REVIEW OF THE
POLLUTION CONTROL GUIDANCE DOCUMENT
FOR
LURGI-BASED INDIRECT LIQUEFACTION FACILITIES

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Science Advisory Board
U.S. Environmental Protection Agency

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SUBCOMMITTEE REVIEW OF THE
"POLLUTION CONTROL GUIDANCE DOCUMENT
FOR
LURGI-BASED INDIRECT LIQUEFACTION FACILITIES"*

SUMMARY OF THE REVIEW OF THE DOCUMENT

The Document* is a comprehensive qualitative presentation, in that

a) it provides in one place a great amount of data that are believed to reflect the best information currently available in the public domain;

b) it focuses on many possible ways to process the Lurgi gases, e.g. the Document discusses 41 process and product streams and 105 discharge streams;

and, even more importantly,

c) it organizes and prioritizes its conclusions. For the eight (8) discharge streams that are considered to provide the most significant pollution problems, commercial or near-commercial methods to render these streams environmentally acceptable at rational costs are presented.

The Document is <u>not</u> a quantitative presentation. That is, it does not present incontrovertible data, precise costs, and precise pollution predictions. Indeed, EPA stresses that the data are fragmentary and, further, that the "guidance" is the result of best engineering judgment which, in order to be implemented must take into account local conditions and the development of new and better data. The Document has no legal implications and contains no mandatory guidelines.

* May 1 draft except for Section 2 which was the May 15 draft.

The Review Subcommittee (members listed below) recognizes the significant qualitative assistance of this enormous pioneering effort, but it also suggests in its review general and specific areas that can be strengthened at this time.

Review Subcommittee

	Specific Areas of Concern
Principal Members:	
Dr. Albert Gomezplata	General, Water, Costing
Dr. Cecil Lue-Hing	General, Water, Solid Wastes
Dr. Francis McMichael (ex officio)	General, Costing
Mrs. Marion Monet	General, Toxic Substances
Dr. James H. Porter	General, Air, Costing
Assisting Consultants:	
Mr. Allen Cywin	General, Water, Solid Wastes, Regulations
Dr. Simon Goren	Air
Dr. W. Leigh Short	General, Air
Dr. Paul Spaite	General, Air, Costing

ORGANIZATION OF THE REVIEW

FOREWORD: an ABSTRACT of the EPA DOCUMENT

The Document exists, physically, as a four-volume work:

Volume I:	Guidance (193 pages)	
Volume II:	Engineering Evaluation (635 pages)	
Volume III:	Appendices (Assumptions, Support Data, and Calculations)	
Volume IIIA:	Sections A-J	(364 pages)
Volume IIIB:	Section K (Cost Data)	(438 pages)

A. The Purpose of the Document

The Document is intended to provide informed guidance to both systems developers and the permitting authorities on control approaches which are available at a reasonable cost for the technologies under consideration. It is also intended to provide the engineering evaluations and support assumptions, calculations and support data to allow those systems developers and the permitting authorities to intelligently tailor the guidance principles to their own specific conditions. (See Volume I, page 1)

The Document is also intended to provide the public with the EPA's best current assessment of: a) the environmental problems posed by Lurgi-based indirect liquefaction facilities, and b) the effectiveness and costs of available controls. (See Volume I, page 1)

The Document has no legal implications and contains no mandatory directions. (See Volume I, page 1)

B. The Technology

Indirect liquefaction involves the application of two generic types of technologies (gasification, followed by synthesis) to produce liquid fuels and chemicals from coal. The gasification technology considered in this Document is the Lurgi process, a commercially available process which has been successfully used, outside of the U.S. for many years to produce industrial fuel gas and synthesis gas for ammonia or liquid hydrocarbon syntheses. This includes one commercial indirect liquefaction facility which is currently being operated by SASOL (the South African Coal, Oil and Gas Corp., Ltd.). (See Volume I, page 2)

Liquefaction of the Lurgi gases is considered in the Document via Fischer-Tropsch (F-T), methanol, and the Mobil M process. With both methanol and Fischer-Tropsch synthesis, a number of approaches to liquids production have been commercially proven. The conversion of methanol to gasoline hydrocarbons via the Mobil M process has only been tested on a pilot scale; however, this process is believed to be sufficiently well developed to be classified as "near commercial" and ready for implementation. (See Volume I, page 3)

