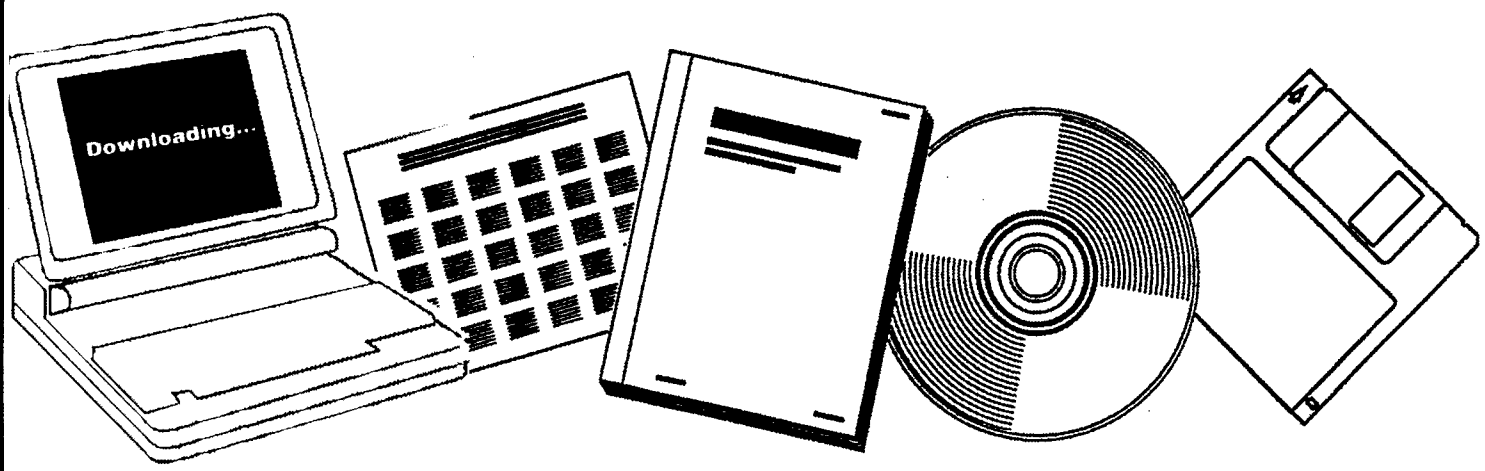
EVALUATION OF ALTERNATIVE USES OF COAL AND COAL-DERIVED FUELS - INDUSTRY, GOVERNMENT, AND PUBLIC VIEWPOINTS VOLUME II

NOV 1975



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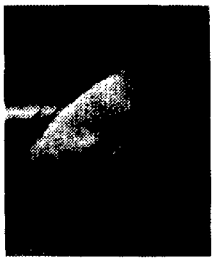

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RESEARCH REPORT

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on

EVALUATION OF ALTERNATIVE USES OF COAL AND COAL-DERIVED FUELS — INDUSTRY, GOVERNMENT, AND PUBLIC VIEWPOINTS

Volume II — Appendices

to

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
Fossil Energy Department

November 17, 1975

by

D. W. Locklin, D. W. Malone, D. E. Molnar,
L. K. Sander, and D. L. Morrison

ERDA Contract No. W-7405-eng 92, Task 74

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Columbus, Ohio 43201

ABSTRACT

This report covers a study by Battelle's Columbus Laboratories to identify viewpoints representative of various interest groups on alternative uses of coal and coal-derived fuels. The study was conducted for the ERDA Fossil Energy Department to provide background inputs to the R&D planning process. A series of nine structured workshops was conducted with participation by selected representatives of the various interest groups.

Participants in the individual workshops included representatives of industrial and utility companies, state and federal governments, and public interest groups. Viewpoints were recorded on (1) the relative importance of five specific evaluation criteria, (2) the evaluation of seven fuel categories against the criteria, (3) a forecast of future fuel utilization by categories, and (4) suggested R&D emphasis for the fuel categories.

The Volume I report is a summary and appraisal of workshop results. This Appendix Volume (Volume II) contains appendices with more detailed records from the workshops.

TABLE OF CONTENTS

APPENDIX A

MATERIALS PROVIDED TO PARTICIPANTS BEFORE AND DURING WORKSHOPS

The following forms and background documents are included here for references purposes:

1. Sample cover letter confirming individual invitations
2. Kit of advance materials mailed to participants
3. Survey forms used during workshops
    a. Predicted Utilization of Coal and Coal-Derived Fuels
    b. Priorities for R&D Emphasis
    c. Evaluation and Feedback.

July 8, 1975

MEETING ON R&D PRIORITIES FOR COAL AND COAL-DERIVED FUELS

Oil and Chemical Industry -- July 15

This is to confirm our telephone conversation regarding our plans for an informal meeting of representatives of the oil and chemical industries to discuss R&D priorities for coal and coal-derived fuels. We hope you or a company representative will be able to participate in the meeting to be held on July 15 at Battelle Columbus.

This is one in a series of meetings being organized as part of a study that Battelle is conducting for the Fossil Energy Division of the Energy Research and Development Administration (ERDA) to identify viewpoints of different industry sectors as inputs to the ERDA planning process.

Meeting and Motel Arrangements

We have reserved rooms for you and the other seven participants at the Hilton Inn, 3110 Olentangy River Road, Columbus, Ohio, for arrival on the night of July 14. They are prepaid and will be held for late arrival if necessary. We will pick you up at the Hilton at 8:00 a.m. on July 15. The meeting will last from 8:30 a.m. to 4:30 p.m., so that departure flights any time after 5:45 p.m. are compatible with this timing.

Scope and Objectives of the Meetings

Meetings are planned to include the following groups:

Electric power generation
Gas industry
Oil and chemical industries
Coal industry
Industrial fuel users
Federal government
State government
Public interest

These meetings are being held to synthesize profiles of priority views representative of the various groups. The focus of the meetings will be on weighting of priority criteria for broad classes of coal and coal-derived end products; it will not be necessary to consider priorities between competing processes within an end-product category. Using a modified "Delphi" technique, we will seek participants' assessments early in the meeting, plus subsequent consideration of these evaluations later in the meeting based on further discussion.

Anonymity of Views

So that all can participate in the discussions with full objectivity, names of individual participants will not be mentioned in the reporting procedure. ERDA staff will not be present. Views will not be identified by individual, except where specific permission is granted.

Background Materials

Some brief background materials on the meeting structure and definitions are attached. Since we will be recording preliminary views early in the meeting, it will be helpful if you will review this material, but no extensive preparation will be necessary.

We hope you will find it possible to participate in the meeting personally. However, if you cannot attend, please call me or Shirley Haynes on Extension 3168 to let us know who will be representing your company.

Sincerely,

David W. Locklin
Program Manager
Combustion and Energy
Utilization Research

DWL:sh

Attachments: A, B, and C

BACKGROUND MATERIALS

Attachments to Letter of Invitation

A. Definition of Fuel Categories for Coal and Coal-Derived Fuels

This will provide the basis for fuel definitions that will be used in the discussion.

B. Criteria for Evaluating the Fuel Categories, plus Rating Sheets

This defines a set of criteria by which the various fuel categories can be evaluated.

We will be using these rating sheets early in the meeting. They are provided now so that you can become familiar with the tasks to be performed at the meeting and, possibly, discuss ratings with others in your organization in advance. As mentioned in our letter, these inputs will be treated anonymously.

C. Format for the Discussion Meeting

This additional information on the agenda and details of the meeting plan will acquaint you with the meeting structure.

DEFINITIONS OF FUEL CATEGORIES
for
COAL AND COAL-DERIVED FUELS

The following definitions are proposed for the categories of coal and coal-derived fuels to be used in priority evaluations:

1. Coal As Mined, Direct Fired, Unconstrained by SO_2 Emission Regulations
2. Low-Sulfur Coal, Direct Fired Specifically to Meet SO_2 Emission Regulations
3. Coal As Mined, Direct Fired with SO_2 Control Equipment
4. Chemicaliy Cleaned Coal
5. Synthetic Liquids
6. Low-Btu or Intermediate-Btu Gas
7. Pipeline-Quality Gas

Additional explanation of these categories follows:

1. Coal As Mined, Direct Fired, Unconstrained by SO_2 Emission Regulations

This category includes coal, as mined, that is to be direct fired in equipment where SO_2 regulations are non-existent, waived, or will permit operation without measures for SO_2 control. Included in this category is coal of any sulfur level, as mined, even though it may be crushed, washed, or screened. Particulate control equipment may or may not be involved, depending on the size and nature of the installation.

For example, this category may apply where SO_2 emission levels of small equipment or older installations are not covered in federal or local regulations. (The federal new source performance standard at present applies only to emission limits of certain types of large new or modified installations.)

R&D in this category would include that directed to increasing the acceptability and extent of direct firing of coal without SO_2 emission control equipment. For example, R&D could be directed to economic and convenience factors, as well as to minimizing emissions of pollutants other than SO_2 (like NO_x and fine particulates).

2. Low-Sulfur Coal, Direct Fired Specifically to Meet SO_2 Emission Regulations

This category applies where coal, to be direct fired, is chosen (on the basis of its sulfur content) specifically for the purpose of meeting SO_2 emission regulations or regulated limits of fuel sulfur content. It includes coal that is sufficiently low in sulfur, as fired, to meet applicable regulations -- whether by its natural sulfur content or with the aid of mechanical preparation and washing.

For example, coal having sulfur content of less than 0.75 percent meets the present federal new source performance standard. However, lower sulfur content may be required to meet some local regulations.

3. Coal As Mined, Direct Fired with SO_2 Control Equipment

This category applies to coal of any sulfur level, as mined, where this coal is to be direct fired in installations with SO_2 control equipment to meet regulations. This covers installations where SO_2 control is achieved either by (1) stack-gas treatment for downstream SO_2 control or (2) chemically active fluidized-bed combustion.

R&D in this category would include that directed to increasing the acceptance and use of stack-gas treatment for conventionally fired solid coal or, alternatively, of chemically active fluidized-bed combustion systems or other systems where SO_2 control is combined with the combustion process.

4. Chemically Cleaned Coal

This category comprises solid coal that has been chemically treated to reduce sulfur content such that no other SO_2 control is needed. Ash may also be reduced, but particulate controls may still

be needed in some installations. Examples are solvent-refined coal or other chemically desulfurized coal that is fired conventionally as solid fuel.

R&D in this category would be that directed to chemical processing for fuel sulfur removal and to utilization techniques that will increase the acceptance and use of these chemically cleaned fuels.

5. Synthetic Liquids

Fuels from coal liquefaction processes comprise this category, along with intermediate liquid products that can be used as feedstocks for further refining to finished fuels or to chemicals. Sulfur levels of such finished fuels are expected to be low enough that SO_2 controls are not required.

A wide range of liquid synthetic fuels are included, for example:

- heavy boiler fuels
  (fired as a liquid)
- "turbine-clean" fuels
  (low in metals and particulates)
- light heating fuels or diesel fuels
- spark-ignition-engine fuels.

R&D in this category would be that directed to (1) liquefaction processes to produce synthetic liquid feedstocks and fuels as primary products, and (2) identifying and solving problems in utilizing these fuels to broaden their acceptance and use.

6. Low-Btu or Intermediate-Btu Gas

This category covers fuel from coal gasification at the site of utilization (or piped for relatively short distances to the point of utilization, as in central supply for industrial parks). The energy value of this fuel gas is less than for natural gas.

Two basic types of gasification processes are under current investigation and are classified by the energy level of the fuel gas they produce:

- Low-Btu gas (~150 Btu/cu ft for air-blown gasifiers)
- Intermediate-Btu gas (~300 Btu/cu ft for oxygen-blown gasifiers)

Generally sulfur and particulate are to be removed from the fuel gas prior to its utilization.

Large boilers designed for coal may be retrofitted with some difficulty for low or intermediate gas, but oil- or gas-designed boilers may require derating, especially for low-Btu gas; many industrial combustion applications may be retrofitted for these gases.

R&D in this category would be that directed to gasification processes, to precombustion clean-up of sulfur and particulate, and to fuel-gas utilization to increase the range of application and acceptance of this approach for a variety of applications.

