of existing stream access sites. Samples from each process feed stream and each process effluent stream must be provided for the Level 1 assessment. Multimedia sampling strategies are organized around five general types of samples: (1) gas/vapor, (2) particulates/aerosols, (3) liquids/slurries, (4) solids, and (5) fugitive emissions. Particulate from gas streams is sized (four fractions recovered) in the operation employing the Source Assessment Sampling System (SASS). The availability of the Fugitive Ambient Sampling Train (FAST) has improved the collection of airborne fugitive emissions. Specifics of the operation of the SASS and the FAST are discussed in the second edition of the Procedures Manual.

Sample size requirements for Level 1 are established to ensure that analytical results will supply meaningful data. Procedures and equipment to be used for various stream types are also specified. Table 1 indicates the

TABLE 1. GUIDELINES FOR LEVEL 1 STREAM SAMPLING[2]

STREAM	SAMPLE SIZE	LOCATION	SAMPLE PROCEDURE
Vapors with or without particulate	30 m^3	Ducts, stacks	SASS train
Liquid	20 L*	Lines or tanks	Tap or valve sampling
		Open free-flowing streams	Dipper method or composite sampler
Solids	1 kg	Storage piles	Coring
		Conveyors	Full stream cut
Gas (reactive) organic material with bp < 100° C; N and S species	2 L	Ducts, stacks, pipelines, vents	Grab sample (glass bulb)
Gas (fixed) O_2, N_2, CO_2, and CO	10-30 L	Ducts, stacks, pipelines, vents	Integrated bag sample
Fugitive emission	2,496 m^3	Ambient atmosphere	FAST or modified hi-vol

*May need additional sample volume depending on the nature of the biotesting employed.

IERL-RTP guidelines for Level 1 stream sampling based on the detection limits of the analytical techniques subsequently employed.

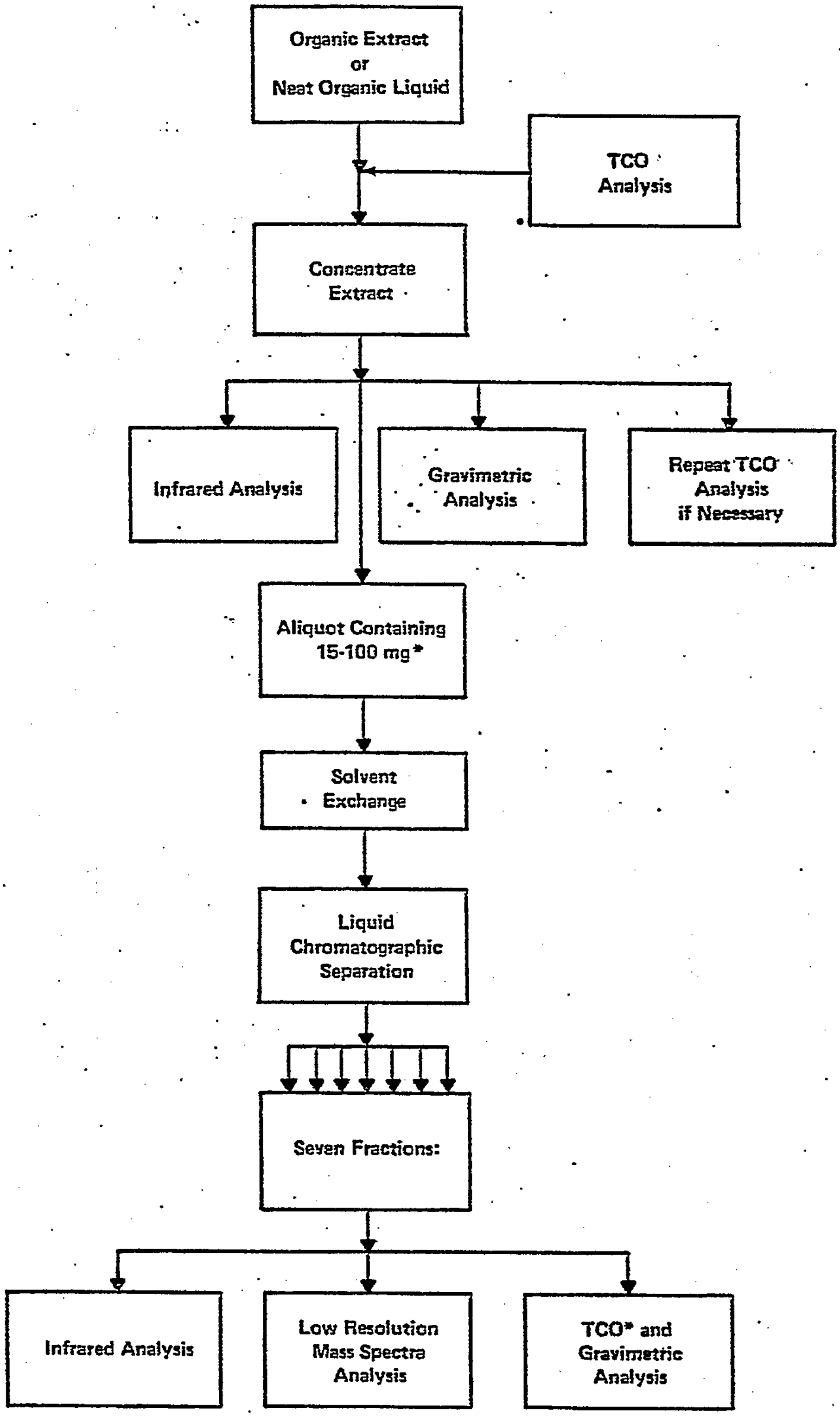
Level 1 Chemical Analysis

Samples collected from a facility are subjected to a Level 1 chemical analysis designed to characterize both organic and inorganic constituents. Solid samples may also receive a morphological examination. The objective of Level 1 organic analysis is to isolate and semiquantitate (accurate to within a factor of three) the predominant classes of organic compounds present in a given sample. Figure 1, adapted from Reference 2, depicts the current procedure set forth for Level 1 organic analysis. Quantitative information is provided by gas chromatography (total chromatographable organics, TCO) and by gravimetry (GRAV). Qualitative and semiquantitative information is obtained from conventional liquid chromatography (LC), infrared spectrometry, and low resolution mass spectrometry (LRMS). A liquid chromatographic separation based on polarity is employed, which results in seven fractions. Categories of chemicals expected to elute in each fraction are recognized, and this information is used in interpreting the LC data.

Inorganic species determined in the Level 1 program include certain inorganic gases; the major, minor, and trace elemental constituents; and selected anions. Inorganic gases are measured at the test site using gas chromatographic, spectrometric, and titrimetric methods. Elemental and ion determinations are performed on both solid and liquid samples in an off-site laboratory. Ion chromatography or commercial test kit procedures are employed for ion determinations. Elemental analysis is accomplished by spark source mass spectrometry (73 elements) and atomic absorption spectrometry (for mercury). It is recognized that analyses by spark source mass spectrometry are better for some elements than for others, but for Level 1 screening purposes the technique is sufficient. More precise determinations may be provided at Level 2.

Level 1 Biological Analysis

While chemical characterization of a sample identifies known hazardous chemicals, biological tests provide complementary information for mixtures whose health/ecological effects are unknown. Biological tests conducted in a Level 1 effort involve short-term screening tests designed to determine the



*If less than 15 mg is recovered, go to LRMS.

Figure 1. Organic analysis methodology.[2]

health-related and ecological effects of the samples.[4,5] The tests to indicate potential health-related effects include the use of both in vitro and whole animal bioassays designed to detect evidence of any toxic or mutagenic response in the test organisms. Ecological tests measure the response of aquatic and terrestrial organisms to the pollutants and include the use of algae, vertebrate and invertebrate animals, land plants, and insects. The revised Level 1 Bioassay Procedures Manual is expected to be made available this Fall from EPA. The specific bioassay tests used in Level 1 screening are indicated in Table 2, updated from Reference 5 to reflect the current bioassay protocol procedures from the revised manual.[6]

The bioassays for Level 1 screening constitute a minimum set of cost-effective tests to evaluate the potential biological effects of a sample. The tests were chosen after extensive evaluation and validation and reflect experience in three pilot studies and other selected applications.

INTERPRETATION OF LEVEL 1 DATA

In the phased approach to environmental assessment, Level 1 test data need to be interpreted so that pollutant categories and waste streams can be evaluated with respect to their potential environmental insult. Such an interpretation of the data will lead to a decision as to what Level 2 tests, if any, should be conducted to better characterize the problem streams. In order to perform this evaluation, it is necessary to have a set of environmental criteria against which the chemical test data can be compared. Criteria which have been developed for this task are referred to as Multimedia Environmental Goals (MEGs).[7,8,9] The procedure designed to guide the systematic interpretation of Level 1 chemical analysis involves a source analysis model called SAM/IA introduced in 1977.[10] (A revised version of SAM/IA is expected to be available in Spring of 1981.[11]) Interpretation of bioassay data has also been systematized using rankings of responses from the various tests performed.

Two major outputs desired from a Level 1 test effort are (1) the ranking of pollutant classes within a stream and (2) the ranking of discharge streams. Both rankings are based on potential adverse environmental effects.

TABLE 2. LEVEL 1 SCREENING BIOASSAYS

HEALTH EFFECTS TESTS

TEST	EFFECT	DESCRIPTION	TEST OUTPUTS
Microbial Mutagenesis (Ames Test)	Mutagenesis	Genetically sensitive strains of microorganisms are exposed to various doses of sample with and without metabolic activation.	Mutagenic response is measured relative to controls.
Cytotoxicity	Cellular Toxicity	Selected cells (RAM, CHO, or WI-38) are exposed to various doses of sample, then various endpoints are measured.	An index of functional impairment, toxicity, and metabolic change is established relative to controls.
Rodent Acute Toxicity (RAT Test)	Whole Animal Toxicity	Rats or other rodents are fed a quantity of sample, then observed daily for adverse symptoms over a 14-day period. The experiment is terminated with a necropsy exam.	Inventory of pharmacological and gross physiological effects in a whole animal system.

ECOLOGICAL EFFECTS TESTS

TEST	EFFECT	DESCRIPTION	TEST OUTPUTS
Algal Growth Response	Algal Growth Inhibition or Promotion	Cultures of selected marine and/or freshwater algae are used to gauge reaction to sample or dilution thereof.	Growth response measure—stimulation or inhibition.
Aquatic Animal Exposure (Static Acute Bioassay)	Toxicity to Fish or Daphnia	Select marine and/or freshwater fish and Daphnia are exposed to a graded dilution series of samples.	Gross index of toxic potential to representative animals.
Plants (Stress Ethylene and Root Elongation)	Stress or Toxicity to Plants	Tests in these three areas are being evaluated.	Effects on plants.
Insect	Toxicity to Drosophila		Effects on insects.
Bioaccumulation	Potential Accumulation	HPLC procedure for evaluation of occurrences in fatty tissue.	Number of components that accumulate. Accumulation potential of each component.

Multimedia Environmental Goals (MEGs)

MEGs are chemical-specific goals expressed as concentrations in air, water, and land (or solid waste). Separate values reflect potential human health effects and potential ecological effects. Two types of MEGs are distinguished--ambient goals (AMEGs) and discharge goals (DMEGs). AMEGs are target concentrations of individual chemical species in the ambient environment to which receptors (i.e., human populations or ecological systems) may be exposed on a continuous, long-term basis. DMEGs represent target concentrations for contaminants in undiluted waste streams. It is assumed that receptors would be exposed only for short intervals to DMEG concentrations.