C. Model Plants Approach

Since no commercial indirect liquefaction facility other than the SASOL (South Africa) plant exists, and only limited environmental source testing data have been obtained for that plant, pollution control guidance cannot be developed based on actual test data from operating integrated facilities. Hence, for purposes of analysis, a model plant approach was chosen to define process operations and associated waste streams which would be generated in representative integrated facilities. Figure 1 shows graphically the options considered. (See Volume I, page 5)

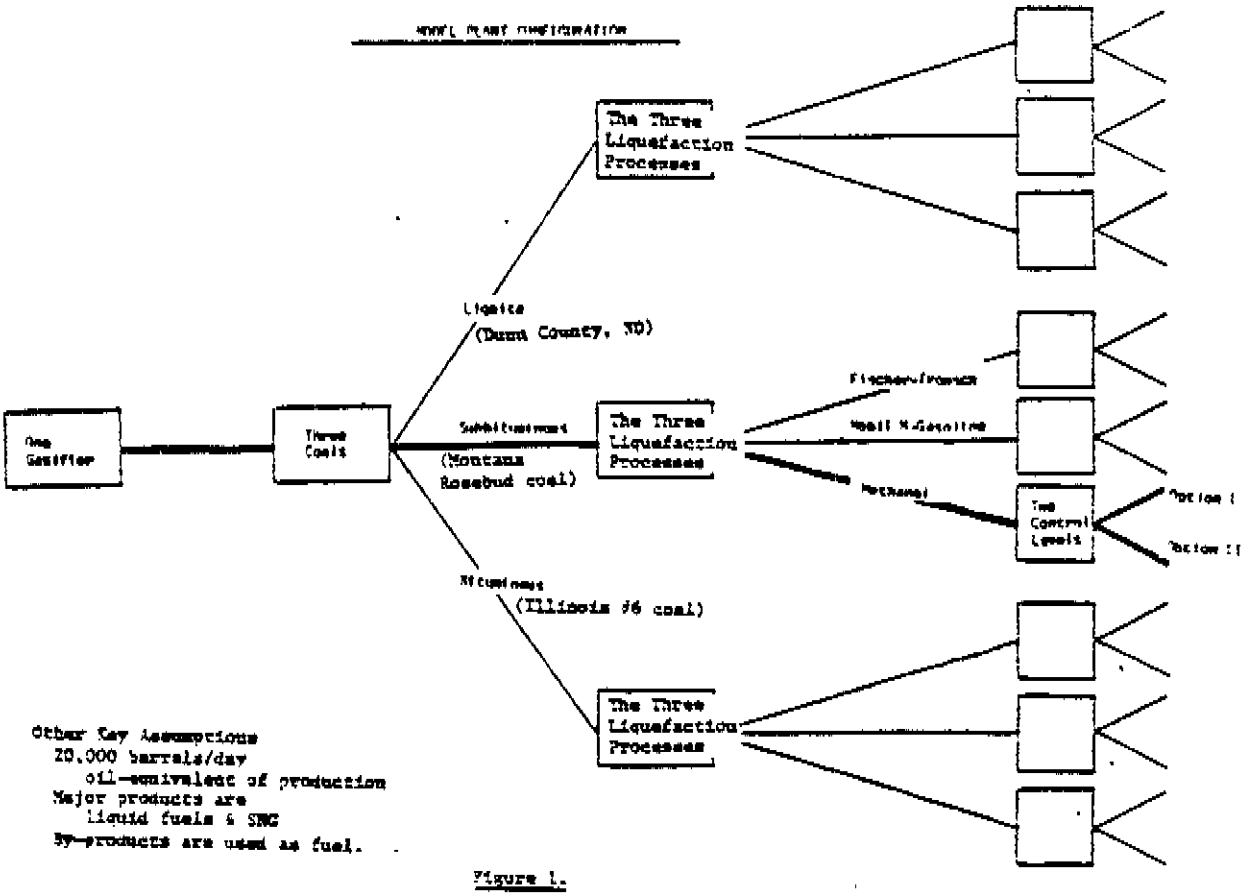
This approach allowed estimation of total stream and constituent flow rates in an integrated facility and served to define the "base plant" waste streams requiring treatment and/or disposal. Forty-one (41) main process, product, and byproduct streams, and 105 discharge streams were identified. (See Volume I, pages 5 and xix)