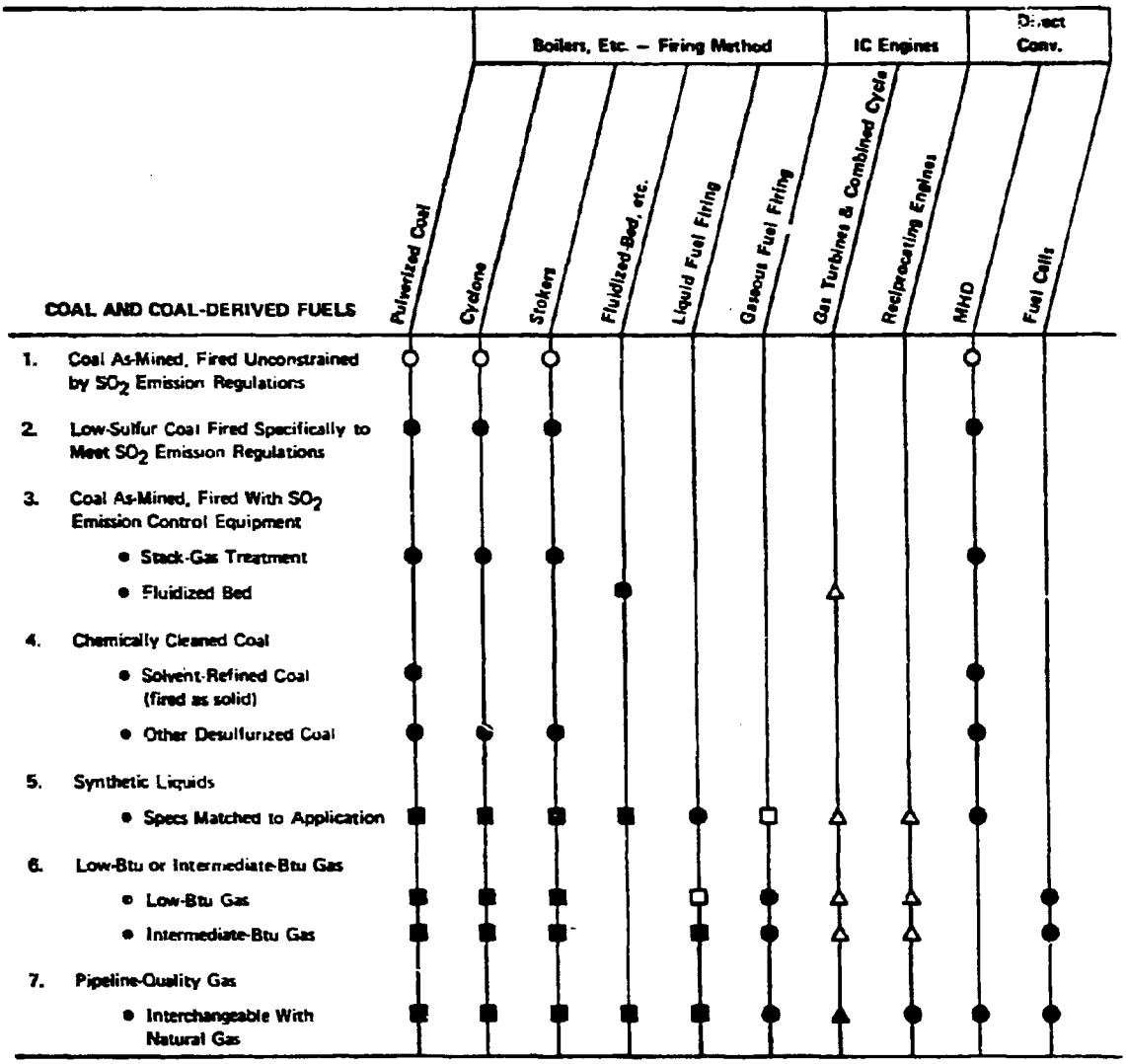
7. Pipeline-Quality Gas

Pipeline-quality gas, or high-Btu gas, from coal is intended to be essentially interchangeable with natural gas in transmission and utilization. It is frequently called "substitute natural gas" or "synthetic natural gas" (SNG).

Large gasification plants near coal fields are in the planning stage for producing pipeline-quality gas from coal. The gasification process may be similar to that for on-site gasification, but cleaned intermediate-Btu gas is upgraded by a methanation step to yield the same energy value as natural gas (~1,000 Btu/cu ft).

R&D for this category would be that directed to processes for gasification, clean-up, and methanation to enable the production and use of pipeline-quality gas from coal. The burning characteristic of the gas is essentially the same as for natural gas, so R&D in utilization would be concentrated on those few industrial processes that are sensitive to small differences in gas interchangeability.

APPLICABILITY MATRIX OF FUELS AND END-USE APPLICATIONS



○ May not meet NSPS limit.* May comply with SO_2 regulations for some sources in some localities.

● <0.75 sulfur coal will meet NSPS SO_2 limit. Lower sulfur may be required in some localities.

△ Special cleanup is necessary to make these fuels "turbine clean". Will meet NSPS limit.

▲ Already "turbine clean". Will meet NSPS limit.

□ Retrofit from listed firing method is generally feasible, but with difficulty and possible derating. Will meet NSPS limit.

■ Retrofit from listed firing method is generally feasible without derating. Will meet NSPS limit.

*NSPS: Federal New Source Performance Standards.

A-9

CRITERIA FOR EVALUATING

THE FUEL CATEGORIES

and

RATING SHEETS

Criteria

The following criteria are considered to be a minimum set needed in judgments concerning R&D priorities for coal and coal-derived fuels. The criteria are listed below without intended order of importance:

A. Contribution to energy self-sufficiency in the United States
B. Extent of technical problems
C. Economics
D. Environmental impacts
E. Human impacts

These criteria are further defined on the subsequent pages.

Rating Sheets

Each of the following sheets contains a brief explanation of the particular criterion to be considered and a set of scales for rating the various fuel categories. In each case, please place an "X" on the scale to indicate your best judgement regarding the relative ability of each of the various fuels to meet the specified criterion.

There are two parts to the set of rating sheets. The first group of 5 sheets (Part I) asks you to assess the extent to which each of the possible coal-derived fuels satisfies each of several specific criteria. The final sheet (Part II) then asks you to rate the relative importance of each of the criteria for use in establishing priorities or preferences for the various fuels; this results in weighting factors for the criteria.

PART I. EVALUATION OF FUEL CATEGORIES

Criterion: A. Contribution to Energy Self-Sufficiency in the United States

This criterion is based on consideration of the extent to which the United States can effectively utilize domestic coal and coal-derived fuels on a major scale to eliminate dependency on foreign energy sources as soon as possible. The criterion refers to the degree to which coal and coal-derived fuels can be used as substitutes for petroleum-based clean fuels to free them for high priority uses, and the degree to which these coal products can have flexibility for serving multiple uses.

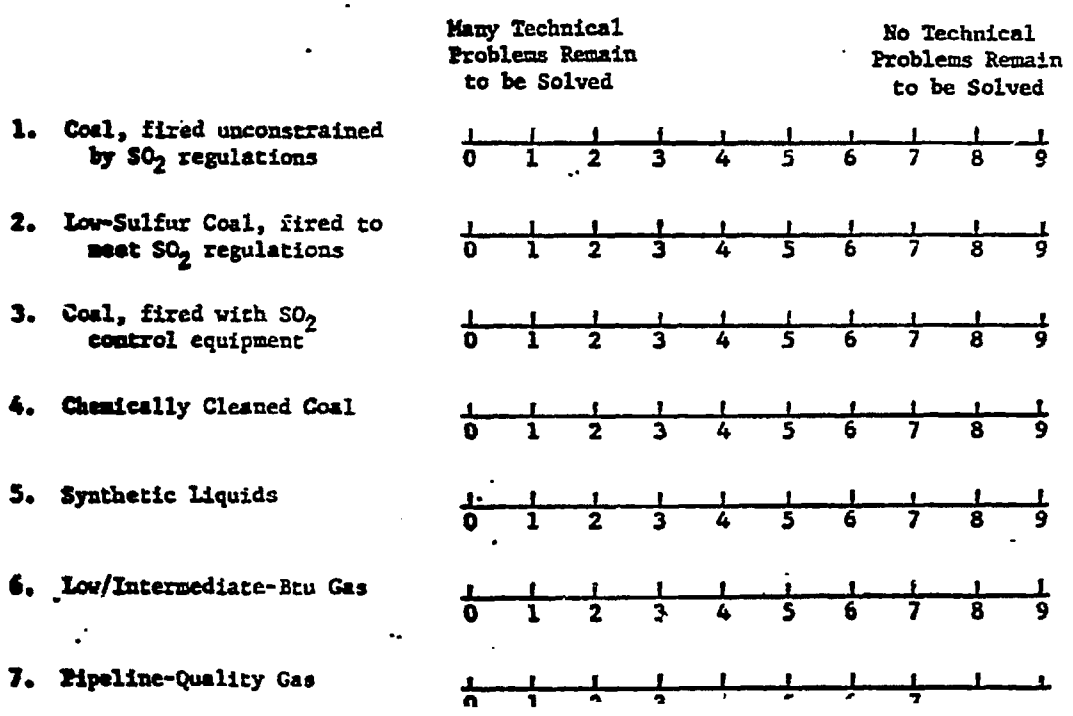
The military preparedness value of a specific contribution to energy self-sufficiency should also be considered.

	Low Contribution									High Contribution
1. Coal, fired unconstrained by SO_2 regulations	0	1	2	3	4	5	6	7	8	9
2. Low-Sulfur Coal, fired to meet SO_2 regulations	0	1	2	3	4	5	6	7	8	9
3. Coal, fired with SO_2 control equipment	0	1	2	3	4	5	6	7	8	9
4. Chemically Cleaned Coal	0	1	2	3	4	5	6	7	8	9
5. Synthetic Liquids	0	1	2	3	4	5	6	7	8	9
6. Low/Intermediate-Btu Gas	0	1	2	3	4	5	6	7	8	9
7. Pipeline-Quality Gas	0	1	2	3	4	5	6	7	8	9

Criterion: B. Extent of Technical Problems

This criterion refers mainly to the state of development of technology associated with the various conversion processes, and with the level of technical risk involved in the problems remaining to be solved. Of particular concern is the probability that the process can be developed to a commercial scale. Related concerns include:

- Technical feasibility of retrofitting existing installations to fire these fuels
- The efficiency of coal conversion (i.e., net energy delivered at the point of use relative to the energy originally mined) that results in conservation of coal resources
- The need for R&D in related technologies (materials development, etc.) and the potential for the R&D influencing the risk associated with the coal conversion processes
- The availability of scarce resources (e.g., water in some areas)
- The ability to produce certain manufactured products (e.g., large pressure vessels) needed to implement the wide-scale use of a given coal product.

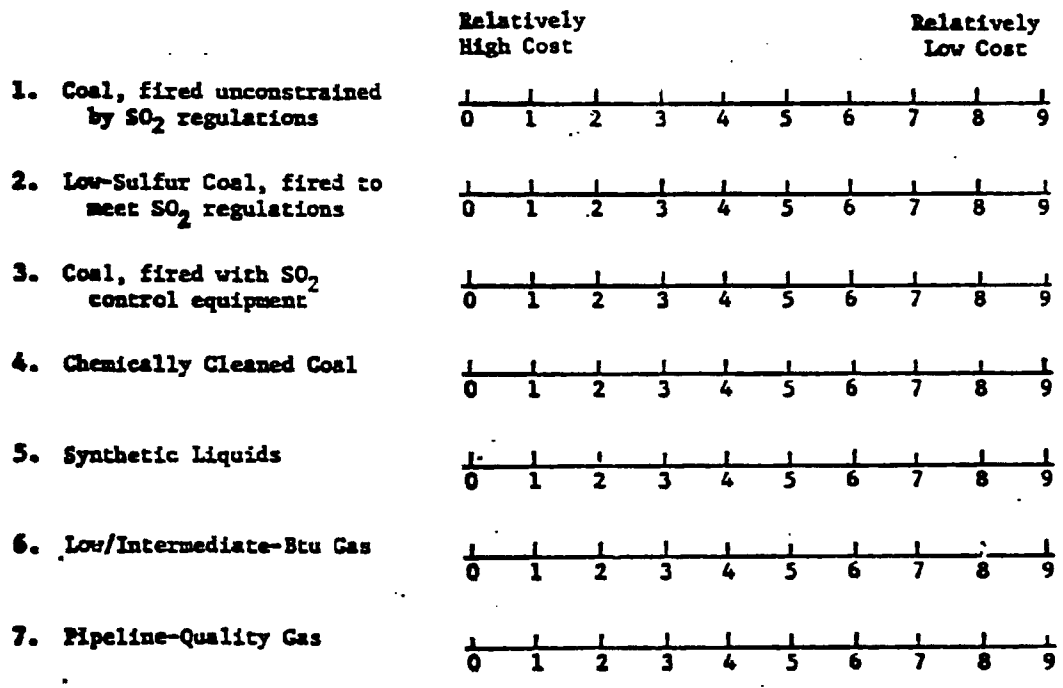


Criterion: C. Economics

This criterion refers to the total cost of building and operating a system to produce, transport, store, and utilize a given coal-derived fuel product. This includes all of the tangible costs that must be incurred to realize full implementation of a given coal-derived fuel.