Chemicals for which Federal standards or guidelines have already been established or proposed are assigned MEG values reflecting the most stringent standards or guidelines. Otherwise, both AMEGs and DMEGs are derived from available toxicity data. Simple mathematical models based on worst-case assumptions are used to transform the raw data into the needed concentration goals for air-, water-, and land-based pollutants. The approach used to generate MEGs for chemical pollutants is illustrated in Figure 2.

Background information is compiled for each chemical and supplied with the recommended set of MEG values. MEGs have been established for approximately 600 chemical substances, and the list is continually updated and expanded. Chemicals addressed by MEGs are grouped in pollutant categories to facilitate their use in Level 1 data interpretation (since Level 1 data are expressed as chemical categories quantified in each LC fraction).

It should be emphasized that the development of MEGs is not related to Standards setting. MEGs are established as criteria for interpretation of environmental assessment data, which necessitates ranking a large number and variety of chemicals, including many nonregulated pollutants.

Source Analysis Model, SAM/IA

To rank the pollution potentials of components within a single stream, one compares the measured stream concentrations to respective DMEG values. A difficulty is that DMEGs are species-specific, whereas Level 1 generally reports only the concentrations of categories of compounds. To circumvent this problem, the entire concentration of a class of compounds found to be present is compared to the lowest DMEG for a chemical in that category. This ratio is called the discharge severity (DS) of the component.

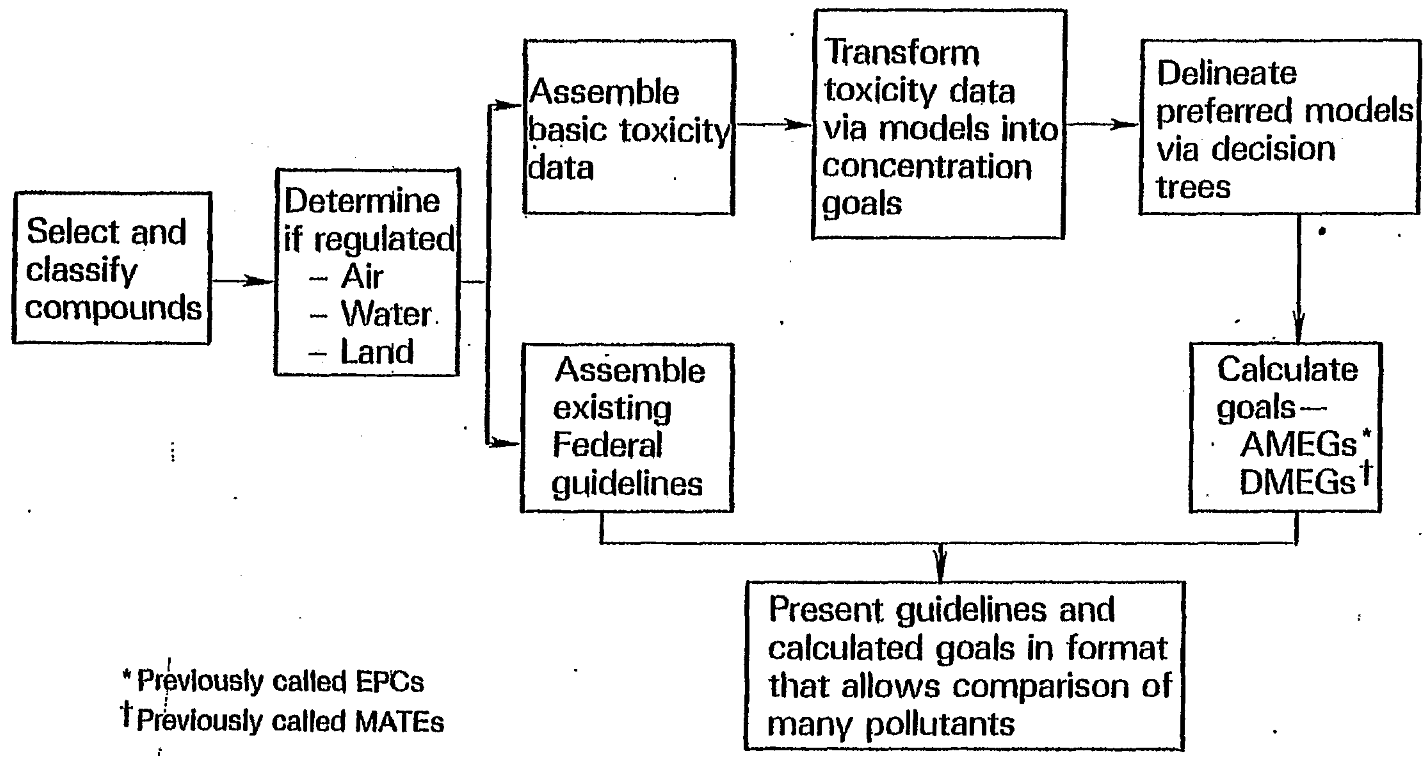


Figure 2. Approach for chemical pollutant MEGs.

$$DS_i = \frac{\text{(component concentration in stream)}}{\text{DMEG}}$$

If good scientific evidence exists to eliminate the most hazardous species from consideration, the next most hazardous species is selected, and so on. In general, components or classes of compounds with discharge severities greater than unity are considered environmentally significant. Repeating this procedure for every category of chemicals found in the stream allows the ranking of these categories on the basis of potential environmental damage. Discharge severities for all components are summed to give a total discharge severity (TDS) for the stream.

$$TDS = \Sigma DS_i$$

In comparing the potential environmental harm of different waste streams using the DS approach, both the stream compositions and mass flow rates must be considered. Therefore, a total weighted discharge severity (TWDS) is defined as the product of the stream mass flow rate and the summation of the component DS_is in the stream.

$$TWDS = \text{(stream mass flow rate)(TDS)}$$

Comparison of the TWDS for different streams that are of the same medium allows comparison and ranking of the streams on the basis of potential environmental insult. Streams with high TDS levels and those that are ranked high using the TWDS as criteria are candidates for Level 2 sampling and analysis.

Bioassay Data Interpretation

Further indication of the potential environmental harm associated with a waste stream is supplied by the biological tests. In Level 1 these tests are short-term bioassays for the detection of acute biological effects. Evaluation of these data is based on the maximum applicable dose for each biological test; i.e., the maximum amount of a substance which can be administered in a given bioassay due to experimental limitations. Test results are ranked as high, moderate, low, or nondetectable biological responses. Table 3 (taken from Reference 5) gives the response ranges and maximum applicable doses for several of the Level 1 bioassays. A positive Ames test or toxic responses from any two other tests suggest a need for Level 2 information. To aid in the interpretation of the bioassay data , IERL-RTP released a report on data formatting for Level 1 in April 1979.[12]

TABLE 3. RESPONSE RANGES FOR RANKING OF VARIOUS BIOTESTS[5]

ASSAY	ACTIVITY MEASURED	MAD	RESPONSE RANGES: HIGH	MODERATE	LOW	NOT DETECTABLE
Health Tests						
Ames	Mutagenesis	5 mg/plate or 500 μL/plate	<0.05 mg or <5 μL	0.05-0.5 mg or 5-50 μL	0.5-5 mg or 50-500 μL	ND at >5 mg or ND at >500
RAM, CHO, WI-38	Lethality (LC_{50})	1,000 μg/mL or 600 μL/mL	<10 μg or <6 μL	10-100 μg or 6-60 μL	100-1,000 μg or 60-600 μL	LC_{50} >1,000 μg or LC_{50} >600 μL
Rodent	Lethality (LD_{50})	10 g/kg or 10 mL/kg	<0.1	0.1-1.0	1-10	LD_{50} >10
Ecological Tests						
Algae	Growth Inhibition (EC_{50})	1,000 mg/L or 100%	<20% or <200 mg	20-75% or 200-750 mg	75-100% or 750-1,000 mg	EC_{50} >100% or EC_{50} >1,000 mg
Fish	Lethality (LC_{50})	1,000 mg/L or 100%	<20% or <200 mg	20-75% or 200-750 mg	75-100% or 750-1,000 mg	LC_{50} >100% or LC_{50} >1,000 mg
Invertebrate	Lethality (LC_{50})	1,000 mg/L or 100%	<20% or <200 mg	20-75% or 200-750 mg	75-100% or 750-1,000 mg	LC_{50} >100% or LC_{50} >1,000 mg

MAD = Maximum Applicable Dose (Technical Limitations)
LD_{50} = Calculated Dosage Expected to Kill 50% of Population
LC_{50} = Calculated Concentration Expected to Kill 50% of Population
EC_{50} = Calculated Concentration Expected to Produce Effect in 50% of Population
ND = Not Detectable

Streams ranked relatively high in potential adverse health or ecological effects on the basis of chemical composition do not always exhibit a highly positive biological response in the Level 1 bioassay battery and vice versa. This is because the DMEGs may be based on biological responses different from those measured in the bioassays. Also, possible synergistic and antagonistic effects occurring in complex mixtures of substances are often characteristic of waste streams; these effects are not taken into account by the MEG/SAM approach, which assumes that toxic effects of compounds are additive. Therefore, chemical tests and biological assays complement each other and should be run in parallel. The decision to proceed with Level 2 data acquisition should be made on the basis of all available chemical and bioassay information. Later this fall, IERL-RTP's Process Measurements Branch will issue a comparison of the sensitivities of bioassay tests and chemical analyses.[6]

SAMPLING AND ANALYSIS--LEVEL 2

Level 2 sampling and analysis is dictated whenever Level 1 chemistry or bioassay indicates a possible hazard. Level 2 inquiries are directed at the confirmation of Level 1 results and at the identification and quantification of specific compounds whose presence was inferred from the Level 1 categorical analysis.

Level 2 generally requires a sampling and analysis scheme specifically tailored to address questions raised by a Level 1 investigation. The appropriateness of a Level 1 sample or sample extract for a more detailed Level 2 study must be carefully evaluated. Was the Level 1 collection efficiency high enough for the species in question? Is the substance to be analyzed sufficiently stable so as to render still valid the original Level 1 sample? Is the Level 1 sample truly representative of the source over a reasonable timeframe? Would an alternative sampling procedure provide a more interference-free sample? Upon consideration of these and similar concerns, the decision may be made to return to the test site for a second sampling effort. While such a Level 2 sampling effort may be expected to provide more rigorous attention to detail, it generally will not be as extensive as in Level 1 due to the elimination of certain streams and compound classes from consideration.

Level 2 Chemical Analysis

It is not possible or practical to formalize a single effective analytical scheme for Level 2 since each question to be answered at this stage represents a unique case. Analytical methods and/or instruments may be used which are capable of greater selectivity and sensitivity than those employed in Level 1. Procedures manuals addressing organic and inorganic sampling and analysis have been issued by IERL-RTP to serve as guidelines for Level 2 data acquisition.[13,14,15]

Refinement of the Level 2 chemical methodology continues. A document prepared by A.D. Little, Inc., on Level 2 Organics Analysis Applications, soon to be released by IERL-RTP, reports on the validation of Level 2 procedures on actual samples. Also, IERL-RTP will soon issue a report on interpretation of LRMS data, which is intended as an aid for the spectroscopist.[3]

Level 2 Biological Analysis

In some cases, Level 2 biological tests may be as simple as those in Level 1. Other cases may require more elaborate and classical methods. A Level 2 biological test protocol is being developed, which will include subacute and chronic effects and/or fractionation of samples for verification and quantification of results from the Level 1 screening studies.[6]

Interpretation of Level 2 Results

Level 2 analytical results may be interpreted by several different protocols. The usual method is simply to recalculate for each stream the component discharge severities (DS_i) and the total weighted discharge severity (TWDS) using the component-specific information now available. Such an iteration may confirm the Level 1 results or may sufficiently alter the DS and TWDS values to rank the components or streams of major concern differently.