D. Pollution Control Considerations & Guidance

Eight "key" waste streams (3 gaseous streams, 2 aqueous streams, and 3 solid waste streams) contained the bulk of the pollutants which are the most environmentally significant. (See Figure 2) For these streams, pollution control technologies are suggested and costs of controls were calculated at two levels: Option II meets control requirements which, in most cases, are consistent with existing requirements for similar streams in related industries; and Option I guidances are generally more protective of the environment (dependent on site-specific constraints), cover both regulated and unregulated pollutants, and are generally more costly to install and operate. (See Volume I, page 5 and page 8)

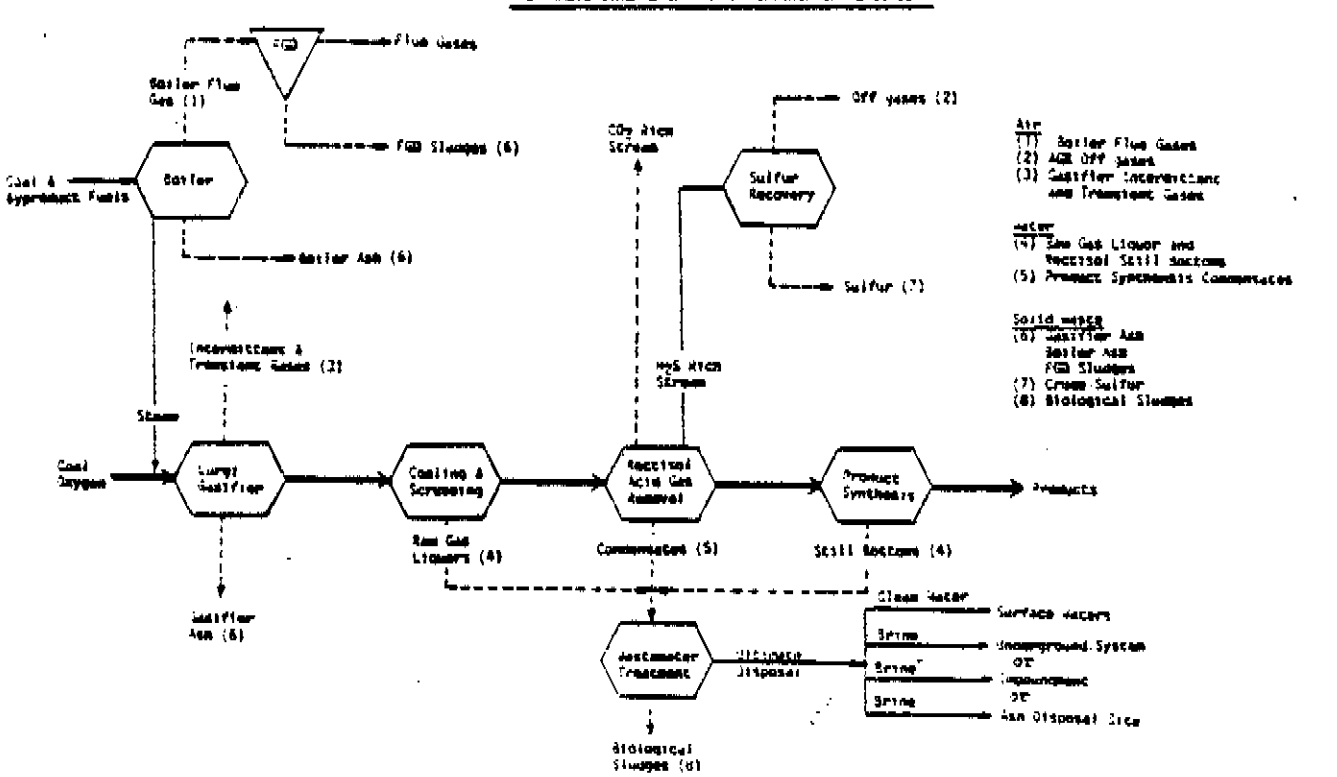
The control levels are defined in terms of either: a) control equipment performance specifications, e.g. percentage removal of a given pollutant; or b) residual pollution discharge rates, i.e. concentration or mass emission limits. (See Volume I, page 5)

Several significant pollutants have concentration levels already addressed by air, water, and solid waste standards for similar industries. Reference in the Document is often made to state and national regulations governing the pollutants.



Other Key Assumptions
20,000 barrels/day
oil-equivalent of production
Major products are
liquid fuels & SNG
By-products are used as fuel.