Costs to be considered include the following:

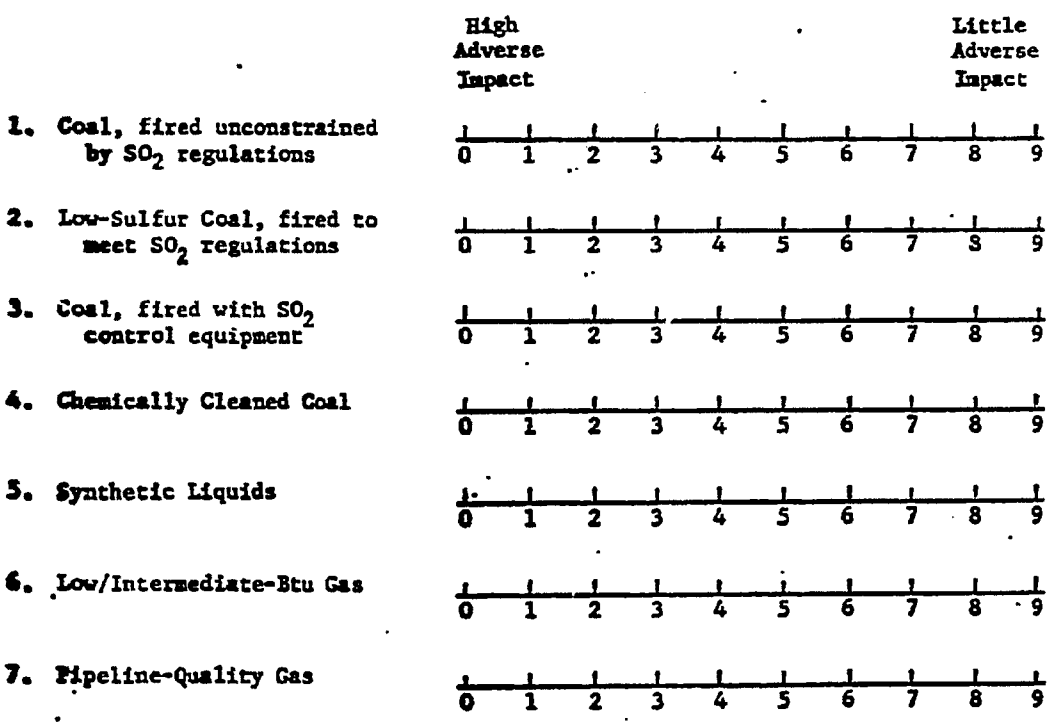
- R&D and demostration costs to enable full-scale operation
- Capital investment for plants and facilities (including land, equipment, construction, interest, and cost escalation during construction, etc.)
- All operating costs in producing finished fuels
- Costs for transportation of finished fuels to point of use
- Costs associated with environmental controls and retrofit at point of use (if retrofit is needed).



Criterion: D. Environmental Impacts

This criterion refers to the relative adverse impact on the physical and biological environment at the conversion site, at the point of use, and in transporting and storing the coal-derived fuel. It also refers to the adverse impact on all elements of the natural environment: namely, air, water, solid waste and thermal, including aesthetic impacts. Requirements for the use of scarce resources, or acceleration of the use of non-renewable resources (resource depletion) are also considered to be environmental impacts.

This criterion deals primarily with localized impacts.



Criterion: E. Human Impacts

This criterion refers to the impact on the net "Quality of Life" of the overall population as a result of extensive use of the various fuels. Of concern are adverse impacts that might affect individuals, communities, or society in general. This includes the overall manpower requirements associated with conversion and utilization of a given coal fuel and the employment shifts caused by changing over to a different fuel. Also included are any significant cultural impacts resulting from the conversion processes and associated activities.

In considering this criterion, emphasis shall be placed on overall impact to the nation; this means that intensive local adverse impacts may have to be carefully weighed against broader or more diffuse benefits.

	Highly Undesirable Overall Impacts ← → Highly Desirable Overall Impacts
1. Coal, fired unconstrained by SO_2 regulations	0 1 2 3 4 5 6 7 8 9
2. Low-Sulfur Coal, fired to meet SO_2 regulations	0 1 2 3 4 5 6 7 8 9
3. Coal, fired with SO_2 control equipment	0 1 2 3 4 5 6 7 8 9
4. Chemically Cleaned Coal	0 1 2 3 4 5 6 7 8 9
5. Synthetic Liquids	0 1 2 3 4 5 6 7 8 9
6. Low/Intermediate-Btu Gas	0 1 2 3 4 5 6 7 8 9
7. Pipeline-Quality Gas	0 1 2 3 4 5 6 7 8 9

PART II. EVALUATION OF CRITERIA

Criteria Weighting Factors

Please place an "X" on the scale to indicate your best judgement regarding the relative importance of the following criteria in determining priorities or preferences for the various coal-derived fuels. The scale results in relative weighting factors for the criteria.

	Negligible Importance									Of Utmost Importance
A. Contribution to Energy Self-Sufficiency in the U.S.	0	1	2	3	4	5	6	7	8	9
B. Extent of Technical Problems	0	1	2	3	4	5	6	7	8	9
C. Economics	0	1	2	3	4	5	6	7	8	9
D. Environmental Impacts	0	1	2	3	4	5	6	7	8	9
E. Human Impacts	0	1	2	3	4	5	6	7	8	9

FORMAT FOR THE DISCUSSION MEETING

Agenda

8:00 Pick up of participants at Hilton Inn

8:30 Morning Session

- Introduction, objectives, and ground rules
- Initial ratings by participants
- Open discussion for clarification of categories and criteria
- Second ratings by participants

11:45 Lunch

1:00 Afternoon Session

- Summary presentation of ratings 1 and 2
- Open discussion of implications
- Final ratings by participants and summary
- Minority statements

4:30 Adjournment

Details of Meeting Plan

Specific workshop activities will be directed to the identification of group viewpoints (including consensus and minority viewpoints), with any needed clarification of fuel categories and criteria.

The first activity of the meeting will be for each of the participants to complete the rating sheet included here as Attachment B. If you have time to fill this out before coming to the meeting, it will facilitate the initial rating procedure and additional time will be freed for discussion.

Following the initial completion of the rating sheet, there will be open discussion within the group to clarify and define appropriate concepts and to adjust any definitions required to remove any ambiguities in the broadly labeled categories and criteria as presented in Attachments A and B. After the discussions, the rating sheet will be completed again to provide an opportunity for participants to adjust positions on the basis of new or clarified information.

In the afternoon, the results from the first two ratings will be presented to the group for review and discussion. Opportunity will be provided for advocates of particular positions to make arguments for adjustments in the group position. Following these discussions, the rating sheet will be completed for the final time, the results presented to the group to examine whether a consensus exists, and time provided for recording of minority views.

An electronic aid will be used to speed up the process of recording the ratings of all participants simultaneously and tabulating the results. Anonymity of the individual participants' votes will be assured, while information related to averages and spreads in votes will be made available to the group as a whole.

At the end of the day, each participant will be provided with a copy of the group's final position. Later, each participant will also receive a copy of Battelle's summary report to ERDA covering the entire series of meetings.

PREDICTED UTILIZATION OF COAL AND COAL-DERIVED FUELS

We would like to obtain your judgments regarding the likely mixes of fuels derived from coal, as they will be used in three distinct time periods. Rate the fuel expected to have the greatest utilization with a 9. Rate the remaining six categories relative to that one. (For example, give a rating of 3 to a fuel that you expect to be used to produce about one-third of the "equivalent energy" produced by the most significant fuel.) Please do this for the three indicated time periods.

	1980	1990	2000
1. Coal, fired unconstrained by SO_2 regs.	_____	_____	_____
2. Low-sulfur coal, fired to meet SO_2 regs.	_____	_____	_____
3. Coal, fired with SO_2 control equipment.	_____	_____	_____
4. Chemically cleaned coal	_____	_____	_____
5. Synthetic liquids	_____	_____	_____
6. Low/Intermediate Btu gas	_____	_____	_____
7. Pipeline-quality gas	_____	_____	_____

R&D PRIORITIES

Priorities for R&D Emphasis

Several of the industry groups have suggested that a direct rating be conducted on the relative emphasis that is needed for R&D to be directed to each of the fuel categories.

Please indicate the relative R&D effort that you believe appropriate to be allocated to each fuel category, considering the evaluation criteria from your own viewpoint and the relative costs of R&D in the various areas.

Use a percentage scale, so that your ratings add to 100.

Fuel Categories	Percent Effort
1. Coal, fired unconstrained by SO_2 regulations	_____
2. Low-Sulfur Coal, fired to meet SO_2 regulations	_____
3. Coal, fired with SO_2 control equipment	_____
4. Chemically Cleaned Coal	_____
5. Synthetic Liquids	_____
6. Low/Intermediate-Btu Gas	_____
7. Pipeline-Quality Gas	_____
	100 %

Please mail completed form to: D. W. Locklin
Battelle Columbus Laboratories
505 King Avenue
Columbus, OH 43201

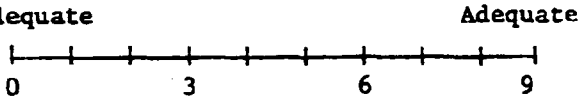
Thank you.

EVALUATION AND FEEDBACK

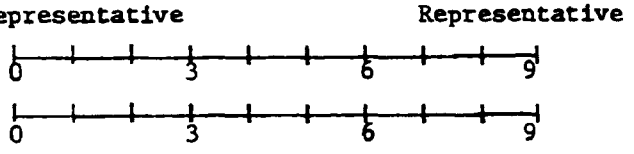
Part 1

Please complete the following questions to help us judge the extent of individual satisfaction with the results of this workshop.

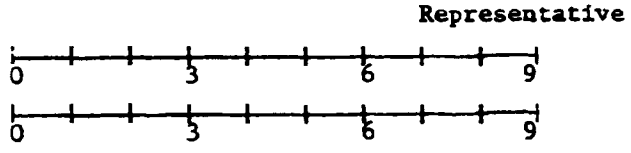
1. Was there adequate opportunity for your ideas to be considered?



2. Do you feel that the final result is truly representative of <u>this group's</u> collective position?



3. Do you feel that the final result is truly representative of <u>your industry's</u> position?



Part 2

4. What activities or conditions did you find particularly useful in helping the group work towards the objective?

5. What activities or conditions did you find distractive or inhibitory to the group task?

APPENDIX B

KEY COMMENTS BY PARTICIPANTS

This Appendix contains key comments of participants or group positions that were selected from notes taken at the workshops as being representative of significant inputs or insights. They have been distilled and combined in some cases.

Comments were recorded on tape only at the request of participants. The most significant of these taped comments, usually as group positions, are included in Appendix C with the principal record of each workshop group.

Comments in this Appendix are organized as follows:

- COMMENTS ON EVALUATION CRITERIA
  (for each criterion)
- COMMENTS ON FUEL CATEGORIES
  (for each fuel category)
- COMMENTS ON R&D EMPHASIS
- COMMENTS ON FEDERAL INCENTIVES
- COMMENTS ON SPECIAL ISSUES
- COMMENTS ON METHODOLOGY
- GENERAL COMMENTARY.

The last 5 sections are arranged by workshop group.

COMMENTS ON EVALUATION CRITERIA

Extent of Technical Problems

- The Germans succeeded in making synthetic fuel in the period from 1930 to 1945. However, this was not considered commercially viable for the U. S. due to economics, safety requirements for workmen, and environmental concern. (Oil and Chemical Industry Group)

- There was a concern by the Composite Group that the weighting scheme for Criterion B--extent of technical problems--cannot be the same used for the other criteria. An illustration is that "there may be no technical problems involved in poisoning the next generation."

Economics

- The Electric Power Industry Group pointed out the distinction between "base-load" and peaking" use. The decisions concerning the proper mix of equipment and fuels translates into tradeoffs between capital equipment investments and operating costs.

Human Impacts

- The Oil and Chemical Industry Group suggested that major developments in energy conversion may cause employment bidding. Major inflation could occur if employment bidding proceeds unbounded.