Because Level 1 data are obtained for rapid screening purposes, no effort is made to consider the dispersion of the various waste streams into the ambient environment. At Level 2, such considerations are desirable to better assess the environmental impact of potentially significant streams. Thus, a second method for interpreting Level 2 data involves estimation of the ambient concentration of a chemical, which would result from a particular source stream, and comparison of that ambient level with the AMEG for the chemical.

A Source Analysis Model, SAM/IA, is being developed to relate Level 2 source test data to AMEGs.[11] This approach represents a degree of refinement above the comparison involving DMEGs in that AMEGs are based upon continuous receptor exposures to individual chemicals in the ambient environment. DMEGs represent goals for short-term exposures, and the use of the SAM/IA approach assumes that human or ecological receptors will come in contact with undiluted discharge streams.

The component-specific data acquired by Level 2 sampling and analysis and the interpretation of that data using either of the SAM models thus provide a reasonable basis upon which to assess the environmental impact of a source. Discharges unsatisfactory from a health/ecological standpoint are readily identified so that appropriate pollution control devices may be recommended.

For developing industries, such as synfuels, Level 2 data may be applied in formulating guidance recommendations for permit writers and developers. Level 2 data may influence standards-setting for existing industries, or the data may trigger Level 3 investigations.

EFFECTIVENESS OF THE APPROACH

Assessments of several technologies have been completed using the Level 1/Level 2 methodology. These studies, directed toward the textile industry, ferroalloy processes, conventional combustion, fluidized bed combustion, low-Btu gasification, and other technologies, have been performed by different contractors. The results of the analytical tests, however, may be compared readily because samples were obtained by similar methods and similar laboratory procedures were followed. Also, the analysis data are compared to a similar basis; i.e., the MEGs. Common formats for reporting of assessment results have simplified the comparison of results from different sources.

The Level 1/Level 2 phased approach to data acquisition has been compared to the direct approach for environmental assessment of particulate-laden flue gases. The Level 1 techniques were shown to be effective in narrowing the scope of the investigation with quantitative Level 2 determinations being directed toward the samples and components of highest environmental significance. It was shown that the cost of the phased approach can be on the order of 75 to 50 percent of the cost of the direct approach.[16] The thorough screening provided at Level 1 ensures that problem streams or components do not go undetected.

DATA MANAGEMENT

A data management system is imperative for storing, editing, updating, and retrieving the vast amount of source test data generated by environmental assessment projects. To this end, IERL-RTP has developed the Environmental Assessment Data Systems (EADS) stored in the UNIVAC computer at EPA's Environmental Research Center in North Carolina. The EADS is a comprehensive system of computerized data bases that describe multimedia discharges from energy systems and industrial processes. The data bases are interlinked across media and across industries.[17]

The EADS serves to (1) consolidate the increasing volume of environmental data, (2) provide uniform data protocols, and (3) maintain current information in a readily accessible mode. Four media-specific waste stream data bases are included to address fine particle emissions, gaseous emissions, liquid effluents, and solid discharges. A fifth data base for multimedia fugitive emissions will be added next year. These data bases are designed to permit entry and retrieval of information pertinent to specific tests, sources, processes, control devices, or specific pollutants. Coding forms for data entry are designed to accommodate results from Level 1 and Level 2 chemical and biological analyses.

In addition to the waste stream data bases, there are currently two important reference data bases within the EADS. These are MEGDAT, which stores MEG values and supporting information for MEGs pollutants, and the Chemical Data Table which contains names, synonyms, CAS registry numbers, and MEG ID numbers for almost 2,000 chemicals. A Quality Assurance/Quality Control reference data base for laboratory audit data is projected to be in place in EADS in 1981. An additional reference data base called the Project Profile System will be linked with the EADS soon. This system presently contains profile information from conventional combustion projects but is also designed to manage data from other technology areas.

EADS is expected to provide essential data to several EPA programs, including:

- Environmental Assessment Programs
- Inhalable Particulate Standards Development

- Wastewater Treatability Manual Development
- Evaluation of Control Technology Alternatives
- Industrial Boiler NSPS
- Identification of Hazardous Pollutant Emissions
- Radionuclide Correlations with Particle Size

An IERL-RTP directive, dated May 1978, requires that all sampling and analysis data obtained under IERL-RTP source sampling contracts awarded after June 30, 1978, be entered in the appropriate EADS data base. User's manuals for the existing data bases are available, and specific information requests will be filled by the EADS Manager at IERL-RTP.[17]

Quality Assurance and Control

Agency policy requires participation by IERL-RTP in a centrally directed Quality Assurance Program for monitoring and measurement efforts. The Quality Assurance Plan developed for IERL-RTP fulfills one requirement under the overall program managed by EPA's Quality Assurance Management Staff, Office of Monitoring Systems and Technical Support. The plan is expected to become effective October 1, 1980.[18] Provisions in IERL-RTP's Plan specify that all measurement and monitoring data collected should be of known and documented quality. Throughout the sampling and analysis segments of any environmental assessment, a program of quality control and quality assurance must be followed to ensure the desired accuracy and precision of results. The quality of the data must be acceptable for its intended use. Analytical methods and procedures should conform to EPA approach methodology when appropriate. Customary requirements of good laboratory practice (including preservation of samples, standardization of reagents, and calibration of equipment) must be verified and documented. An independent group working in cooperation with the laboratory personnel may review the laboratory's methods, engage in on-site inspections, provide blind samples for analysis, and duplicate the sample analyses to confirm results obtained by the test laboratory. Audited each year will be 10 to 20 percent of the projects within IERL-RTP.

CONTINUED DEVELOPMENT TRENDS

The phased environmental assessment approach described here has been undergoing continual development since its inception in 1976. The various components of the methodology have been and continue to be subjected to critical review from both inside and outside the Agency. A major peer level review involving 15 panelists was held in January 1979.[19] As a result of such reviews, on-going research at IERL-RTP, and from user comments, refinements continue in the sampling/analysis procedures, data reporting formats, MEGs development, SAM models for data interpretation, nomenclature, bioassays, and mechanisms for data management.

Areas designated for significant future development include:

1. Although the MEGs methodology makes use of most types of readily available toxicity data, the models involve many assumptions and extrapolations. Substantial refinements in the MEGs methodology are planned for Phase II MEGs. Among the modifications will be (a) adoption of the EPA Carcinogen Assessment Group approach for relating concentrations of potential carcinogens to the resulting level of risk in the exposed population; (b) methods to address accumulation and bioconcentration; (c) category-specific models for utilizing animal data; (d) better use of inhalation data; and (e) improved, category-specific models to generate values for solid waste. A review of the Phase II methodology by the EPA Science Advisory Board is being scheduled for 1981.

2. Research is being initiated on health and ecological effects for both individual chemical substances and complex mixtures for which inadequate data exist to derive MEGs. As results of these tests become available, they will be incorporated in chemical information summaries and will serve as the basis for new MEGs values.

3. Efforts are underway to improve models for predicting risks to human health or to the ecology as a function of exposure to hazardous chemicals. Such models will be incorporated in MEG as data for their implementation becomes available.

4. Development of MEGs to account for skin absorption is being considered.

5. Regional and site-specific models are needed to describe the transport of pollutants from point of discharge to receptors in the ambient environment. Transformation models are also needed for use in more sophisticated SAMs.

6. The current environmental assessment methodology does not include evaluation of water parameters such as hardness, total dissolved solids, BOD,

and COD. Because these parameters contribute to the environmental significance of waste streams, MEG values are needed.

7. Level 3 sampling and analysis methodologies need to be formulated.

8. Standardization of laboratory procedures and techniques for interpreting instrumental analysis data (especially LRMS) is essential if data from different laboratories are to be comparable. Thus, analytical information assimilation through IERL-RTP is being emphasized.

Assessing the potential for environmental damage from complex industrial sources is an awesome and formidable task but one which is necessary for providing guidance for pollution control needs, control technology development, health and ecological research, and regulatory/standards-setting activities.

The phased approach to environmental assessment as described in this report is indeed on the right road to fulfilling its primary purpose, namely, to identify in a cost-effective manner the environmental problems associated with industrial processes and fossil energy systems. This methodology is proving especially valuable in predicting potentially adverse effects from emerging technologies, such as coal gasification and liquefaction. In such cases, it is vital to project the likely environmental problems while these processes are still in the pilot or demonstration-scale stages, so that appropriate pollution control measures will be available when the processes are ready for full-scale commercialization.

The IERL-RTP approach to environmental assessment is an iterative and evolutionary methodology, improving as faults are revealed and as new information becomes available. At its present level of development, it provides a valuable framework and focus for environmental assessments.

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THE PERMITTING PROCESS FOR NEW SYNFUELS FACILITIES

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ABSTRACT

The Environmental Protection Agency and the respective State Departments of Health are involved in a joint partnership with shared responsibilities for protecting the environment during the development of synthetic fuels. Legislation in the form of the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Safe Drinking Water Act, and the Toxic Substances Control Act provide the framework for EPA's regulatory responsibilities. The current status of implementing regulations and agency policies vis-a-vis these Acts is provided in this paper. Also, important aspects of State environmental regulations are provided.

Permit applications for synthetic fuels facilities are being received by EPA Regional Offices and by State agencies. Synfuels EISs are being reviewed. Decisions on Best Available Control Technology are being made. These engineering judgements are also discussed in this paper.

THE PERMITTING PROCESS FOR
NEW SYNFUELS FACILITIES

I. INTRODUCTION

EPA has legislative mandates to protect air and water quality, to insure a safe drinking water supply, and to provide for an environment conducive for the enjoyment of man on this earth. In order to accomplish these goals, EPA is involved in a partnership with State and local agencies in the formulation and enforcement of regulations which implement the legislative intent. A major component of the regulatory process is the requirement for industrial operations such as synthetic fuels facilities to obtain a permit for the project. This paper discusses the EPA permit mechanism and its framework (Table 1).

II. LEGISLATION

The general process of legislation/regulations is that the U.S. Congress establishes environmental legislation that provides a framework for State legislation and implementation of Federal and State regulations. State legislation and regulations can be more (but not less) stringent than Federal requirements if a State is delegated responsibility for administering the program in a given media. The Federal government retains an oversight/reviewing role for those programs that are delegated to the States. State legislation in general parallels Federal legislation in form and substance. The following discussion highlights the major aspects of the legislative mandates of EPA as it applies to a synthetic fuels industry.

Clean Air Act

Under the Clean Air Act (PL 95-95) synthetic fuel facilities must: (a) employ Best Available Control Technology (BACT), (b) insure that National Ambient Air Quality Standards (NAAQS) (Table 2) are not violated, (c) not violate the prevention of significant deterioration (PSD) ambient air quality increments (Table 3) (40 CFR 52.21), (d) not significantly degrade visibility in mandatory Class I areas (40 CFR 51), and (e) perhaps obtain up to 1 year of baseline data before applying for a PSD permit to construct and operate. BACT has been defined in the form of allowable emissions limits and control device operational characteristics. Source monitoring, ambient monitoring, record keeping and reporting requirements are also part of the PSD permit. (40 CFR Part 60.7) Also EPA has the ability to request monitoring data, to take enforcement actions, and to take administrative and judicial actions if there are any emergency episodes of pollutants that present an imminent and substantial endangerment to public health.