Figure 1.



(EPA "Synfuels" presentation
F. T. Princiotta, 5/27/81)

Figure 2.

A. General Review

The draft Document* is a successful effort to organize a complex, often uncharted area. This organization shows the difficulty of controlling emissions from such a large integrated facility, before the facility is fully conceived. Also, this organization shows how to recognize the important effluent streams and how to prioritize them.

This Document is not a "cookbook" or a "compliance document" which must be followed step-by-step. The Document is a "how to" book to allow its users to make judgments for themselves on how to approach an evaluation, how to recognize the problems, and how to effect reasonable solutions for their own specific problems.

The results presented in this Document have done much to put the technology into better environmental perspective. The model plant approach conveys an understanding of the total "system" that could not be gained from study of individual processes. And, individual discharges with their associated pollution potential have been assessed to estimate their relative importance. This Document plus an understanding of special local constraints can provide a preliminary base from which to begin interactions toward development of pollution control technology and compatible permits. This clarification of important areas should help permittors, constructors, and concerned residents.

The possibility of using multi-media trade-offs is suggested qualitatively. This is timely advice in the development of control technology for these plants to achieve cost-effective controls.

* May 1 draft except for Section 2 which was the May 15 draft.

This Document has an encyclopedic compendium of data related in greater or lesser degree to the Lurgi Indirect Liquefaction of coal process and to its attendant discharge streams with various degrees of polluting potential. The collection of this much data is of significant value; although, in later specific areas of our review some regrettable omissions are mentioned.

Although this numerical data base exists in the Document, users should not feel that the resulting numbers are more than qualitative approximations. The data, which are also of uneven quality, have come from

a) pilot plants using coal but without integrated pollution control systems;
b) full-scale foreign installations without significant pollution controls; and
c) data from related industries, such as petroleum refining.

There are no data from full-scale Lurgi indirect coal liquefaction plants operating with any of the proposed control systems. Also, no mention is made in the Document of consistency checks of the data -- e.g., for the emissions gases of the Lurgi gasifier, the composition of the gases can be checked for consistency by employing chemical equilibria calculations.

Specific Suggestions and Comments

a) Section 2 is a strong summary of Volume I. This is not immediately apparent from the Table of Contents or from the Section itself. Section 2 should be highlighted or perhaps rewritten to make it more obvious to the user.

b) At least two flow diagrams are needed in the Document:

i) Flow diagram of the model plant configuration (gasifier using 3 coals, 3 product syntheses, and 2 control levels); and

ii) Flow diagram showing key waste streams (and where they originate) of primary environmental concern.

Note: We have included a suggested form for such diagrams on page vi of this report.

c) Some future high priority needs are

i) development and demonstration of more effective and lower-cost control systems; and

ii) development of additional exposure and effects data to improve assessments of relative risk in order to specify control level options.

d) The Document is written, with few exceptions, in metric units. Current professional usage, with few exceptions, utilizes British units. The usage in the Effluent Guidelines Documents includes both British and metric units.

e) In Volume I of the Document, the use of acronyms for terms used only once or twice should be minimized.

f) The philosophy and implications of Option I and Option II controls are not discussed in detail in any one place -- perhaps Section 2 would be a suitable place for this to be discussed explicitly.

g) The Document should clearly indicate the implied assumptions or philosophies used during evaluation and interpretation of the data. For example, What is the implied meaning of "general practice in cost estimating" in the presentation of cost estimates? Or, What are the assumptions behind "reasonable" for pollution control costs?

h) The conclusion about Noise (Volume 2, Section 3.5) should be included in Volume I: noise from a Lurgi facility will not be of sufficient level to disturb either humans or animals beyond the confines of the plant site.

i) The references in Volume III should be improved to allow the source of the data to be documented. The references should be specific, identifiable sources.

B.1. Air Pollution Control Considerations

Review of the air pollution content of Volume I revealed no problems associated with the technical content or its quality, as far as this can be judged from the information in Volume I.

Specific Suggestions and Comments

a. There was general agreement that pollution control costs, expressed as cost per unit of coal input, would be a useful addition to the cost data presented.

b. In Section II, the Summary Section, some information on pollution concentration before and after control (i.e., relative efficiency level) would be helpful along with the cost and volume data presented.

c. Section 4.1 mentions fugitive dust problems associated with coal storage and handling, and perhaps crushing and grinding. More emphasis could be given to this dust problem.

d. A clear statement is needed to indicate how the engineering analysis was carried out.

e. The most important pollution control costs should be identified and more fully discussed, including the accuracy of the cost estimates for individual devices.

f. If possible from the present data, total mass flows and concentration levels of all pollutants emitted from the gasifier should be specified.