- We generate energy for a purpose. We do not just push energy through transmission lines and pipelines for the fun of it. The energy is used to improve the human condition and it affects the environment in both positive and negative ways. (Composite Group)

Environmental Impacts

- A participant suggested that there are many secondary impacts associated with fuel categories 3 through 7 that we know very little about, e.g., carcinogenic agents. (Federal Government Agencies)

Interplay of Criteria

- A participant illustrated the interplay of the criteria as follows: "We could be walking in the dark, looking for work, but breathing clean air." (Electric Power Industry Group)

COMMENTS ON FUEL CATEGORIES

- The Coal Industry Group indicated that the fuel categories are less efficient from Category 1 to Category 7, i.e., the usable energy derived from a ton of coal is less in the end use, going from Category 1 to Category 7.

Coal, Fired Unconstrained by SO_2 Regulations

- The Public Interest Group questioned the health effects of SO_2. Sulfate and particulate matter were mentioned as being important, especially respirable particulates.

- The Federal Government Agencies Group indicated that there are many places where we could burn coal unconstrained and still meet the ambient standards. To solve our energy problems we will have to burn coal unconstrained.

- The Coal Industry Group stated that there is a serious problem in reconverting many plants back to coal burning. The distribution system for coal would have to be completely rebuilt.

- The Coal Industry Group stated that in order to convert oil-designed burners to coal burners, they would have to be derated. This is generally not feasible. A 5 percent derating is usually unacceptable to a utility.

Low Sulfur Coal, Fired to Meet SO_2 Regulations

- The Coal Industry Group indicated that low sulfur coal is a desirable answer but there is not a great supply.

- The Oil and Chemical Industry Group indicated that the real problem is transportation. The need for coal in power generation is in the northeast portion of the country, but the low sulfur coal is in the southwest.

Coal, Fired with SO_2 Control Equipment

- The Federal Government Agencies Group commented that stack gas scrubbers do not work at the present time. There is a need for a massive expansion of a new industry in order to make scrubbers viable. The capital cost of scrubbers is the real problem.

- A participant commented on fluidized combustion as being a very attractive technology under the fuel category. It may be most economical for retrofitting. There is high technical risk associated with AFBC and a question of the availability of limestone at a reasonable cost. This process will not be used extensively in industry (except for very large companies), but pressurized FBC may be another matter. (Composite Group)

Chemically Cleaned Coal

- The Electric Power Industry Group suggested that the problem with SRC is that it is neither coal (solid) nor oil (liquid) and it is very difficult to store, it may be carcinogenic, and there is a great materials handling problem.

- The State Governments Group expressed reservations as to the economics of chemical cleaning processes.

Synthetic Liquids

- The Coal Industry Group pointed out that the transportation sector is dependent on liquids.
- The Oil and Chemical Industry Group suggested that synthetic liquids should be broken down to several categories--methanol, Fisher-Tropsch, hydrogenated syncrude, and lightly hydrogenated coal (which may have carcinogenic problems).
- The Oil and Chemical Industry Group stated that the state of the art in synthetics is not good. Government action in R&D is needed. *
- The Electric Power Industry Group indicated that the experience with synthetic liquids is that they sludge out. Pyrolysis liquids have gummed up equipment. There are a lot of problems yet in this area.
- The Industrial Fuel Users Group questioned the absence of oil shale in the list of fuel categories. This may be a lower cost alternative than synthetic liquids.
- The Federal Government Agencies Group suggested that there is a strong suspicion of toxicity associated with liquid coal products.

Low/Intermediate BTU Gas

- The Gas Industry Group commented that intermediate BTU gas is almost the same price as SNG. Intermediate BTU gas is the basic problem for pipeline quality gas.
- A participant preferred to separate low- and intermediate-BTU gas. The places for use of low-BTU gas are limited. Retrofit possibilities for nitrogen-bearing gases are limited. (Oil and Chemical Industry Group)

* See also recorded comments by Oil and Chemical Industry Group in Appendix C.

- The Federal Government Agencies Group pointed out that low-BTU gas has potential for combined-cycle use with high efficiency. Much of the current thrust in low-BTU gas is for combined-cycle use.

Pipeline Quality Gas

- The Electric Power Industry Group agreed that the use of gas as a boiler fuel should be discouraged to preserve gas for processes that are difficult to convert. (One representative indicated that it was against company policy.)

- The Oil and Chemical Industry Group stated that the problem with synthetic fuels is the difficulty in obtaining financing.

- The Gas Industry Group stated that the country cannot afford to give up a highly efficient distribution system; i.e., the gas distribution system.

- A representative from the Electric Power Industry Group commented that pipeline quality gas is so expensive that it will not be viable for a long time.

Mixed Fuels (Coal Industry Group Only)

- Many R&D opportunities with the blending technologies are being missed. This is not esoteric; it is close at hand. A G.M. demonstration project was mentioned.

- There may be more problems with mixed fuels than first realized; e.g., materials handling. A new technology may be required to make possible delivery as a liquid; e.g., a stabilized liquid.

- The costs associated with mixed fuels will depend on several factors: whether the liquid is natural or synthetic; pulverizing to a colloidal level; the emulsifier; whether it's transported as a slurry or colloidal suspension. These possibilities suggest that this is a fruitful area of research.

COMMENTS ON R&D EMPHASIS

Oil and Chemical Industry

- There is a distinction between R&D priorities and action plans. Fuel priorities apply to action plans, whereas R&D priorities might not be directly related to the priority of fuel uses.

Gas Industry

- The group assumes that there will be thrusts in all the fuel categories and that R&D should be encouraged for all categories.
- The ERDA should put time and effort into synthetic fuels, but not exclude the immediate role of burning coal.
- We should spend money on things "right on the threshold" in order to help things happen more quickly.
- There was a concern that ERDA would interpret a high rating on a fuel category as a high vote for R&D expenditures; e.g., a high vote on fuel category 1.

Electric Power Industry

- Research is needed to obtain data to develop cost/benefit analyses for ambient environmental standards.
- There was a suggestion that we should not assume that things will not change. It is better to assume that it is possible to intervene.

Industrial Fuel Users

- Nonenergy intensive industries in which gas and oil are heavy fossil fuel sources are not interested in converting to coal, but they will use derivatives from coal. The ERDA R&D efforts could be most useful in this area.

Public Interest Groups

- The R&D strategy should internalize all social and environmental costs and be concerned with long-term problems and options.

State Governments

- Some of the questions are not relative to R&D, e.g., that we can make pipeline quality gas, low-BTU gas, and solvent refined coal are well demonstrated.

Composite Group

- The State Governors have gone on record for separation of data collection from regulations.
- There is not a one-to-one correspondence between the ratings of the fuel categories and the priorities for R&D.

COMMENTS ON FEDERAL INCENTIVES

Coal Industry

- There is a need for Congress to provide incentives so that projects can move forward.

Oil and Chemical Industry

- The U.S. Congress has got to take a strong stand and stick to it. That will encourage new projects to help to move forward.

Industrial Fuel Users

- If we cannot build or expand plants because of ambient standards, the overall effect will be the dispersion of industry and that may mean a very great overall effect on the population, economy, etc.

Composite Group

- There is a vital concern that there must be constancy of the regulations in order to allow industry to make decisions and not have "the rug pulled out".
- The real problem today is with the OPEC nations. The Government has to guarantee that the OPEC nations will not undercut the price of our own coal-derived fuels. Industry cannot risk the R,D&D.

COMMENTS ON SPECIAL ISSUES

Coal Industry

- The uncertainty of the future legislation is a problem. Coal companies cannot risk new developments with this degree of uncertainty.
- Industry has to forecast a viable position in making investment decisions. This is impossible with too many uncertainties due to shifting rules.

Electric Power Industry

- In considering regulations, it would be helpful to establish a modified position. For example, the standard could be based on ground-level ambient conditions, with managed operation with shutdown at times of inversion, and cost/effective considerations of all sources for ambient standards. This would assume removing point source emission regulations.

Oil and Chemical Industry Group

- (See Appendix C.)

Industrial Fuel Users

- There was mention of Senator Randolph's bill to convert all units above 50 million Btu/hr to coal by 1985. The stoker industry may not be willing to expand three times for a 10-year program. Industry cannot be converted too rapidly.

- One industrial materials company representative pointed out that it is important that all his suppliers and customers also have gas. It does not help if they are self-sufficient if they do not have gas.

Public Interest Groups

- This group thought that its greatest contribution to the exercise is in setting priorities on the criteria. The group felt most competent in evaluating these priorities.

- There was a concern that we might be building in a dependence on coal in future years.

State Governments

- This group pointed out that although the consumer is aware of energy costs, he is not aware of the environmental protection cost.

Federal Government Agencies

- The Federal Government Agencies Group indicated that we need all of the fuel categories--none are less important. They predict that we will fall short of our total needs.

Composite Group

- It was suggested that this group think in terms of all related Federal agencies, rather than just ERDA.

- It should be recognized that some coal conversion plants have multiple product outputs, e.g., liquid fuel, gas, and char. It may be more energy efficient to consider these together.

- One representative made the observation that we were addressing the budget format as isolated entities and thus getting bland results.

SCORING

Public Interest Groups

- Expressed concern that any time a mathematically derived "score" is used, there are questions about reliability and validity.

- There is great potential for misinterpretation or misuse of numbers like a "score".

- Expressed annoyance about the scoring, since it is not clearly defined and it is not clear how it will be used.

- The definitions of the fuel categories and criteria are too wide and this creates "smearing" and "skewing" of the results.

Composite Group

- One individual explained that he had factored constraints into his ratings under criterion--energy self-sufficiency-- and, therefore, it was "double counting" to mulitply the ratings by the weighting factors for the other criteria.

- There was a view that the scoring process is less sophisticated than the participants.

GENERAL COMMENTARY

Gas Industry

- The EPA/ERDA should do a service by establishing the effect that SO_2 has on the population.

Public Interest Groups

- Current research on health aspects show that sulfates are being studied more carefully and that with particulates the most significant health hazard is the 1 percent that is uncontrollable, i.e., the respirable particulates.

- There was concern that there are differences between Federal and State regulations and standards and no one seems to know the basis for these. Perhaps we are wasting money to do things we do not need to be doing.

Industrial Fuel Users

- Many new plants are designed with coal-fired central heating to insure that fuel will be available, even where gas is now available.

- One company is looking to coal for any new industrial plants.

APPENDIX C

PRINCIPAL RECORDS FROM EACH WORKSHOP

This appendix contains the principal records from each of the workshops. The material for each group includes the following:

- Composition of the Group
- Edited Tape Recorded Comments
- Final Evaluation Matrix
- Graphical Ratings of Fuel Categories and Criteria
- Graphical Rating of Fuel Categories and Criteria (High and Low Votes Removed)
- Forecast of Relative Mix of Fuels for Each Group--Relative Allocation of R&D Effort for Each Group.

WORKSHOP OF

COAL INDUSTRY GROUP

July 8, 1975

COMPOSITION OF COAL INDUSTRY GROUP

Type of Organization	Description of Representative
• Steel company producing 25 million tons of steel per year. Utilizes about 29 million tons of coal per year.	R&D staff position in coal utilization and energy.
• Manufacturer of coal handling and preparation equipment and engineering of coal handling systems and preparation plants with worldwide capability.	Management of research and development projects. Experienced in mineral processing.
• Operating underground and surface mines in South, Midwest, and West. In coal business for over 80 years.	Position in energy planning and environmental quality.
• Engineer-contractor using broad scope of technology worldwide. Has experience in coal mining, preparation, gasification and liquefaction.	Vice president, Energy Engineer Sources. Experienced in worldwide management of engineering and construction.
• Large energy company producing oil, gas, coal, uranium, and shale. Developing coal-derived synthetics.	Manages synthetic fuel development.
• Resource, transportation, and user of energy products. Energy and resource management producing oil, gas, coal, and chemicals.	Department head with main field of experience in engineering process design, plant operations (oil and chemical), and business management.
• Coal mining and sales with 12 mines, 25 million annual production. Have had 50 years experience in coal mining and utilization.	Manager technical services, with experience in coal utilization and steam generator design considerations for utilization.
• Steel company which is major coal producer and consumer. Has approximately 10 major manufacturing plants and approximately 12 coal mines.	Supervisor of energy research. Experienced in fuel utilization. Currently involved in synthetic fuels research project.