Table 1

Synfuels Permits

Permit Title	Jurisdiction
1. Environmental Impact Statement (EIS)	Federal
2. Resource Recovery and Conservation - definition and control	Federal
3. Toxic Substances-definition and control	Federal
4. National Pollutant Discharge Elimination Systems (NPDES)	Federal
5. Prevention of Significant Air Quality Deterioration	Federal
6. Soil Prevention Control and Counter-measure (SPCC)	Federal
7. Well Operation Permit (underground Injection)	Federal
8. Erection of Towers or Other Tall Structures	Federal
9. River and Stream Crossing Permit	Federal
10. Major Fuel Burning Installation Approval	Federal
11. Rights of Way Across Public Lands	Federal
12. Scientific, Pre-Historic and Archeological	Federal
13. Sundry Notices and Reports on Wells	Federal
14. Oil Shale Mineral Rights Lease	Federal
15. Detailed Development Plan	Federal
16. Collection of Environmental Data and Monitoring Plan	Federal
17. Exploration and Mining Plans	Federal
18. Mine Safety and Health definition and control	Federal
19. Notice of Intent to Prospect	State
20. Permits for Special Operators	State
21. Permit for Limited Impact Operations	State
22. Permit for Regular Mining Operations	State
23. Storage of Flammable Liquids	State
24. Application for Diesel Permit - Underground Operations	State
25. Operator's Notice of Activitiy	State
26. Hoistman Certificate	State
27. Application to Store, Transport and Use Explosives	State
28. Reservoir Construction	State
29. Water Well and Pump Installation (requirements)	State
30. Air Contaminant Emission Notices	State

Table 1 (continued)

Permit Title	Jurisdiction
31. Land Use Special Permit	State
32. Air Contaminant Emission Permit	State
33. Fugitive Dust Permit	State
34. Open Burning Permit	State
35. Subsurface Disposal Permit	State
36. Discharge Permit	State
37. Waste Disposal Plant Operator Certificate	State
38. Potable Water Supply and Safety Compliance	State
39. Sewage Plant Site Approval and Plant Approval	State
40. Purchase, Transportation and Storage of Explosives	State
41. Oil Facility Inspection	State
42. Boiler Inspection Permit	State
43. Oil Shale Leases	State
44. Ground Water Well Application	State
45. Application for Water Rights	State
46. Mined Land Reclamation	State
47. Permit for Exploration and Excavation	State
48. Open Burning	State
49. Fuel Burning-Sulfur Content Exemption	State
50. Permit to Construct Facilities that are Sources of Air Pollution	State
51. Permit to Construct and Operate Treatment Works	State
52. Water Quality-Definition and Control	State
53. Permit to Operate Solid Waste Disposal Site	State
54. Notice of Intention to Operate or Suspend Operations	State
55. Hoistman-Qualifications	State
56. Escape and Evacuation Plans	State
57. Boiler and Pressure Vessel- definition and control	State
58. Storage of Explosives	State
59. Construction of Wastewater Ponds and Holding Facilities	State
60. Construction of Sewage Facility	State
61. Subsurface Discharges	State
62. Mining Permit, Mining and Reclamation Plan	State
63. Notification of Mining Operations(control)	State
64. Discharges-In Situ Mining	State
65. Construction and Operating Permit for New or Modification to Existing Facility	State

Table 1 (continued)

Permit Title	Jurisdiction
66. Open Burning Permit	State
67. Permit to Dispose of Hazardous Wastes	State
68. Approval for Construction and Operation of Waste Facility	State
69. Construction and Operating Permit for New or Modification to Existing Facility	State
70. Exploration Permit, License to Explore	State
71. Industrial Zone Change	County
72. Conditional Permit	County
73. Mineral Extraction	County
74. Rights-of-Way Approvals	County
75. Solid Waste Disposal	County
76. Rezoning Permit	County
77. Temporary Use Permit	County
78. Conditional Use Permit	County
79. Building Permit	County
80. Special Use Permit	County
81. Sewage Disposal	County
82. Solid Waste Disposal Permit	County
83. Conditional Use Permit	County
84. Sewage Disposal System	County
85. Installation of Utilities in Public Right-of-Ways	County
86. Driveway Permit Across County Roads	County
87. Recreation Forest and Mining Zone (RF&M)-definition and control	County
88. Mining and Grazing Zone (M&G-1) definition and control	County
89. County Requirements in Addition to the Mining and Grazing (M&G-1) and Recreation Forest and Mining (RF&M) Zoning Requirements	County

TABLE 2 NATIONAL AMBIENT AIR QUALITY STANDARDS, UG/M^3***

Pollutant	Averaging time	Primary standard	Secondary standard
SO_2	Annual	80	---
	24 hour	365	---
	3 hour	---	1,300
Particulate matter	Annual	75	60
	24 hour	260	150
NO_x (as NO_2)	Annual	100	100
O_3	1 hour	240	240
CO	8 hour	10,000	10,000
	1 hour	40,000	40,000
Lead	Quarterly	1.5	1.5
HC (non CH_4)	3 hour	160***	160***

* 40 CFR Part 50
** Reference conditions = 760 mm Hg and 25°C
*** Not a standard; a guide to show achievement of the O_3 standard

TABLE 3 PREVENTION OF SIGNIFICANT DETERIORATION OF AIR QUALITY (PSD) STANDARDS*

Pollutant	Averaging time	Maximum Allowable Increase, mg/m^3 Class I	Class II	Class III
Particulate matter	Annual	5	19	37
	24 hour	10	37	75
SO_2	Annual	2	20	40
	24 hour	5	91	182
	3 hour	25	512	700

* 40 CFR 52.21 and 42 USC 7401 et seq section 163.

Notes:

1. Variances to the Class I increments are allowed under certain conditions as specified at Section 165(d)(c)(ii) and (iii) and at 165(d)(D)(i) of the Clean Air Act of 1977.

2. EPA was to have promulgated similar increments for HC, CO, O_3 and NO_x by August 7, 1979; they are under development. Increments for Pb are due to be promulgated by October 5, 1980.

Clean Water Act

The Clean Water Act (PL 95-217) established goals of (a) no discharge of pollutants into navigable streams by 1985, (b) attainment by July 1, 1983, of water quality suitable for protection and propagation of fish, shellfish, and wildlife and provides for recreational use, and (c) prohibition of discharges of toxic amounts of toxic pollutants. The Act contains requirements in sections 402 and 404 for potential permits for synthetic fuel facilities. A National Pollutant Discharge Elimination System (NPDES) permit must be obtained under requirements of Section 402 if water is discharged to a navigable stream (defined as waters of the United States and in fact could be a dry creek bed which flows during runoff). Neither effluent guidelines (Section 304) nor New Source Performance Standards (Section 306) have been promulgated for any synthetic fuels operations. However, in their absence, NPDES effluent limits are established on a best engineering basis. A Section 404 permit must be issued by the Army Corps of Engineers and concurred upon by EPA if any dredge and fill operations take place in a navigable stream (defined for 404 purposes as stream flow greater than 3 cfs). Section 303 of the Act provides the mechanism for establishing water quality stream standards. Plans developed by State Water Pollution Control Agencies must define water courses within the State as either effluent-limited or water-quality-limited. Best management practices (BMP's) to control nonpoint source runoff may be defined via section 208 and 304(e) of the Act.

Safe Water Drinking Water Act

Underground injection control (UIC) regulations proposed on April 20, 1979 (Title 40 of the Code of Federal Regulations (CFR), Part 126)were promulgated in the May 19 and June 24, 1980 Federal Register. These regulations will govern the injection or reinjection of any fluids. Permits (40 CFR 122.36) will be required for in situ operations and for mine dewatering reinjection. Various States require reinjection permits under existing regulations. The basic thrust of the UIC program is to require containment of reinjected fluids. Monitoring (40 CFR 146.34) and mitigation measures (40 CFR 122.42) to prevent the endangerment of the groundwater system are requirements under these UIC regulations.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) will govern the disposal of solid and hazardous wastes generated by a synthetic fuel facility. Criteria for the identification of hazardous wastes were proposed by EPA on December 18, 1978 at

40 CFR, Part 250. Final regulations were promulgated in the May 19, 1980, Federal Register at 40 CFR 261-265. It appears that some high volume-low risk materials will not be considered a hazardous waste. Instead, it will be subject to requirements at 40 CFR 257 (September 13, 1979, Federal Register). A concept of Best Engineering Judgement will govern the disposal of hazardous wastes such as API separator sludge.

Testing of effects, record keeping, reporting, and conditions for the manufacture and handling of toxic substances are being defined under the auspices of the Toxic Substances Control Act (TSCA) of 1976. An inventory of all commercially-produced chemical compounds is now being compiled and was published in May 1979. If a substance is placed on the inventory, it is "grandfathered" from the TSCA pre-market notification requirements. Ten synthetic fuels were identified on this list of 43,000 compounds. However, these ten are being reviewed to determine the validity of their being placed on the list. Being on the list does not "protect" a product from possible control requirements included in Section 8. If a material is found to be a hazard, certain restrictions including labeling, precautionary handling requirements or even a ban on its production may be imposed by EPA.

The final piece of environmental legislation in which EPA participates which is relevant to synthetic fuels is the National Environmental Policy Act (NEPA). EPA reviews, and in limited cases writes, the EIS when a project involves a major Federal action. EPA's role as a reviewer is to comment on the environmental aspects of the project.

EPA's legislation as described above normally provides a permit process mechanism. Companies wishing to construct and operate a synthetic fuel facility must receive a permit from EPA or from the State permitting authority in order for the facility to be operated. A listing of the major permits/clearances necessary for a project appears in Table 1.

III. APPLICABLE FEDERAL AND STATE POLLUTION CONTROL REGULATIONS

Federal and State legislation generally prescribes the establishment of National and State environmental standards for a given media (i.e. air, water, solid waste, etc.). Regulations designed to control emissions/effluents from an individual facility are promulgated to achieve the stated environmental standards. This section briefly describes this concept of standards/regulations. In almost all cases, the standards/regulations concept requires a developer to obtain a permit to construct and operate his facility. It is the intent of EPA to delegate the permit programs to the State.

Air

Regulations to protect air quality exist in two forms-ambient air quality standards and stack emission standards. All EPA regulations are codified in Title 40 of the Code of Federal Regulations. Applicable parts are referred to in discussions of the various regulations below. Pursuant to Section 109 of the Clean Air Act, EPA has established National Ambient Air Quality Standards (NAAQS) for seven criteria pollutants (40 CFR Oart 50). Primary standards are designed to protect public welfare (vegetation, materials corrosion, aesthetics, etc.). States may also establish ambient air quality standards.

The Clean Air Act also established the concept of prevention of significant deterioration (PSD) of air quality designed to protect clean air areas (40 CFR Part 52.21). Class I areas include national parks larger than 2,428 ha(6,000 acres), national wilderness areas greater than 2,023 ha(5,000 acres), and international parks, and national memorial parks that exceed 2,023 ha (5,000 acres). Areas in the United States that presently have lower ambient air quality than that specified in the NAAQS are designated as nonattainment areas; the remainder of the United States is designated Class II. Redesignation of Class II areas to either Class I or Class III by the state is possible. Recent court rulings have resulted in some major changes in the PSD regulations which appear in the August 7, 1980 Federal Register.