B.2. Water Pollution Control Considerations

The Document states, "If adequate control over aqueous discharges in these plants is to be achieved, the early demonstration of the technical and economic viability of the candidate controls identified in this document ... is desperately needed." This is indeed true.

The authors state that, "Most of these processes (water pollution control) have not been applied directly to the control of indirect liquefaction plant wastewaters. Evaluations of the applicability, performance, and costs of these controls have been based upon experience gained primarily in the byproduct coking industry, petroleum refineries, and the electrical utility industry. Also, extensive use was made of conceptual information developed by designers and potential operators of future Lurgi facilities." This leads to the great strength and the weakness of the Document.

The approach to permit design flexibility in dealing with site- and process-specific effects is commendable.

The Document is useful in outlining the problem areas and in providing access to the related information. However, the material is not satisfactory for design considerations. One of the major principles in environmental engineering is that wastewaters from similar processes can be very different from one another. One cannot extrapolate and assume that the unit process performance on a particular wastewater will be identical for another wastewater. Several of the recommended unit processes should be piloted before adoption, and a caveat to that effect should be included.

Specific Suggestions and Comments

a. Volume I, page 8: Include flow diagrams for key waste streams.

b. Volume I, page 12: The statement relative to control levels defined by Options I and II as being achievable at reasonable cost and with conventional equipment is questionable. The statement contradicts the Agency's admission that wastewater treatment pilot plant data, both design and operational, were not available for evaluation.

c. Volume I, page 14: The 0.02 mg/l total phenol level should be checked. This appears to be a severe limitation on the effluent and may not be necessary even to protect primary surface drinking water sources.

d. Volume I, page 24: The limits for both Option I and II appear to be technology based. The Document should recognize the fact that water quality criteria will control in the absence of Federal regulations.

e. Volume I, page 26: There is much emphasis on the need to control air emissions from surface impoundments, even following steam stripping, biological oxidations, and forced evaporation. The loss of volatile organics from these impoundments should be re-evaluated when data are available. The paragraph needs restructuring.

B.3. Solid Waste Considerations

Specific Suggestions and Comments

a. Volume I, page 30, Section 2.3.3:

The Document does not appear to reference the latest information on hazardous waste management or disposal. For example, the guidance documents published by the U.S. EPA Office of Solid Waste. This information was available in draft form during the preparation of this Lurgi Document.

b. Volume I, page 27:

The statement is made that "the costs of solid waste disposal associated with these options are not accounted for in these figures." This omission is considered to be serious. Solid waste disposal costs

could represent a significant portion of total disposal costs, especially if the solid wastes must be disposed of as hazardous wastes.

c. Volume I, page 30, Section 2.3.3.: (See also page 179, the Section on Sulfur.)

i) We recommend a more critical analysis of whether it is more cost-effective to dispose of sulfur-containing streams directly or to recover sulfur and dispose otherwise.

ii) Following sulfur recovery, would the vanadium, thiocyanate, etc. present in the residues still require disposal as a hazardous waste?

iii) If the residues following sulfur recovery are hazardous, what are the cost implications relative to total costs of solid waste management or disposal?

d. Volume I, page 30:

The assumption of an economic break-even operation with "income balancing recovery operation costs" should be based upon a cost estimate made for more than one geographic region of the country when one considers the cost of transportation for marketing heavy bulk materials such as dry ash and sulfur.

e. Volume I, page 30:

It is recommended not only for bio-sludge but for all solid wastes that the proposed list of hazardous materials in hazardous waste streams, issued by the U.S. EPA under Section 3001 of RCRA, should be double checked for relevancy.

f. Volume I, page 30:

Land treatment of bio-sludge may not be universally applicable for reasons such as soil type, ground water, or climate conditions.

B.4 Costing

The Document, as a qualitative presentation of areas of concern, presents a very helpful approach to the estimation of costs for pollution control equipment.

Data, developed for both the pollution control equipment costs and for the uncontrolled process equipment costs, are in Volume III-A and in Volume III-B. The comparison of all pollution control unit operations costs to the base cost of an uncontrolled plant may be misleading.