COAL INDUSTRY

Relevant Comments From Tape

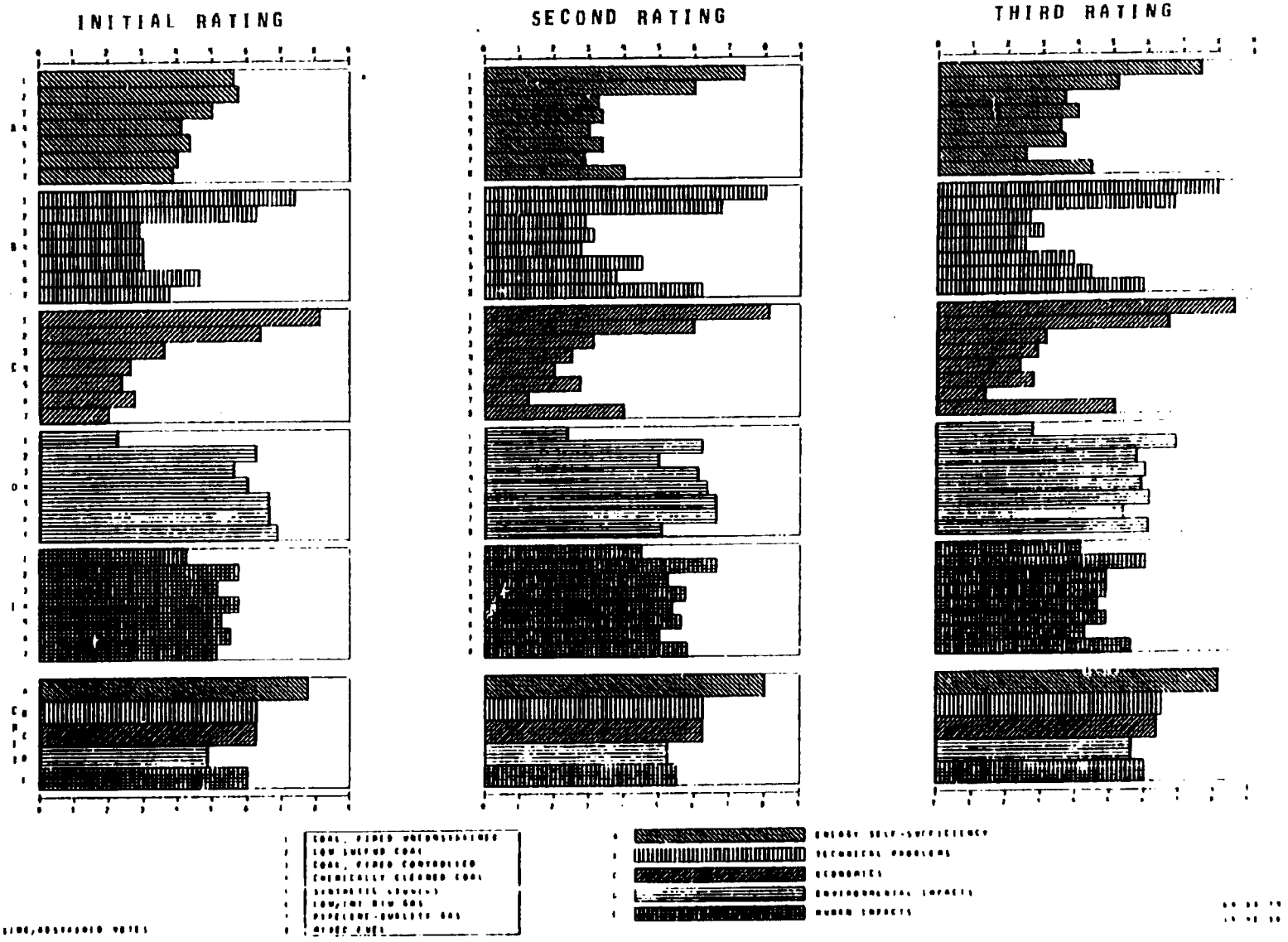
- The time frame for rating the fuel categories is defined as present to 1990.

- The group added another fuel category. Category 8 is defined as "mixed fuel". This is a "colloidal" product having firing characteristics of a liquid. It would be (1) a mixture of pulverized coal and petroleum products (a coal/oil slurry) with the coal beneficiated by present technology or advanced technology; or (2) a mixture of pulverized coal and synthetic liquids (coal-derived). The product has potential for being distributed by conventional systems or new pipeline distribution systems. For this exercise it is assumed that the product would be transported by existing methods.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	8.1 (7/9)	6.5 (4/9)	6.4 (5/8)	5.6 (4/7)	6.0 (4/9)	
1. Coal, fired unconstrained by SO_2 regs.	7.5 (6/9)	8.0 (6/9)	8.5 (7/9)	2.8 (4/7)	4.1 (1/8)	10.0
2. Low sulfur coal, fired to meet SO_2 regs.	5.1 (1/9)	6.8 (5/9)	6.6 (5/8)	6.9 (6/8)	6.0 (3/8)	9.4
3. Coal, fired with SO_2 control equipment	3.6 (2/6)	2.6 (1/6)	3.1 (2/5)	5.8 (4/7)	4.9 (3/7)	5.8
4. Chemically cleaned coal	4.0 (2/6)	3.0 (2/5)	2.9 (2/4)	6.0 (5/7)	4.9 (3/7)	6.1
5. Synthetic Liquids	3.5 (2/7)	2.5 (1/4)	2.4 (1/5)	5.9 (3/7)	4.6 (3/7)	5.5
6. Low/Intermediate Btu gas	3.6 (2/7)	3.9 (1/8)	2.8 (1/4)	6.1 (5/7)	4.9 (3/7)	6.2
7. Pipeline-quality gas	2.5 (1/5)	4.4 (1/9)	1.4 (0/3)	5.4 (2/8)	4.2 (2/7)	5.1
8. Mixed Fuels	4.4 (3/7)	5.9 (4/9)	5.1 (4/7)	6.1 (5/7)	5.6 (4/7)	8.1

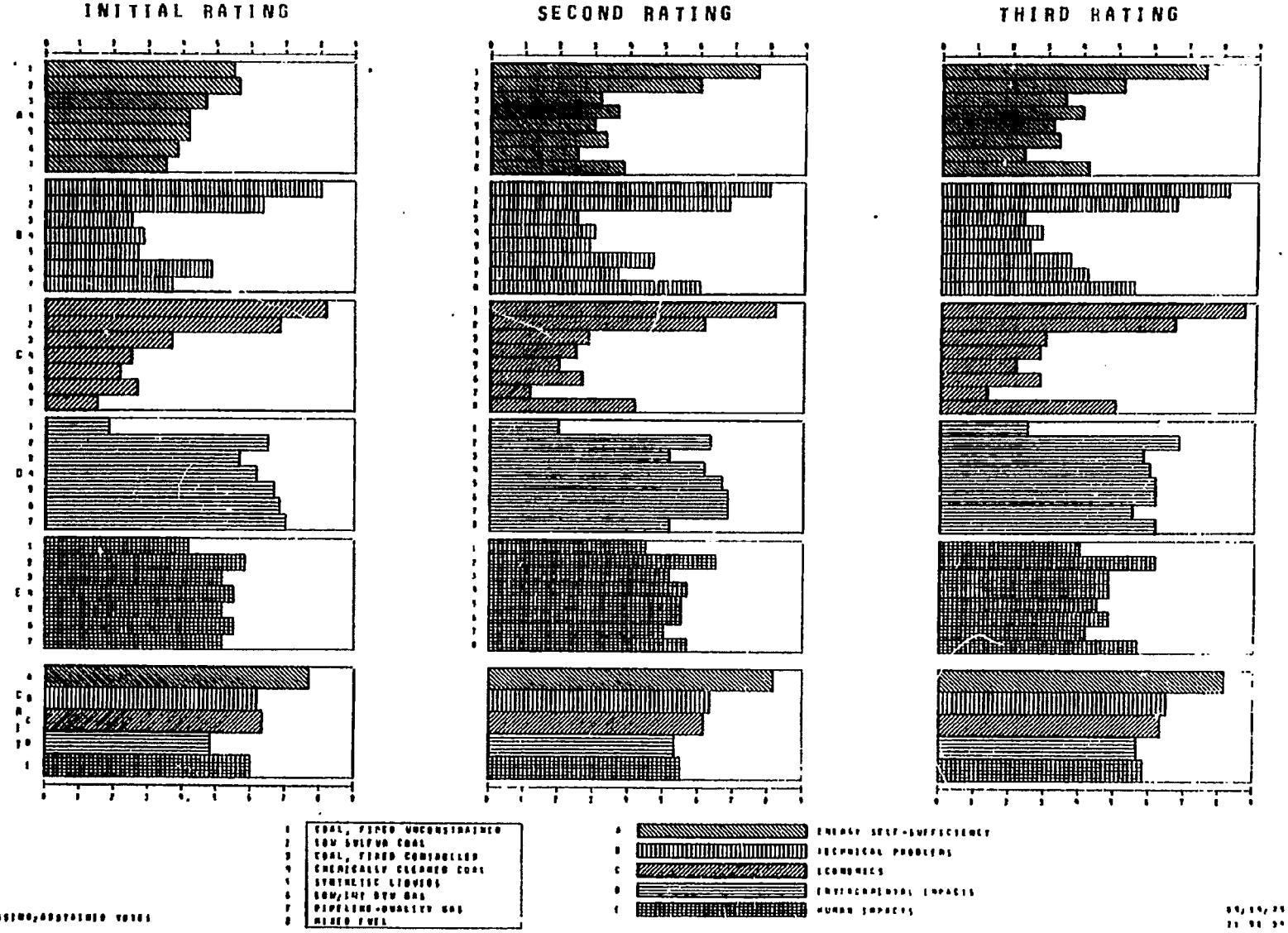
FINAL EVALUATION MATRIX, COAL INDUSTRY

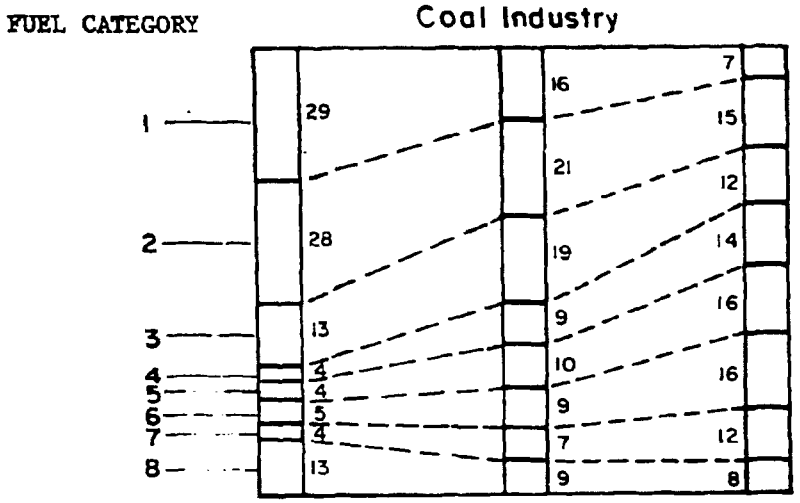
COAL INDUSTRY



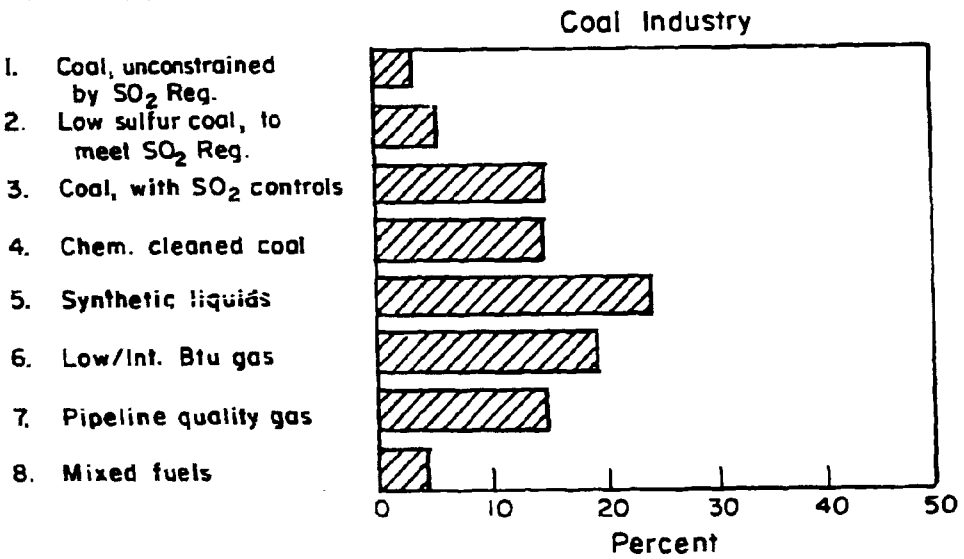
COAL INDUSTRY

(High and low votes removed)





FORECAST OF RELATIVE MIX OF FUELS



RELATIVE ALLOCATION OF R&D EFFORT

DISSENTING VIEW (OR MINORITY REPORT)

The following letter was submitted by one of the Coal Industry Group participants after the workshop.