A second ambient air quality consideration is the visibility protection afforded to Federal Mandatory Class I areas via Section 169A of the Clean Air Act (40 CFR, Part 51). Regulations are to be promulgated by EPA (November 1980) and the States (August 1981) that are designed to prevent visibility impairment in the Federal Mandatory Class I areas. Since there are many issues to be resolved, it is too early to delineate the potential implications of the visibility regulations. Proposed regulations appeared in the May 22, 1980, Federal Register at 40 CFR 51.300. An EPA Report to Congress on visibility was published in November 1979.

Limitations on the amounts of pollutants emitted from a synthetic fuel facility are the enforceable mechanism to assure that the NAAQS and PSD increments are not violated. EPA establishes New Source Performance Standards (NSPS) 40 CFR Part 60), States establish emission standards, and EPA (or the State) must define emission limits that reflect the BACT. NSPS have not been defined for synfuels facilities, but BACT has been defined for five oil shale facilities and one coal gasification via the PSD permit process.

Water

Water pollution control requirements exist in the form of Water Quality Criteria, State Water Quality Standards, Drinking Water Standards, National Pollutant NPDES limits, and effluent guidelines. The following discussion summarizes the major aspects of surface water and groundwater quality standards; a complete discussion of the enforceable mechanism to attain these standards, that is the NPDES and UIC permit systems, may be found in other EPA references. (1)

Surface Water Quality Standards

Water quality standards are addressed in Section 303 (Water Quality Standards and Implementation Plans) of the Clean Water Act. Excerpts and summaries of requirements for establishment and implementation of water quality standards of that section are presented below:

Water quality standards shall be reviewed at least every 3 years by the Governor or State Water Pollution Control Agency and shall be made available to the Administrator.

State revised or adopted new standards shall be submitted to the Administrator (EPA) for approval. Such revised or new water quality standards shall consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses. Such standards shall be such as to protect the public health or welfare, enhance the quality of water, and serve the purposes of the Act(FWPCA). Such standards shall be established, taking into consideration their existing or intended potential use and value for public water supplies, propagation of fish and wildlife, recreational purposes, agricultural, industrial, and other purposes, while also taking into consideration their use and value for navigation.

Each State shall identify those waters for which existing or proposed effluent limitations are not stringent enough to attain established water quality standards and establish waste load allocations for those waters. Regulations promulgated at 40 CFR 131.11 and further discussed in the December 28, 1978 Federal Register describe the Total Maximum Daily Load concept.

Each State shall identify those waters or parts thereof within its boundaries for which controls on thermal discharges are not sufficiently stringent to assure protection and propagation of a balanced indigenous population of shellfish. fish, and wildlife.

(1) Environmental Perspective on the Emerging Oil Shale Industry, November, 1980.

The 208 Process

Section 208 of the FWPCA required States to designate areawide waste treatment planning agencies. These 208 agencies are to plan, promulgate, and implement a program designed to protect surface water quality. Stream classifications and water quality standards are to be developed.

Local input in most States on the proposed stream use indicated a desire to assign multiple classification systems wherever possible. Although the apparent intent of State classification systems (1978) is simply to identify the criteria applicable to a given stream segment, there is considerable local concern that a single "use" classification may be used later to restrict other uses, particularly agricultural ones. Intermittent streams have not been classified because of provisions made for this situation in the proposed classification system.

As an example, the four combinations of multiple use classifications that are proposed for Colorado include:

Class 1: Aquatic Life. Water Supply, Recreation, and Agriculture
Class 2: Water Supply, Recreation, and Agriculture
Class 3: Recreation and Agriculture
Class 4: Agriculture

The proposed water quality standards allow exceptions under certain conditions. Using the guidelines in the proposed criteria, the water quality data base, the proposed water quality criteria, the existing water quality problems, and a subjective analysis of potential effectiveness of potential control measures, three types of exceptions were identified for Colorado:

- Permanent exception - The current criterion limit is not valid for the drainage area because of natural environmental conditions. It is assumed that, given a return to prehistoric conditions, this parameter would still violate the criterion limit. The parameter should be monitored regularly, and any trend of increasing concentration would require evaluation/investigation of possible causes beyond natural conditions. It is further assumed that it is uneconomical to attempt controlling runoff.

- Temporary exception (10 Years) - This exception is requested when a criterion violation is identified as a possible consequence of man's activities in the basin and management strategies are available to improve water quality, but it will take 19 years to evaluate effectiveness.

- Temporary Exception (5 Years) - This exception is requested when a limited data base indicates a problem but more data are required to identify the cause, extent, and correctability of the problem. The 5-year exception should allow sufficient time for necessary additional data collection and analysis.

Ground Water Quality Standards

Federal - Federal regulations that may pertain to groundwaters are addressed in the Safe Drinking Water Act. This act has most recently been interpreted as applying to well injection of waste into aquifers that do or that might serve as sources for public drinking water. Such underground drinking water sources, while specified to include aquifers with less than 10,000 mg/l total dissolved solids, must have the potential to be sources of public water supply. Underground injection control (UIC) regulations were promulgated at 40 CFR 126 on May 19, 1980. In situ operations will fall into the category of "Class III wells". Drinking water standards are listed in Tables 4 and 5. Note that pits, ponds, and lagoons are not identified as underground injection sources at this time. They are covered under the RCRA.

Solid and Hazardous Wastes

The RCRA requires that solid and hazardous waste generators and transporters receive permits and that wastes be disposed only by safe practices. Regulations have been promulgated at 40 CFR Part 261 for (1) the criteria to identify solid and hazardous wastes (Section 3001); (2) disposal standards (Section 3004); and (3) permit programs (Section 3005). If a waste is not defined as hazardous (i.e., it is defined only as a solid waste) disposal will be governed by the Section 4004 regulations as promulgated at 40 CFR Part 257 on September 18, 1979. The promulgated regulations defined a waste as hazardous if it is ignitable (flash point $< 60^\circ$ C or 140° F), corrosive (extract pH ≤ 2 or ≥ 12.5), reactive (explosive or oxidizing), or toxic (extract concentration is 100 times greater than drinking water standards). Over burden mine wastes that are returned to the mine are exempt from these regulations. Also, materials ready for further processing are exempt.

RCRA regulations probably will result in materials such as API separator sludge, spent catalysts, gasifier ash, distillation tank bottoms and perhaps others being defined as a hazardous waste.

TABLE 4 PROMULGATED DRINKING WATER STANDARDS (40 CFR 141)

The following are the maximum contaminant levels for inorganic chemicals other than fluoride:

Contaminant	Level, mg/l
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05

When the average of the maximum daily air temperatures for the location in which the community water system is situated is the following, the maximum contaminant levels for fluoride are:

Temperature, °F	°C	Level, mg/l
53.7 and below	12.0 and below	2.4
53.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

The following are the maximum contaminant levels for organic chemicals. They apply only to community water systems. Compliance with maximum contaminant levels for organic chemicals is calculated pursuant to Section 141.24.

	Level, mg/l
a. Chlorinated hydrocarbons:	
Endrin (1,2,3,4,10, 10-hexachloro-6.7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1.4-endo-5,8-dimenthano naphthalene).	0.00002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer).	0.004
Methoxychlor (1,1,1-Trichloro-2,2-bis (p-methoxyphenyl) ethane).	0.1
Toxaphene ($C_{10}H_{10}Cl_8$-Technical chlorinated camphene. 67-69 percent chlorine).	0.005
b. Chlorophenoxys:	
2,4-D, (2,4-Dichlorophenoxyacetic acid).	0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid).	0.01

TABLE 5. LEVELS OF CONTROL APPLICABLE TO EXISTING SOURCES UNDER 1977 AMENDMENTS TO FWPCA

Pollutant	Conventional	Nonconventional	Toxic	
Name	Best Conventional Pollutant Control Technology	Best Available Technology Economically Achievable	Best Available Technology Economically Achievable	Effluent Standards (or Prohibitions)	Best Management Practices
Abbreviation	BCT	BAT	BAT		BMP's
Statutory Deadline	July 1, 1984	July 1, 1984/as appropriate.[a] Never later than July 1, 1987	July 1, 1984/as appropriate[b]	Up to one year after promulgation/as appropriate[c]	None
301(c) Economic Variance	No	Yes	No	No	No
301 (g) Environmental Variance	No	Yes	No	No	No

[a]July 1, 1984, or three years after limitations are established, whichever is later. Never later than July 1, 1987.

[b]July 1, 1984 for those 129 toxic pollutants which appeared at 43 Federal Register 4108 (January 30, 1978). For other pollutants which may be added to the toxics list, three years after limitations for such pollutants are established.

[c]The effective date for an effluent standard for a toxic pollutant may be extended to three years after the standard is promulgated if earlier compliance is technically infeasible.

IV. PROPOSED PRECOMMERCIAL APPROACH TO INDUSTRY STANDARDS

The approach regulating the first synfuels facilities must ensure compliance with existing standards, but, more important, should emphasize characterization of residuals from the facility. EPA Region VIII has expressed their desire to see a synfuels industry proceed in a phased orderly manner. Rigorous testing programs and data analyses should be performed on the first facilities, which would be representative of commercial size. Comprehensive monitoring of emissions, effluents, and waste materials should be performed. Research programs designed to define the optimum control technology for a given pollutant for a synfuels industry should be conducted. Trade-offs among air pollution, water pollution, and solid waste must be defined. The energy penalty, water consumption, and cost of control must be defined. The comprehensive monitoring efforts should not be limited to only the regulated pollutants, but should characterize nonregulated pollutants.

As previously stated, emphasis should be placed on source characterization. A moderate degree of ambient impact monitoring should be performed to validate predicted impacts and to document trends and changes from baseline. Programs to evaluate effects on receptors should be performed to provide feedback on the source and ambient monitoring programs. There are two principal bases for writing permits for synfuels facilities. The first relies upon the transfer of pollution control technology from related industries. The second relies upon the development of EPA's Pollution Control Guidance Documents.

The BACT for air pollutants must be employed for any proposed synfuels facility with the potential for emitting 91 tonnes (100 tons) or more (controlled) per year of any regulated air pollutant. Those facilities that have smaller potential emissions do not need BACT but should perform comprehensive monitoring in order to develop emissions data for potential permit applications. Two primary mechanisms exist to define the BACT. First, several synfuels facilities have received Prevention of Significant Deterioration (PSD) permits. The BACT has been defined on a case-by-case basis for these facilities. Second, air pollution control technology that has been defined as the BACT for synfuels related facilities may be considered as transferable to the industry. It is highly likely that air quality requirements may prove to be the governing constraing to the size of synfuels industry in certain parts of the country. Therefore, in order to maximize the amount of oil production capability of oil shale country it is important to maximize the air emissions control for each facility.

A no-discharge-of-pollutant concept is being considered by several developers as a means of handling their wastewater streams. Three types of water should be considered--mine, process, and in situ water. A no-discharge-of-process-water concept has been written into water permits. If any water is discharged to surface streams or reinjected into the ground-water system, it would consist of mine inflow (but not process or in situ water) or uncontaminated surface runoff. Treatment may or may not be necessary. Effluent limitations will be defined for certain pollutants including toxics for certain process streams in the NPDES permit. Best available technology economically available (BATEA) must be provided. (See Table 6). Major concepts to be addressed by regulatory agencies and the developer are summarized as follows. First, because of the semi-arid, water-short condition of potential development areas, it may be environmentally best to encourage treatment if necessary and discharge to a surface stream of mine water. Second, because of salinity considerations, treatment of mine water and/or minimization of water consumption is a desirable policy. Third, disposal of process water onto processed shale piles or ash piles without treatment may not be desirable. The high organic and salt concentration of the process water may represent too great a risk to groundwater/surface water quality because of potential catastrophic events or unexpected permeabilities/leaching., and they represent a deterrent to successful revegetation. Fourth, maximum recycling and reuse of process and nonprocess water will be encouraged; cost effectiveness must be considered. Finally, land application of untreated mine water may be desirable only for a short period of time because of the potential nonpoint source runoff problems.