Specific Suggestions and Comments

a. The method of presenting costs is awkward and does not follow typical practice. Costs should be presented on several bases in Volume I and Volume III:

i) as a percentage of total plant costs;

ii) as dollars of capital costs per unit plant feedstock capacity, e.g., $/ton of coal; and

iii) as dollars of annualized costs per unit of feedstock processed, e.g., $/ton of coal/day.

For items ii) and iii), it is important also to report the removal efficiencies for key pollutants.

Column headings for the tabulation might be as follows:

Control process description
Input treated -- stream capacity
Capital cost
    $
    $/ton
    % of total plant
Annualized cost
    $/ton
    % of total plant annualized cost
Removal efficiency

b. Volume I, page 11: It is stated that the cost estimates are judged to be accurate to +50%. This is a qualitative range within a qualitative document. Also, the authors are not consistent in treating this value as the range for each component of the cost estimate or as the range for the totalled costs. It makes a difference. In addition, the consequences of these uncertainties on pollution control costs should be identified.

B.5 Requirements for Toxic Substances Control (Volume I, page 52, Section 3.4)

The TSCA situation is described well for Section 5 of the Act, Premanufacture Notification (PMN). As more Sections of TSCA are put into effect, they should be followed assiduously because many of the streams are of interest under TSCA. One example is TSCA, Section 4 -- Testing Guidelines.

The Discussion of PMNs should also mention "intermediate streams." Under the present interpretations of Section 5, any stream that is sent to storage, even though it is processed on the plant site at a later time (even one day later), is subject to PMN.

The advice of the Document, to maintain a working liaison with the Synfuels/Toxics Workgroup (STWG) of the EPA Office of Toxic Substances, is the best possible advice at this time.

B.6 Regulations

Specific Suggestions and Comments

a. Air Pollution Regulations (Volume I, page 37, Sections 3 and 3.1)

The Section on air regulations appears to be adequate.

b. Water Pollution Regulations (Volume I, page 40, Section 3.2)

i) The Criteria Pollutants listed in Section 307a in the Clean Water Act of 1977 should be

compared to those effluent pollutants from a Lurgi plant because these will be used in the next series of water quality standards.

ii) It is likely that state water quality standards will be the basis for most permits. Perhaps this point can be addressed by a site specific example.

iii) The Document needs to have a discussion of the applicability of water quality standards and/or those based upon technology, and when one set of standards or the other applies.

iv) The date for technology-based effluent standards (July 1, 1983) is no longer applicable. This should be updated.

v) Table 3-3 (Volume I, page 42) should be upgraded to indicate the regulations under Sections 316(a) and 316(b) of the Clean Water Act.

c. Solid and Hazardous Waste (Volume I, page 46, Section 3.3)

i) The regulations under Section 3001 of RCRA (listing hazardous waste data, hazardous waste metals and chemicals, and hazardous waste substances) are omitted. These were available in proposed form since December of 1978 and August 1979, and part were promulgated in May of 1980. The proposed list is an indication of what will be issued in the future.

ii) A number of RCRA regulations were promulgated as this Document went to press. It is assumed that the lists on pages 48 and 50 of Volume I will be updated.

d. Superfund

Under the Clean Water Act and now under Superfund, every plant of this type and size will be subject to severe penalties for spills of oils and/or chemicals. It behooves every plant to have a "Spill Prevention and Control Program." Mention should be made of this.

C. Conclusions and Comments

The great strength of the Document is that it has taken a complex and tentative technology and provided a qualitative guide for considering the environmental implications of the plant. The Document will be worth the effort of its production if its timely, tentative, non-binding perspective and organization could

a) provide a tentative basis for discussion between regulators and constructors;

b) encourage the design and installation of cost-effective pollution controls at the time of plant construction;

c) reduce permitting delays;

d) reduce regulatory uncertainty and risks of costly retrofits; and

e) promote public confidence in the environmental safety of first-generation plants.

Although individual details can be challenged, the results are qualitatively useful for guiding analyses of pollution streams and control. The engineering approach, including the engineering judgments used to bridge the areas of incomplete data, are valid, although probably never optimal. The model plant approach allows for combinations of process steps and allows for estimating, albeit roughly, the pollution potentials of waste streams. The concepts are presented to allow early decisions on multi-media choices -- the trade-offs between air/water/solid wastes pollutant streams to be treated.