July 28, 1975

I am submitting a minority report to the ratings developed during the Coal Industry session because I feel the majority put too much emphasis on only meeting the fuel requirements of the electric utilities industry.

My analysis is based on the belief that the overriding criterion is energy self-sufficiency (weight of 9) and that to attain self-sufficiency it will be necessary to provide coal derived fuels to meet the needs of industrial users as well as the electric utility industry.

We predict that by 1985 (we have not extended our prediction to 1990) the industrial sector will have a fossil fuel requirement of 22.5 quadrillion Btu/year (not including coking coal) and the electric utility sector will have a requirement for fossil fuel of 21.0 quadrillion. Thus the total fossil fuel requirement in 1985 for industrial use and electric power generation will be 43.5 quadrillion Btu/year.

If we assume that all of the electric utility requirement and 1/3 of the industrial requirement can be met by direct firing of coal, 28.5 quadrillion Btu/year can be provided for in this manner. This leaves 15.0 quadrillion Btu/year that must be provided for by other than direct firing of coal. We also predict that domestic oil and gas production in 1985 will total 46.5 quadrillion Btu/year or 7.1 quadrillion Btu/year more than the combined fossil fuel requirement of 39.4 quadrillion Btu/yr for the residential and transportation sectors. Thus, assuming the maximum possible usage of direct firing of coal and using all domestically available oil and gas there would still be 7.9 quadrillion Btu/year of fossil fuel requirement for industrial users that must be made up from some other source, e.g., imported oil and gas, oil from coal, or gas from coal.

Based on these general assumptions, I have prepared the attached evaluation matrix. As to how I arrived at the values shown, I offer the following comments.

First, regarding the relative weights of the five criteria. As stated before, the No. 1 consideration is always being able to supply the necessary fuel, i.e., Energy Self-Sufficiency. This I rate at 9. Economics and environmental impacts are important considerations and are rated 7 and 6, respectively. In my opinion, the extent of the technical problems yet to be solved and the

human impact are of lesser importance and each should have a rating of 3. Highly technical processes should not be rated poorly if they offer significant other benefits. Extent of technical problems should not be confused with chance of success.

Under A) Energy Self-Sufficiency we have rated each fuel category according to its ability to meet all of the fuel requirements, as stated above, within the constraints imposed assuming an unlimited supply of that fuel category. Synthetic liquids, low, intermediate and high-Btu gas will meet all of the requirements for fossil fuels. Chemically cleaned coal and direct firing of coal can be used for 28.5 quadrillion/year or 7/9th of total fossil fuel requirement. Hence the rating of 7. Our rating of 3 for mixed fuels is based on the belief that SO_2 regulations and other constraints will restrict the use of this type of fuel.

I believe that the bases for the ratings on B) Extent of Technical Problems, C) Economics and D) Environmental Impacts are self-evident.

For the Human Impacts ratings I have taken the position that all of these fuel categories will fall somewhere between "Highly Undesirable" and "Highly Desirable" Overall Impacts. The categories for straight firing of coal and for mixed fuels I have given a rating of 5. Since the synthetic fuel categories will require additional manpower, I have given these a rating of 4.

On the final scores, I obtain high ratings for categories 1 and 2, as was the case in the majority rating. But as we know, category 1 will never be allowed and in my evaluation I assumed an unlimited supply of low-sulfur coal for category 2, whereas in actuality the supply is inadequate to meet the total requirement. Thus neither of these represent realistic solutions to the problem of increased coal utilization.

After these first 2 categories, Synthetic Liquids and Low/Intermediate Btu gas have the highest ratings.

I believe that this analysis represents a more balanced consideration of <u>both</u> industrial and electric utility fuel users, and feel that the higher rating for coal conversion research in general and liquefaction in particular is more representative of the true requirements in the U.S. than the average rating developed during the meeting in Columbus.

I was pleased to have the opportunity to participate in your coal industry session, and hope that you will be able to corroborate and give additional weight to the views presented herein.

Very truly yours,

Attachment

EVALUATION MATRIX

COAL INDUSTRY MINORITY REPORT

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	9	3	7	6	3	
1. Coal, fired unconstrained by SO_2 regs.	7	7	7	2	5	8.8
2. Low sulfur coal, fired to meet SO_2 regs.	7	6	6	7	5	10.0
3. Coal, fired with SO_2 control equipment	7	2	1	5	5	6.6
4. Chemically cleaned coal	7	3	4	6	4	8.1
5. Synthetic Liquids	9	3	3	7	4	8.8
6. Low/Intermediate Btu gas	9	5	3	6	4	8.8
7. Pipeline-quality gas	9	5	1	3	4	7.0
8. Mixed Fuels	3	6	4	5	5	6.9

WORKSHOP OF

OIL AND CHEMICAL INDUSTRY GROUP

July 15, 1975

COMPOSITION OF OIL AND CHEMICAL INDUSTRY GROUP

Type of Organization	Description of Representative
• International petroleum company which owns coal deposits, R&D on synfuels from coal. 1974 product sales 2.3 million barrels/day, revenues $24.5 billion.	Manager, special studies in research department. Experience in analysis and planning of research, engineering-economics studies.
• Major fully-integrated petroleum company with growing interests in alternative energy sources. Operates 4 domestic refineries and is opening its first coal mine.	Directs the planning and assessment of new technology for oil and gas exploration and production. R&D experience in petroleum processing and synthetic fuels production.
• Major oil company with 5 domestic refineries and 1 operating mine. Ten years experience of coal research.	Planning manager. Experienced in planning in areas of oil and coal.
• Medium sized integrated oil company. No major coal holdings or coal processing experience.	Technical advisor to vice-president of Research and Chemicals. Experienced in enhanced recovery of hydrocarbons.
• Chemical manufacturer with 100 plants having $5-6 billion sales. Considerable experience in coal and coal derived fuels prior to 1956.	Research manager, Energy and Materials Department. Experienced in chemical research.
• Large engineering and construction contractor, serving principally the oil and chemical industries having approximately $700 million business per year. Contractor for engineering and construction of 1 major coal conversion plant (overseas). Also active in R&D in coal gasification.	Director of process engineering. Experience in process engineering, principally synthesis gas, petroleum refining, petrochemicals.
• Multination broad base company. Annual sales about $4-5 billion, chemicals and plastic sales about 50 percent of total corporate sales. Extensive R&D in coal chemistry, coal conversion, coal utilization	Department manager. Experienced in chemicals and plastics, coal conversion.

OIL AND CHEMICAL INDUSTRY

Statements Prepared on Wallcharts by Participants*
(No taped comments)

Things ERDA should consider in setting R&D priorities:

(1) Short range - maximize coal substitution

(2) Liquid hydrocarbon has priority uses (e.g., transportation). Coal can and should substitute for nonpriority uses.

(3) Technology for production of methanol from coal is considerably more advanced than production of syncrude from coal.

(4) Technical and economic uncertainties produce an unjustified derating of synthetic liquids.

(5) Long term-synthetic liquids will not displace existing high priority fuels, rather they should supplement them.

  (a) Portable liquid fuels for transportation (engine fuels)

  (b) Home heating oils

(6) Aromatics for chemical use will come progressively more from coal as petroleum supplies decline.

(7) Real need is for liquid hydrocarbons from coal

(8) Immediate acceleration for producing a range of petroleum liquids

(9) Important objective of sulfur removal from coal is depreciated in this rating by tying it to S.R.C.

(10) Possibly overlooked processes which produce a combination of products.

(11) The real environmental impact of surface mining is acceptable. The problem lies in conveying this to the public.

(12) A practical problem to be faced is obtaining financing for synthetic fuels plants without certification that designs are based upon technology which has been demonstrated on a commercial scale. Development of synthetics could be accelerated if commercial scale plants were built and operated with federal funds to satisfy the technical requirements for future private investment in such plants.

(13) In the second round of voting, "Synthetic Liquids" rated lower than the group felt was justified because of confusion over timing and definition of terms. If this category is limited to "Synthetic Liquid Hydrocarbons" if we concentrate on a time frame from 1985 to 2000, then "Synthetic Liquids" assume great significance. In particular we believe they will be of increasing importance as transportation and space-heating fuels, and as chemical feedstocks, first to supplement petroleum and then to substitute for it.

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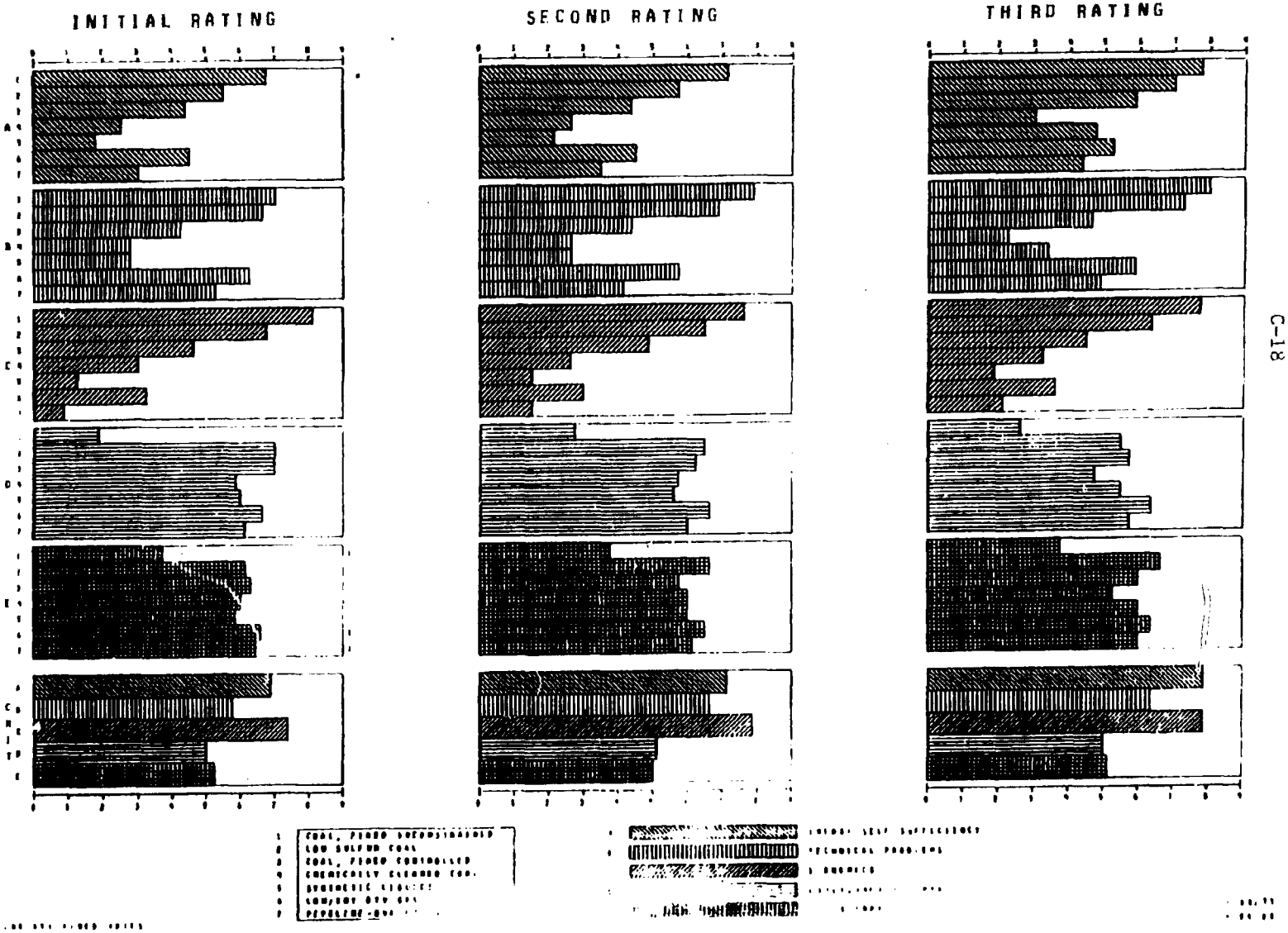
* Statements recorded between second and third ratings.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	7.9	6.4	7.9	5.0	5.1	
1. Coal, fired unconstrained by SO_2 regs.	7.8	8.0	7.8	2.6	3.8	9.9
2. Low sulfur coal, fired to meet SO_2 regs.	7.0	7.2	6.4	5.5	6.6	10.0
3. Coal, fired with SO_2 control equipment	5.9	4.6	4.5	5.8	6.0	8.0
4. Chemically cleaned coal	3.0	2.2	3.2	4.8	5.2	5.3
5. Synthetic Liquids	4.8	3.4	1.9	5.5	6.0	6.0
6. Low/Intermediate Btu gas	5.2	5.9	3.6	6.4	6.4	7.9
7. Pipeline-quality gas	4.4	4.9	2.1	5.8	6.0	6.5