Solid and hazardous wastes should be disposed of in a manner that avoids contact with water and subsequent toxic concentrations. Disposal practices should also be designed that preclude (or at least minimize) the potential for the solid material from becoming airborne as a fugitive dust. Safe disposal practices as defined at 40 CFR 264 apply to synfuels facility hazardous wastes such as spent catalyst, API separator sludge, tank bottoms, cooling tower sludge, and water treatment plant sludge. Surface disposal for solid wastes from a synfuels industry at a minimum should conform to those practices found in 40 CFR 257.

Pollution Control Guidance Documents

Regulating new, presently non-existent energy industries, of course, presents different problems from regulating long-standing segments of United States industry. The differences are of such an extent that a unique regulatory approach is demanded. The differences arise primarily from the facts that the new energy industries are, for the most part, not yet

TABLE 6. NEW SOURCE PERFORMANCE STANDARDS FOR SYNFUELS RELATED ACTIVITIES

40 CFR 60.40 Subpart D (NSPS for Fossil Fuel Fired Steam Generators)

TSP	0.10 pound per million BTU
SO_2	0.80 pound per million BTU (liquid fuel)
NO_x	0.20 pound per million BTU (gaseous fuel) 0.30 pound per million BTU (liquid fuel)

40 CFR 60.100 Subpart (NSPS for petroleum refineries)

H_2S	0.10 grain/dscf
HC	Floating roof or vapor recovery if true vapor pressure is >1.5 psia but <11.1 psia reporting requirements only if true vapor pressure is <1.5 psia.

40 CFR 60 (NSPS for Refinery Claus Sulfur Recovery Plants)

Gaseous fuel burning	0.1 grain/dscf
Sulfur recovery	
oxidation system	250 ppm SO_2
reduction system	300 ppm total S 10 ppm H_2S

Proposed NSPS

1. Gas Turbines $>10 \times 10^6$ BTU/hour

   75 ppmv NO_x at 15% O_2
   150 ppmv SO_2

2. Coal Gasification (Guideline)

   250 ppmv total S
   99.0 percent total S removal
   100 ppmv HC

3. Field gas processing units

Gaseous fuel burning	160 ppmv H_2S
Sulfur recovery	250 ppmv SO_2 (oxidation) 300 ppmv S (reduction)

commercialized in the United States and have potentially different effluents and emissions from those from existing pollution sources.

There is , unfortunately, little or no existing source of commercial-scale data on which to base a "conventional" regulatory approach at this time. In some instances standards from related industries may be borrowed. (See Table 6) Because of these circumstances, the general approach we are taking is to issue, as pre-regulatory guidance, a series of Pollution Control Guidance Documents, PCGD's -- one for each of the major energy technologies. The focal point of each PCGD is to be a set of recommendations on available control alternatives for each environmental discharge along with associated performance expectations. The basis for these recommendations will be presented. The intent is to present guidance for plants of typical size and for each significantly different feedstock likely to be used. PCGD's will not have the legally binding authority of regulations but each will be reviewed extensively both within and outside of EPA. These documents will provide useful and realistic guidance to permit writers within EPA and the States and to the energy industry itself during its formative stages. As the energy industry develops, permits for individual installations are being issued based on best engineering judgment and, as the various PCGD's become available, permits will be prepared in light of the information the PCGD's contain. Then, as the energy technologies mature, EPA will invoke its normal regulatory procedures: in the water quality area, for example, the issuance of effluent guidelines and establishment of appropriate water quality standards.

It is clear that for most new energy technologies, exemplary full-scale and even pilot-scale waste treatment installations do not yet exist. Moreover, there is a unique chance not available to actually influence, in an environmentally productive way, the choice by industry of the very process technology to be commercialized and the overall designs of new plants such that the most cost-effective environmental protection methods can be incorporated into process design from the very beginning so that more expensive pollution control retrofitting is minimized or eliminated. The Pollution Control Guidance Documents, therefore, have two key purposes: (1) to aid permit writers in preparing realistic, comprehensive permits for the energy industry by describing and characterizing projected waste discharges from the various energy technologies under development and by providing the best possible information on the expected cost and performance of the variety of control options that appear applicable and (2) to provide guidance to the energy industry itself with regard to the kinds of environmental impacts with which EPA will be concerned for their particular kind of facility, the control options which EPA has deemed to be potentially applicable and EPA's projections of probable cost and performance of the various options.

Let me now elaborate on the general structure of PCGD's. The Document will consist of three Volumes. Volume I is a summary report including recommended pollution control technology options and related costs; Volume II is a detailed report describing pollutants, waste streams and alternative control options, including cost and performance; Volume III is an appendix providing the data base for stream and pollutant characterization and control costs and performance.

The major users of the PCGD's are expected to be the permit writers. The Document for a particular energy technology should help them to better understand permit applications and to prepare a proper permit. Best available control technology will be suggested but information on alternative control methods will also be provided for use in considering site-specific situations. For example, a permit writer may be faced with having a very small allowable incremental increase in an air pollutant, say sulfur dioxide, when conducting a Prevention of Significant Deterioration (PSD) review. The PCGD will, hopefully, let him consider alternatives that achieve stringent control but will also indicate what the cost of such a level of protection would be.

The Documents will also serve as a beginning for future data base developers and regulation writers. When the industry becomes commercialized, the EPA program offices responsible for preparing regulations will need to collect commercial-scale data as the basis for authoritative regulations. The data base in the PCGD's should serve as a guide to identifying needs, organizing and carrying out these future data collection efforts.

For the developers, the PCGD's should influence the choices they have to make on control options and even on certain process alternatives. If industry and the other Federal and State agencies which directly support energy development are aware of anticipated environmental problems and available control technologies, their development and plant design efforts can incorporate features which will help to avoid the necessity for future retrofitting of control technology.

It shoud be noted that providing an early indication of EPA's concerns for various pollutants and options on pollution limits will not just produce "passive reactions". On whatever information EPA provided, it will receive feedback and criticism. By precipitating this feedback process while the energy technologies are still being developed, many issues regarding environmental protection should be resolved prior to construction and operation. The advance notice of EPA's thinking will permit regulators, developers and other segments of the public to work together to a greater degree than has been possible in the past and should result in the development and commercialization of an environmentally sound energy industry.

The specific energy technologies for which separate PCGD's are now planned are the following:

- o Low Btu Coal Gasification
- o Indirect Coal Liquefaction
- o Oil Shale (mining and milling)
- o Direct Coal Liquefaction
- o Geothermal (first revision of existing PCGD)
- o Medium Btu Coal Gasification
- o High Btu Coal Gasification

Table 8 provides the schedule for their development.

EPA has taken specific measures to assure that the development of regulatory approaches for the energy industries will involve a wide range of interested parties, both in the preparation of PCGD's and in their review. These parties include government, industry, environmentalists and the public in general. Within EPA, we have established an Alternate Fuels group which has the responsibility for coordinating all research and all regulation development--on a multi-media basis--for new energy technologies. Serving on this group are representatives from all of the major policy/program and research offices charged with related research and regulation development and from some of the Regional Offices which are most concerned with synfuels commercialization. The Group's overall responsibility is to develop the EPA regulatory approach for the new energy technologies. Within this context the Alternate Fuels Group is charged with producing Pollution Control Guidance Documents, overseeing the creation of a program to insure the development of coordinated standards taking into account cross-media pollutional impacts and generating and updating a research plan. Under the Alternate Fuels Group are various "work groups" which concentrate on specific energy areas. There are separate work groups for oil shale mining and retorting, coal gasification, indirect coal liquefaction, direct coal liquefaction, alcohol production and geothermal energy. The members of the work groups are EPA employees but we have also invited participation from other involved Federal agencies, viz., the Department of Energy (DOE), the Tennessee Valley Authority (TVA) and the Department of the Interior (DOI).

The Pollution Control Guidande Documents will go through an extensive internal and external review process. Internally, the Alternate Fuels Group and the relevant work group will be directly involved but final sign-off will occur at the level of the Agency's Assistand Administrators who serve on EPA's Energy Policy Committee, the Agency's highest level energy coordination group. Externally, the Documents will be reviewed

TABLE 7. POLLUTION CONTROL GUIDANCE DOCUMENT REVIEW SCHEDULE

Technology	1st Draft (data base)	Public Forum	Final Publication
Low Btu Gasification	11/80	4/81	8/81
Indirect Liquefaction	11/80	5/81	9/81
Oil Shale	11/80	5/81	9/81
Direct Liquefaction	9/81	3/82	7/82
High Btu Gasification	4/82	10/82	2/83
Medium Btu Gasification	1/82	7/82	11/82

Table 8. Processes To Be Covered In Pollution Control Guidance Documents Now Under Preparation

o Low Btu Gasification (Single State, Atmospheric Fixed Bed)

- Riley-Morgan
- Wilputte-Chapman
- Wellman-Galusha

o Indirect Coal Liquefaction

Gasification	Synthesis
- Texaco	Coal-To-Methanol
- Lurgi	Mobil "M" (Methanol for Gasoline)
- Koppers Totzek	Fischer-Tropsch

o Oil Shale

- TOSCO II
- Paraho
- Union
- Superior
- Occidental
- Rio Blanco

o Direct Coal Liquefaction

- H Coal
- SRC
- Exxon Donor Solvent

by other Federal organizations such as DOE, TVA and DOI and by a wide variety of industrial reviewers and also public interest groups. Associations such as the American Gas Association, the Gas Research Institute and the National Council of Synfuels Producers will also serve as reviewers. A public forum providing a second opportunity for external review will be announced in the Federal Register sixty days prior to its occurrence. Review comments from individuals and from technical societies such as the Federation will be most welcome. The final Document will be revised to reflect response to all appropriate comments. The proposed review schedule for the six PCGD's now under preparation or planned is shown in Table 1.

Although the major objective of a PCGD is to recommend pollution control options, it will contain a great deal of background information on the energy processes themselves and on process streams and pollutant concentrations, and will, on the basis of a series of "case studies", offer specific technology based control guidance for various kinds of energy processes. Processes to be included will cover those that are expected to be built for demonstration or commercial application first. Table 9 shows planned process coverage for the four PCGD's currently being written). It is intended that discussion of product (E.G., liquefied coal) uses also will be included if use is integral with the manufacturing process. The process descriptions will detail the key features of each process and their pollution potential. If various process modifications are likely to be used at different locations, the changes in process configuration will be covered and expected changes in pollutant releases will be indicated. Pollutant releases that vary non-linearly with plant size or flow rates will also be identified and quantified to the extent possible.

The environmental control alternatives to be considered will include both end-of-pipe treatment techniques and process changes. Candidate control alternatives will be identified from existing United States and foreign bench-pilot-and commercial-scale facilities or from different United States or foreign processes that have similar discharges. Performance and design will be included as will information on capital, operating and annualized costs. Energy usage for control alternatives will also be included. Finally, techniques for monitoring control performance will be identified. The source of all data will be clearly referenced to allow referral to original sources; uncertainties in the data will be indicated.