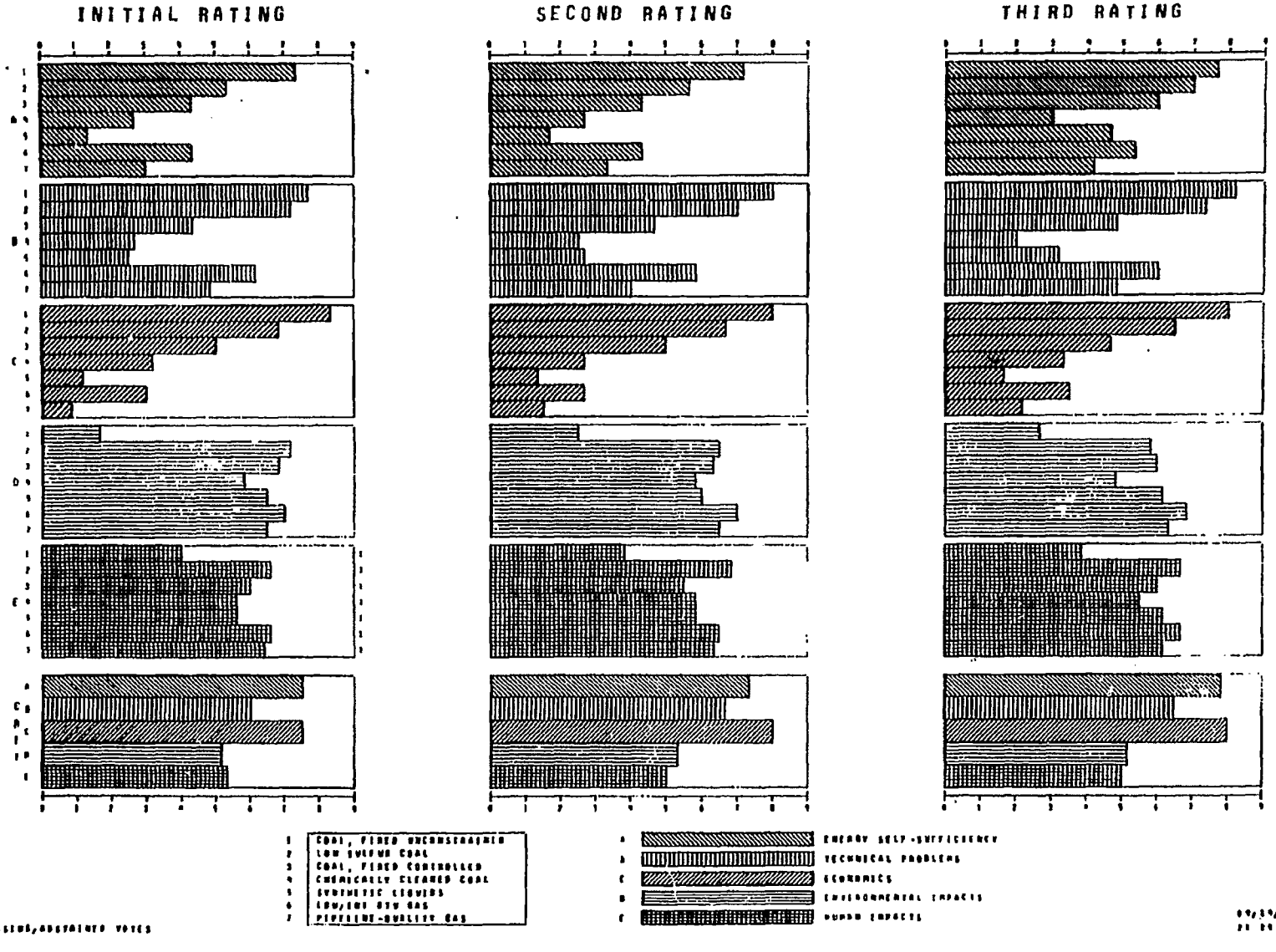
FINAL EVALUATION MATRIX, OIL AND CHEMICAL INDUSTRY

OIL AND CHEMICAL INDUSTRY



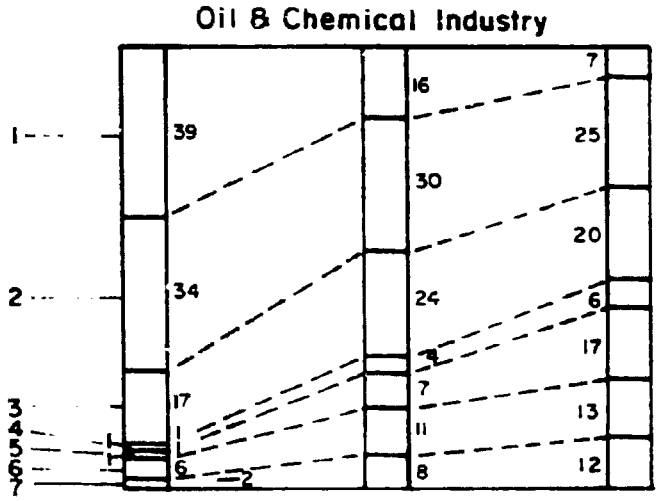
OIL AND CHEMICAL INDUSTRY

(High and low votes removed)



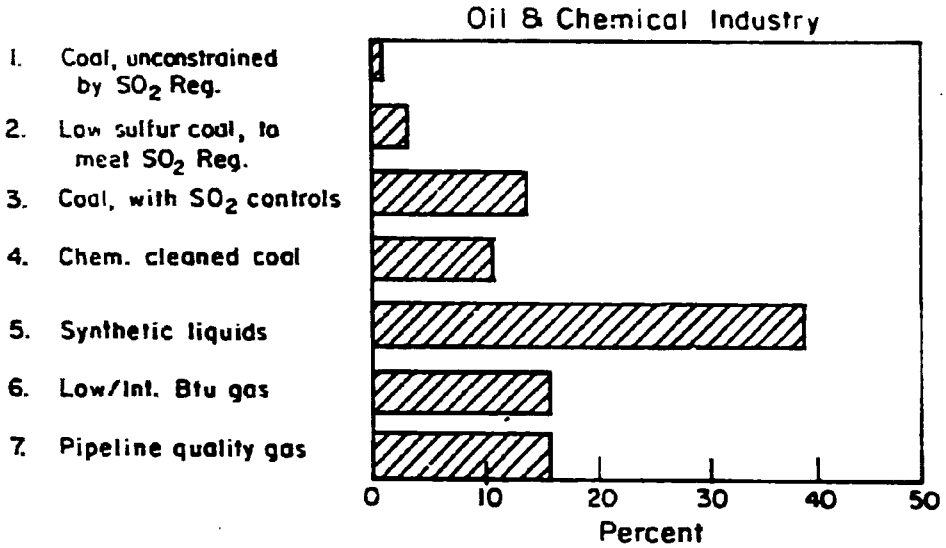
*ABSTENTIONS, ABSTAINED VOTES

FUEL CATEGORY



FORECAST OF RELATIVE MIX OF FUELS

FUEL CATEGORY



RELATIVE ALLOCATION OF R&D EFFORT

WORKSHOP OF

GAS INDUSTRY GROUP

July 2, 1975

COMPOSITION OF GAS INDUSTRY GROUP

Type of Organization	Description of Representative
• Gas distribution company having 3 million customers. Six years experience in feasibility study and design of coal gasification facility.	Responsible for administration of environmental programs, contract administration, management systems, etc., for coal gasification project.
• Gas distribution utility having over 1 million meters. Pursuing coal gasification projects. Engaged in coal research for 15 years.	Officer—R&D, engineering, transmission, and storage responsibilities.
• Fully integrated natural gas company having a 4-state market. Experience in investigating high and medium-Btu coal gasification.	Vice president.
• Interstate pipeline company operating throughout southwest. One of first P/L companies to commit to coal gasification.	Environmental scientist.
• Worldwide engineering contractor having all forms of energy plants from coal, petroleum, and other energy-based projects. Experience in design, engineering, and construction of coal to various energy uses.	Project management in solids fuel department involved on a detailed design project plus numerous other studies.
• Integrated gas company involved in production, transportation, and distribution. Has 2 million meters retail in 7 states, major wholesale sales. Own considerable coal properties, conduct coal research.	Research management.
• Major gas pipeline company. Production and marketing of hydrocarbons, gas, and oil exploration. Experienced in evaluation of coal projects and coal gasification projects.	Production and R&D of SNG from coal and petroleum hydrocarbons.
• Energy/construction organization very large in energy facilities. Intensive study and design experience primarily with gasification and transportation. Heavy experience in all phases of coal to electric power.	Heads technology group for coal conversion.

GAS INDUSTRY

Relevant Comments From Tape

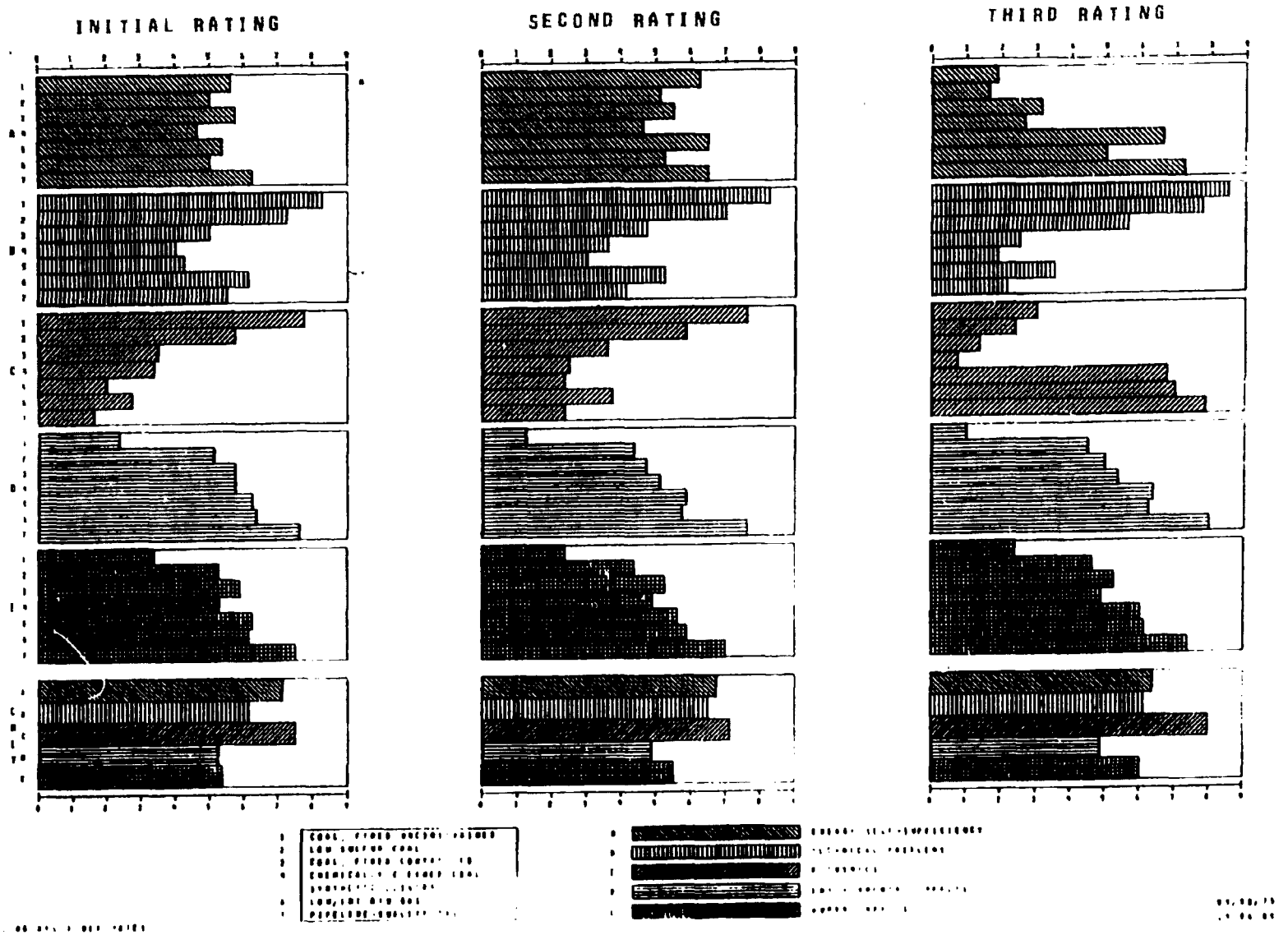
- In considering energy self-sufficiency, any use of coal will decrease the requirement for imported fuel. However, the first four fuel categories suggest that the end product is electricity, as opposed to the last three elements. Thus, if the first four fuel categories are emphasized then the implication is toward the electrification of the United States. This is the implication even though all uses of coal will contribute to energy self-sufficiency.
- The direct use of coal contributes to energy self-sufficiency through electrification of the U.S. Electrification carries the burden of inefficiencies in the use of capital as well as inefficiencies in the use of a lower energy form. For these reasons the direct use of coal, in and of itself, cannot make a major contribution to energy self-sufficiency through electrification.
- There is a concern that if the group consensus shows that direct firing of coal can contribute to energy self-sufficiency, ERDA may interpret that as an urging to spend research money on problems others have already considered, or problems other agencies should be considering. ERDA should be determining programs for this nation to become energy self-sufficient and on action programs to accomplish that. ERDA should not "re-invent the wheel" for the nth time.
- The first four fuel categories imply that SO_2 control is an important activity of concern. This is indeed a field of study that is worthy of research money, but it is not an ERDA activity to deal with health effects or other already assigned responsibilities. ERDA's responsibilities are not in that area! (individual participant comment)
- The group accepts the position in this meeting that the forced utilization of coal to produce electricity to replace petroleum-based premium fuels has a negative cost-benefit result, except in the use of coal in existing boilers.