V. CONCLUSION

Permits to construct and operate synthetic fuel facilities must be obtained by developers. The basis for review of these permit applications is contained in various EPA regulations, standards, and guidance documents. EPA and the respective State agencies have a shared responsibility in the review, permitting, and ensuring compliance of synfuels facilities.

THE TVA AMMONIA FROM COAL PROJECT

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TVA's Ammonia from Coal Project involves retrofitting a coal gasification process to the front end of its existing 225-ton-per-day ammonia plant. The purpose of the project is to develop design and operating data to assess the technological, economic, and environmental aspects of substituting coal for natural gas in the manufacture of ammonia. Preliminary operation of the facility was begun in September 1980. In the absence of specific environmental guidelines for coal gasification processes, TVA's approach to the potential environmental problem is to meet or exceed the emission control requirements for specific components, i.e., sulfur compounds, particulates, aqueous discharges, etc. Also, TVA's facility contract specified limits on certain discharges based on anticipated guidelines. In addition to a discussion of the emissions control activities, a program is described that examines the environmental health and safety aspects of the Ammonia from Coal Project.

THE TVA AMMONIA FROM COAL PROJECT

TVA's Ammonia from Coal Project involves retrofitting a coal gasification process to the front end of its existing 225-ton-per-day ammonia plant. The purpose of the project is to develop design and operating data to assess the technological, economic, and environmental aspects of substituting coal for natural gas in the manufacture of ammonia. Preliminary operation of the facility began in September 1980.

The environmental considerations for this project were unique; no environmental regulations presently exist specifically for coal gasification facilities. TVA's approach to the problem was to meet or exceed the emission control requirements for specific components, i.e., sulfur compounds, particulates, aqueous discharges, etc. In addition, TVA's facility contract specified limits on certain discharges based on anticipated guidelines.

The facility is designed to produce 60 percent of the feed gas required for the 225-ton-per-day ammonia plant. The ammonia plant can operate at 60 percent turndown, therefore, the ammonia plant can operate at its design rate with 60 percent of the feed gas supplied from coal and the remaining 40 percent from natural gas; or, the plant can be operated at 60 percent of design rate (135 tons per day of ammonia) with all the feed gas supplied from coal. The capability of operating the ammonia plant with 100 percent natural gas feed is retained. This arrangement will make the greatest use of the existing ammonia plant and minimize the amount and size of new equipment required. Also, the coal gasification facilities can be operated independently from the ammonia plant by burning the carbon monoxide and hydrogen gas in an existing steam boiler.

The coal gasification unit is based on the Texaco partial oxidation process. Engineering, procurement, and erection of the coal gasification and gas purification facility was done by Brown and Root Development, Inc. The air separation plant required to provide high purity oxygen and nitrogen for the process was handled similarly by Air Products and Chemicals, Inc. Engineering, procurement, and construction of the coal handling and preparation area, interconnections to the existing ammonia plant, slag disposal, and services and utilities required for the complex were performed by TVA.

A flow scheme for the TVA Ammonia from Coal Project (ACP) is shown in Figure 1. Coal is received by rail and is sent to open storage and later recovered by front-end loader or it is crushed in a primary crusher to minus 1/2-inch and conveyed directly to the coal slurry preparation area.

Coal is pulverized in disk mills as required for the gasifier operation. Water is added to the disk mills to form a coal-water slurry. From the disk mills, the slurry goes to one of two mix tanks where the solids content of the slurry is adjusted to the desired level. The slurry is pumped to a feed tank and then metered to the reactor at the process rate of about 8 tons of coal per hour. Gaseous oxygen from the air separation plant is fed to the reactor at about 8 tons per hour through a metering system interlocked with the coal slurry feed.

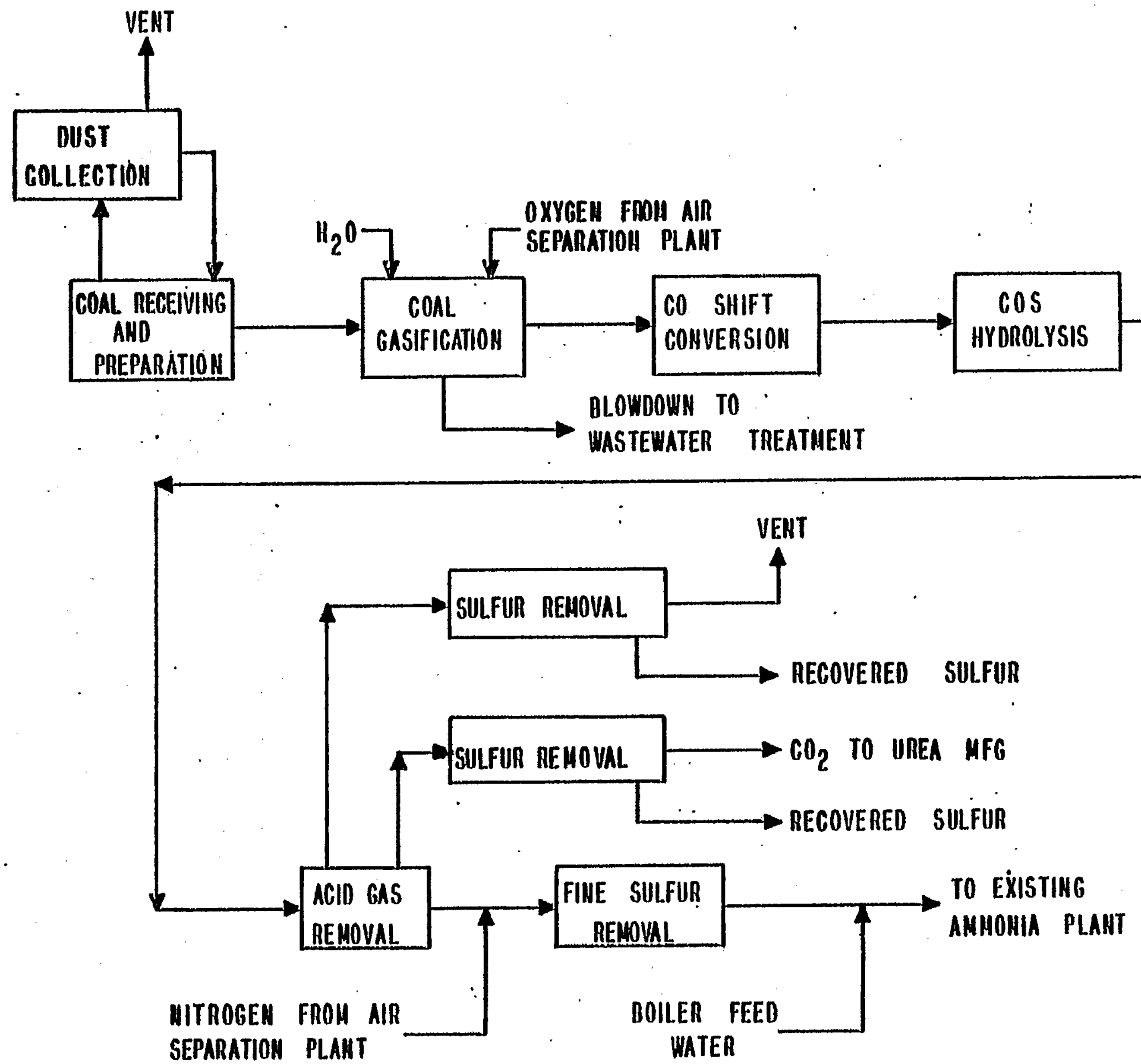

Figure 1 Flow scheme for TVA's Ammonia from Coal Project

The gasification process takes place in the reactor at a pressure of about 510 psig and at a temperature in excess of 2200^{o}F. The carbon in the coal is reacted with steam to produce carbon monoxide and hydrogen. Oxygen is injected to burn part of the coal to provide heat for the endothermic reaction. In addition to the gasification reaction, coal combustion forms carbon dioxide (CO_2), and sulfur compounds in the coal are gasified in the reducing atmosphere to produce primarily hydrogen sulfide (H_2S) and some carbonyl sulfide (COS). Small quantities of other compounds such as ammonia and methane also are formed. According to Texaco's pilot-plant experience, essentially no long-chain or aromatic hydrocarbons are formed.

Slag produced from the ash in the coal is removed from the reactor through a lockhopper system. The slag is glassy in appearance and is very similar to the bottom ash produced in a coal-fired power plant boiler. Initially, trucks are used to transport the solids to a disposal area. A slurry pumping system may be installed later to handle and transport the slag to the disposal area. In such a system, the slag would be washed and screened to remove oversize material which would be crushed to a size suitable for slurrying and pumping.

The gas leaving the reactor is water-quenched and particulate matter (fly ash) is removed in a scrubber. A blowdown to control dissolved solids is taken from the water recirculating loop and pumped to a wastewater treatment facility, which uses chemical, physical, and biological treatment processes. The wastewater is first treated in a clarifier by addition of ferrous sulfate and hydrated lime. The clarifier underflow is sent to a sludge conditioning unit and then to a filter press for solids removal.

The liquid fraction from the clarifier is steam-stripped to remove ammonia which is recovered and routed to the coal slurry preparation area to neutralize the acidic slurry. The stripped aqueous material containing some organic matter, primarily as formates and cyanates, along with water from washdown operations is sent to an equalization-cooling basin for pH control, mixing, and cooling. After aeration, the combined waste then flows to the activated sludge unit for biological treatment. The treated water from the unit is metered and sampled on its way to discharge. The digested sludge flows to the filter press where the solids are removed for disposal. Plans are to recycle the solids to the gasifier. The filtrate is returned to the wastewater treatment system.

The process gas from the quench scrubber flows to two carbon monoxide (CO) shift converters. The converters are charged with a sulfur-activated catalyst marketed by Haldor Topsoe. The design CO content of the gas entering the converter is about 22 percent (wet basis). After full shift, the CO content is about 2 percent which matches the CO content of the gas entering the low-temperature shift converter in the existing ammonia plant.

The COS produced during the gasification process is not affected by the Holmes-Stretford sulfur recovery system that is used to recover H_2S from the off-gas streams from the acid gas removal system. Therefore, the quantity of COS must be decreased to meet the sulfur emission limitations. To accomplish this, a

COS hydrolysis unit containing a catalyst also marketed by Haldor Topsoe is provided between the CO converter and the acid gas removal (AGR) system to promote the reaction:

$$COS + H_2O \rightleftarrows CO_2 + H_2S$$

The process gas from the COS hydrolysis unit flows to the AGR system. The AGR system uses Allied Chemical's Selexol process (a physical absorbent system) to remove the CO_2, H_2S, and the remaining COS from the process gas. This system is capable of decreasing the total sulfur in the synthesis gas stream to less than 1 ppm.

Nitrogen from the air separation plant is added to the process gas from the AGR system to produce an $H_2:N_2$ ratio of 3:1. The gas then flows through a zinc oxide bed to decrease the sulfur content to less than 0.1 ppm. Deaerated boiler feedwater is added to bring the steam-to-dry-gas ratio to 0.44:1. The gas is then heated to about 600°F prior to its entry into the existing ammonia plant at a point immediately upstream of the low-temperature CO shift converter. The pressure of the gas at the battery limits is about 385 psig. The composition of the process gas is very nearly the same as the composition of the gas leaving the high-temperature CO shift converter in the ammonia plant. The approximate composition of the gas is shown in Table 1. It should be noted that the Selexol system is capable of decreasing the CO_2 to a value much lower than that shown in the table. The 10.8 percent CO_2 (wet basis) is a design requirement and is not set by Selexol process limitations.

Two reject acid gas streams are produced during regeneration of the Selexol AGR solvent. One stream containing up to 4 percent H_2S is sent to one train in the Holmes-Stretford sulfur-recovery system. The Holmes-Stretford system, furnished by Peabody Process Systems, Inc., uses a proprietary solution containing an oxidized form of vanadium salts. The H_2S is oxidized in the solution to produce elemental sulfur according to the following reaction:

$$2H_2S + O_2 \rightarrow 2S + 2H_2O$$

As stated before, the COS is unaffected by the Holmes-Stretford system. The reduced metal salt is regenerated by blowing air through the solution. This operation also floats the elemental sulfur to the surface. The sulfur is skimmed off and filtered to produce a wet cake. The tail gas from the Holmes-Stretford system contains about 160 ppmv H_2S, less than 30 ppmv COS, and less than 500 ppmv CO. This stream is vented to the atmosphere under conditions of our emissions permit.

The second stream from the AGR solution regeneration system is relatively pure CO_2. This gas is sent to the second train in the Holmes-Stretford unit and then to a vessel containing zinc oxide to decrease the total sulfur content to less than 0.5 ppm to meet requirements for urea manufacture. This gas will be vented to the atmosphere when the urea plant is not operating.

ENVIRONMENTAL CONSIDERATIONS

The Ammonia from Coal Project management brought TVA's environmental and medical expertise into the project at the very beginning. They worked with

Table 1 APPROXIMATE COMPOSITION OF GAS MANUFACTURED FROM COAL AT THE TVA AMMONIA FROM COAL PROJECT

COMPONENT	PERCENT BY VOLUME	
	WET BASIS	DRY BASIS
HYDROGEN	42.0	60.6
NITROGEN	14.1	20.3
CARBON MONOXIDE[a]	2.3[a]	3.3[a]
CARBON DIOXIDE	10.8	15.6
METHANE	0.1	0.1
ARGON	0.1	0.1
WATER	30.6	
TOTAL	100.0	100.0

BASIS: TOTAL SULFUR = 0.1 ppmv MAXIMUM

STEAM-GAS RATIO = 0.44

HYDROGEN-NITROGEN RATIO = 3.0

NOTE: [a]THE CARBON MONOXIDE CONTENT OF THE GAS IS BASED ON END-OF-RUN CONDITIONS FOR THE SHIFT CONVERSION CATALYST.

the project management team to develop the project specification covering the environmental, health, and safety requirements. These specifications were then included in the contract for the coal gasification project.

An environmental evaluation was made on the project and it was determined that an environmental impact statement was not required. Also, because of its size--180 tons-per-day coal feed rate--and because the plant is scheduled to operate one-half of the available operating time, it was determined that the emissions were sufficiently low so that the plant was not considered to be a major pollution source according to EPA's Prevention of Significant Deterioration (PSD) rules. These two facts shortened considerably the lead time required to obtain the necessary environmental permits. Three State of Alabama permits covering emission to the atmosphere were obtained. One covers the coal receiving, unloading, conveying, and storage. Dust suppression equipment is required at all transfer points as a condition of the permit. A second permit covers the primary coal crushing operation and conveying to the pulverizing and slurrying operation in the gasification section. This permit requires dust suppression equipment at all transfer points and a wet scrubber on the crusher operation. The third permit covers the coal gasification and gas purification unit. This permit restricts the quantity of total sulfur compounds, CO, and NOx compounds that can be emitted to the atmosphere. In addition, an uncontrolled vent is allowed for startup and emergency but its use is limited to a certain number of hours per year; combustion of the vent gases is required.

Wastewater is processed routinely as stated earlier by chemical precipitation, stripping to remove ammonia, biological treatment, clarification, solids separation, pH treatment and finally discharge through a flow and pH monitoring system into an existing NPDES-permitted stream. Our efforts to meet regulations required that we obtain a modification to the existing NPDES permit.

Solid wastes are to be disposed of in a landfill. Because we had no concrete data proving otherwise, and as a precautionary measure considering the developmental nature of the project, TVA elected to handle the slag from the gasification operations as if it were hazardous and accordingly applied to the State of Alabama for permission to dispose of the slag in a nearby site. We lined the disposal pond with a minimum of 2 feet of clay having a permeability of 10^{-7} cm/sec or less. We will accumulate the water drainage from the slag and return it to the gasifier operation. Four monitoring wells, one upstream and three downstream of the disposal pond, are provided for sampling to detect any changes in the groundwater composition.

Environmental Studies

Thus far we have discussed the environmental effort in regard to meeting the applicable regulations and emission standards. In addition to these activities, a program is planned that looks further into the environmental, health, and safety aspects of the ACP. Table 2 lists the study areas, the sources of the samples to be analyzed in evaluating these study areas, and the analyses to be performed on the samples. These analyses will help to evaluate the environmental impact of our project and also may serve as a guide in evaluating the impact of future gasification projects. For instance, we fully expect that the slag studies will show that the slag is nonhazardous and should be handled similarly to the bottom ash from a coal-fired power plant.

Table 2 ENVIRONMENTAL STUDY PROGRAM OUTLINE

STUDY AREA	SAMPLE SOURCE	ANALYSES PERFORMED
Gaseous Emissions Monitoring and Characterization	Sulfur recovery tail gas	Sulfur species Nitrogen species Hydrocarbons Particulates Trace Elements
Liquid Effluent Monitoring and Characterization	Treated effluent Accumulator discharge to wastewater treatment	Priority pollutants (129) Trace Elements Other[a]
Solid Waste Monitoring and Characterization	Gasifier slag Solids to landfill (from wastewater treatment) Background Monitoring wells	Trace Elements Hazardous waste extraction
Radiological Characterization	Coal Gasifier slag Sulfur recovery tail gas Accumulator discharge to wastewater treatment Treated effluent/Disposal pond & monitoring wells Solids to landfill (from wastewater treatment)	Ra-226 Ra-228
Medical Surveillance	Operating personnel (individual) Maintenance personnel (individual)	Preplacement physical examinations Periodic physical examinations Transfer/Termination physical examinations Followup physical examinations
Basic Industrial Hygiene	Operating personnel (individual) Maintenance personnel (individual) Employee work stations (ambient air)	CO H_2S COS Particulates Aromatic Hydrocarbons

[a] NH_3, NO_2, and NO_3, organic N, TDS, TSS, VSS, BOD_5, alkalinity, COD, $S^=$, anide, TOC, formate. Also may include Ca, Mg, SO_4, SiO_2, PO_4

to be performed on the samples. These analyses will help to evaluate the environmental impact of our project and also may serve as a guide in evaluating the impact of future gasification projects. For instance, we fully expect that the slag studies will show that the slag is nonhazardous and should be handled similarly to the bottom ash from a coal-fired power plant.

The first four items in Table 2 covering the area of gaseous emission, water and solid discharge, and radiological characterization affect the health and welfare of the community beyond the plant boundary limits and as such are tremendously important. However, the studies listed here are routine and could be expected to be carried out in any program similar to the Ammonia from Coal Project.

The last two items deserve a closer look. The purpose of the medical surveillance and the industrial hygiene programs is first, to protect the workers assigned to the TVA Ammonia from Coal Project and second, to gain knowledge to answer the persistent questions concerning the health and safety of workers exposed to the coal gasification environment in general.

The medical program, developed by TVA's medical staff, includes a series of medical examinations. The first examination or preplacement examination of the candidate workers was made to determine preexisting conditions that might be adversely affected by work in the ACP. These people were advised of their conditions and counseled regarding methods of protection. Particular emphasis was placed on evaluating the condition of the skin, respiratory tract and genitourinary tract. Also, high quality color photographs were made of the exposed skin of the face, neck, hands, and any suspicious lesion or other skin problem areas. Periodic examinations will be made at not more than 12-month intervals. These will be complete physical examinations similar to the preplacement examinations. Termination and/or transfer examinations will also be essentially the same as the preplacement examination. In addition, followup examinations of former ACP employees may be made on a voluntary basis as part of an epidemological study of the employees. The epidemological study will involve pairing the ACP workers as a group with two other similar groups (comparable sex, age). One, a similar group of workers with histories of work in chemical plants except for this group's lack of exposure to the gasification environment. The second comparative group will have "clean" histories with no exposure in chemical plants. Statistical analysis will include a comparison between the two control groups and the ACP workers to determine the contribution, if any, of the gasifier environment to adverse health effects of exposed workers.

The primary objective of the ACP industrial hygiene program is to protect ACP employees from developing occupational diseases during the operation of the projects and at any time in the future. But, because of the demonstration nature of the ACP, another goal is to determine as completely as possible any health and safety hazards associated with the process. This overall assessment is expected to supply data for future coal conversion projects.

The possible hazardous agents that are of interest from an industrial hygiene standpoint which might be found in the environment and their maximum limits for unprotected workers are listed in Table 3.

Table 3 POSSIBLE HAZARDOUS AGENTS AND THEIR STANDARDS

AGENT	STANDARD (8 hr. TWA)
CARBON MONOXIDE	50 ppm[a]
HYDROGEN SULFIDE	10 ppm[a]
CARBONYL SULFIDE	(no standard)
COAL DUST	2 mg/m^3[b]
AROMATICS	10 ppm as benzene[b]
COAL TARS	0.2 mg/m^3 as benzene soluble fraction[b]
NOISE	90dBA[b]
HEAT	30°C WBGT (Wet bulb globe temperature)[a]

[a] Source: American Conference of Government Industrial Hygienists

[b] Source: Department of Labor, Occupational Health and Safety Administration

As a result of review of the plans and specifications for the gasification facilities by industrial hygiene personnel, control measures such as area monitors with audible alarms for carbon monoxide and hydrogen sulfide have been or will be built into the physical plant. Other control measures identified so far through the review process are: personnel protective equipment such as protective clothing, hearing protection, and safety glasses; positive pressure ventilation in control and analysis rooms; and provision of deluge showers and eye baths.

Before the initial startup of the ACP facilities, a walk-through inspection and evaluation of the plant was conducted. Area monitors and alarm systems were tested; control systems were evaluated; and procedures for the personal hygiene, protective clothing, and protective equipment were reviewed. The plant operational procedures will be reviewed periodically to evaluate their health and safety impacts.

A concentrated effort was begun during startup and will continue through preliminary operation of the ACP facilities to identify and measure hazardous agents produced by the operation of the facilities and equipment. Individual worker environment is being sampled by portable devices attached to the individual. Area samples are taken by fixed, automatic sampling stations located at strategic points throughout the plant. Samples from these sources are being analyzed in an attempt to identify unexpected as well as expected agents that could be generated. A statistically valid number of samples will be taken for each agent so that the confidence level will be maintained. This means that the individual worker environment probably will have to be sampled several times during the startup phase. If during the initial survey an unexpected hazardous situation is discovered, additional sampling will be scheduled.

Results from the initial survey will be evaluated and will serve as the basis for developing a secondary workplan that will cover all future industrial hygiene activities for ACP. The secondary workplan will cover at least the following items: the hazardous agents that will be periodically measured; the employees' exposure history; and the decision points concerning protective clothing usage. The workplan will be a dynamic guideline that will be subject to continuous change depending on the requirements of the ACP program.

The list of activities discussed above for the medical and industrial hygiene studies on the ACP is by no means complete. However, it does cover the major items of interest and indicates the degree of health protection and surveillance that is built into the ACP program. We anticipate that hindsight will show that we have considerable overprotection and overcaution in this area, but at this stage we are taking no chances.