- There is agreement that fuel category 6, low/intermediate BTU gas, should be changed to "industrial fuel" gas in the range of 100 to 500 BTU per cubic foot. This category encompasses application in the combined cycle.
- The U.S. uses about 600 million tons of coal per year in present coal-fired boiler plants.
- Relative to the long-term solution to our energy independence, we have to concentrate our efforts on the last three fuel categories. Immediately, we can make a contribution by considering the first four categories, but we cannot depend on those to solve the problem in the long run.
- In considering fuel categories 4, 5, 6, and 7, the group agrees to consider new technologies in ratings under criterion 3, Extent of Technical Problems.
- In considering fuel categories 1, 2, 3, and 4, the group agrees to interpret "finished fuels" to be electricity.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	6.4	6.1	8.0	4.9	6.0	
1. Coal, fired unconstrained by SO_2 regs.	1.9	8.5	3.0	1.0	2.4	5.2
2. Low sulfur coal, fired to meet SO_2 regs.	1.6	7.8	2.4	4.5	4.6	6.0
3. Coal, fired with SO_2 control equipment	3.1	5.6	1.4	5.0	5.2	5.6
4. Chemically cleaned coal	2.6	2.5	0.8	5.4	4.9	4.3
5. Synthetic Liquids	6.6	1.9	6.8	6.4	6.0	8.6
6. Low/Intermediate Btu gas	5.0	3.5	7.0	6.2	6.1	8.6
7. Pipeline-quality gas	7.2	2.1	7.9	8.0	7.4	10.0

FINAL EVALUATION MATRIX, GAS INDUSTRY

GAS INDUSTRY



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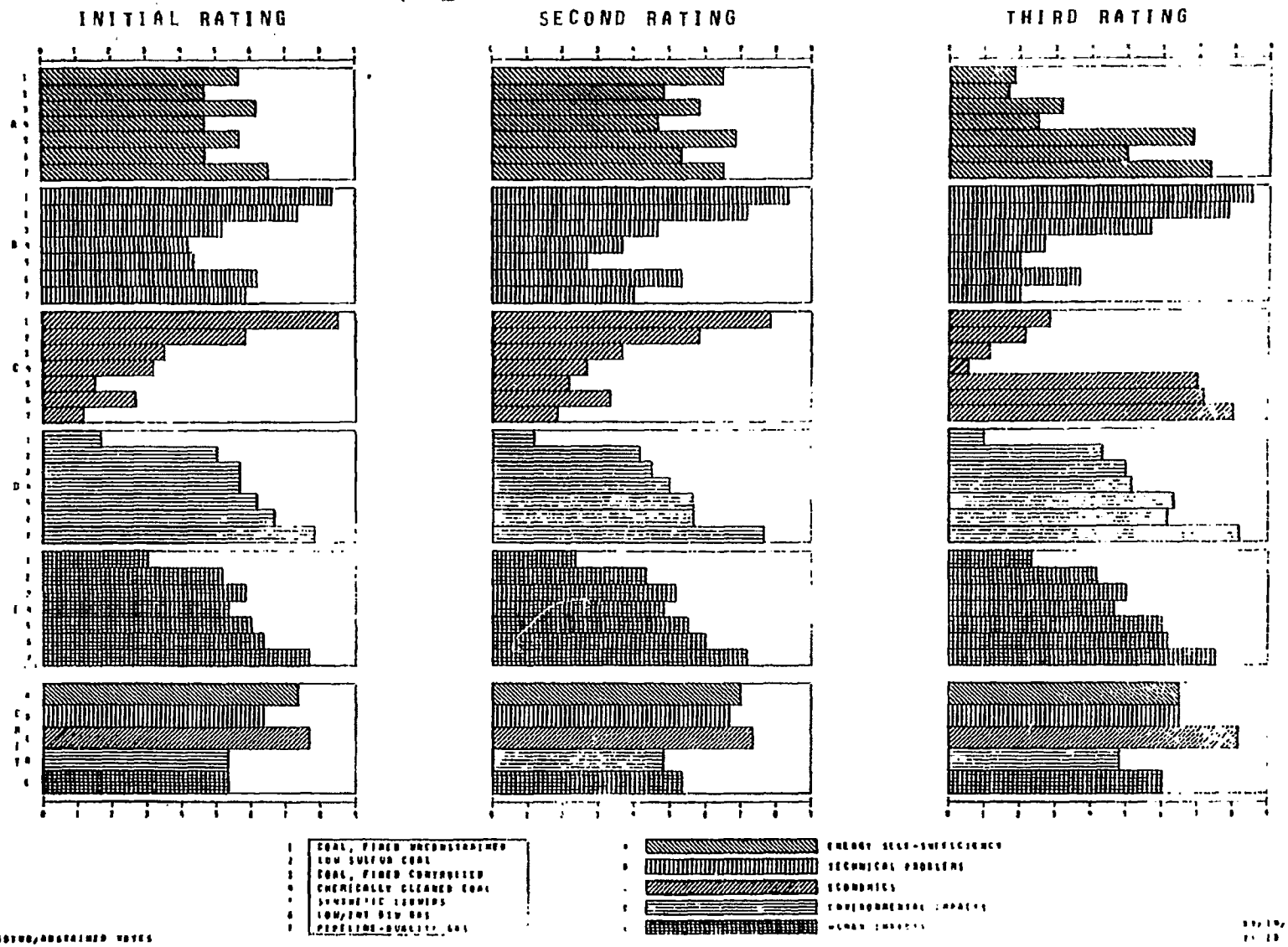
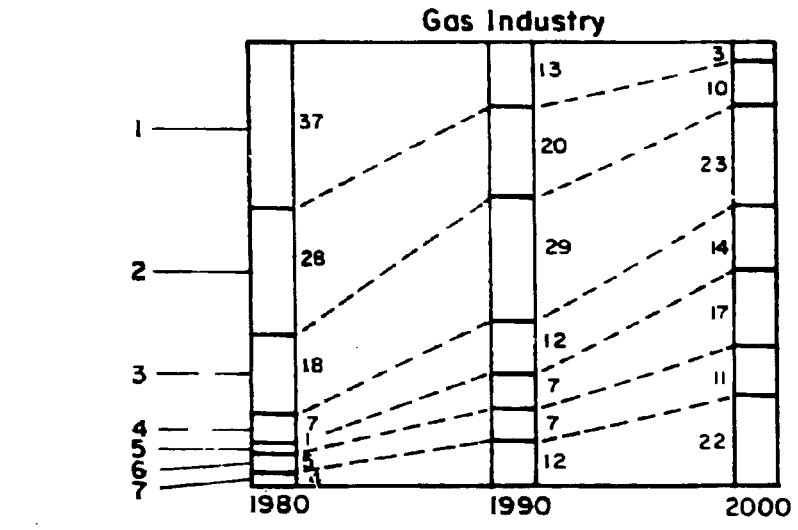
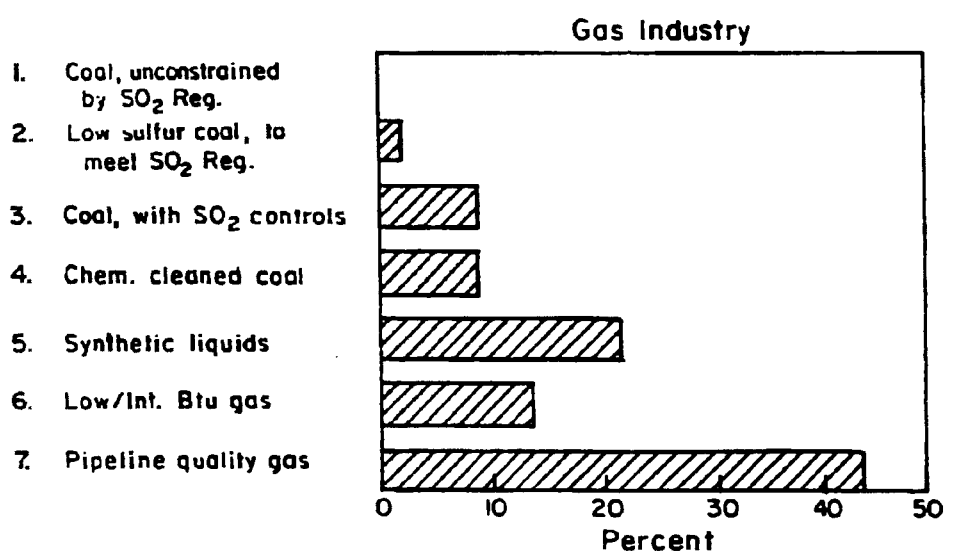


*REJECTED/ABSTAINED VOTES



FORECAST OF RELATIVE MIX OF FUELS



RELATIVE ALLOCATION OF R&D EFFORT

C-29

WORKSHOP OF

ELECTRIC POWER INDUSTRY GROUP

June 30, 1975

COMPOSITION OF ELECTRIC POWER INDUSTRY GROUP

Type of Organization	Description of Representative
• Manufacturing, power plants, engineering development, research in materials, processes, etc. Gross sales around $3 billion. Studies on use of coal-derived fuels.	Corporate engineering planning.
• Large manufacturer of energy-related products worldwide. Approximately 8 manufacturing plants associated with nuclear and fossil fuels. Broad experience in all forms of coal and other fossil fuels.	Fossil product development, including present product improvement and development of new products. Approximately 20 years experience in design and performance of fossil-fired steam generators.
• Federal agency operating in 6 states doing development in the areas of regional resources and electric power. 30 years experience in coal-fired power plants.	Supervision of electric power related energy/fuels conversion research. Primary experience in R&D nuclear power, coal conversion.
• Large international engineering/construction company providing services to utility and process industries. Have constructed many utility plants on all types of fossil fuels. Also, participated in several energy R&D studies related to coal-derived fuels.	Assistant Chief Environmental Engineer, involved in analyzing environmental impacts from energy and process plant facilities including siting and socio-economic evaluations.
• Large electric utility system operating in 7 states.	Vice president, system planning. Extensive experience in planning.
• Designer and manufacturer of fossil-fired boilers for power and industrial use, and nuclear steam supply systems. Manufacturing capacity for 4-6 nuclear units/yr, 15-20 fossil power units/yr, 100-150 industrial boilers.	Manager, central technology. Identify and plan R&D work to assure technology availability for future experience in equipment design and operation of boilers and related equipment.
• Large manufacturer of power generation and electrical equipment. Over 100 plants with a broad scope for electric power generation equipment. Have performed considerable research in utilizing coal in gas turbine cycles over the last 20 years.	In charge of strategic planning pertaining to power generation equipment. Extensive experience in electric power generation particularly steam and gas turbine.
• Large multiplant utility presently firing gas, oil, and coal having 15 plants, 13,000 employees, $4 billion capitalization.	Internal consultant. 35 years technical experience, directed combustion 1/4 billion tons of coal, 10 years R&D synthetic fuels.

ELECTRIC POWER INDUSTRY

Relevant Comments From Tape

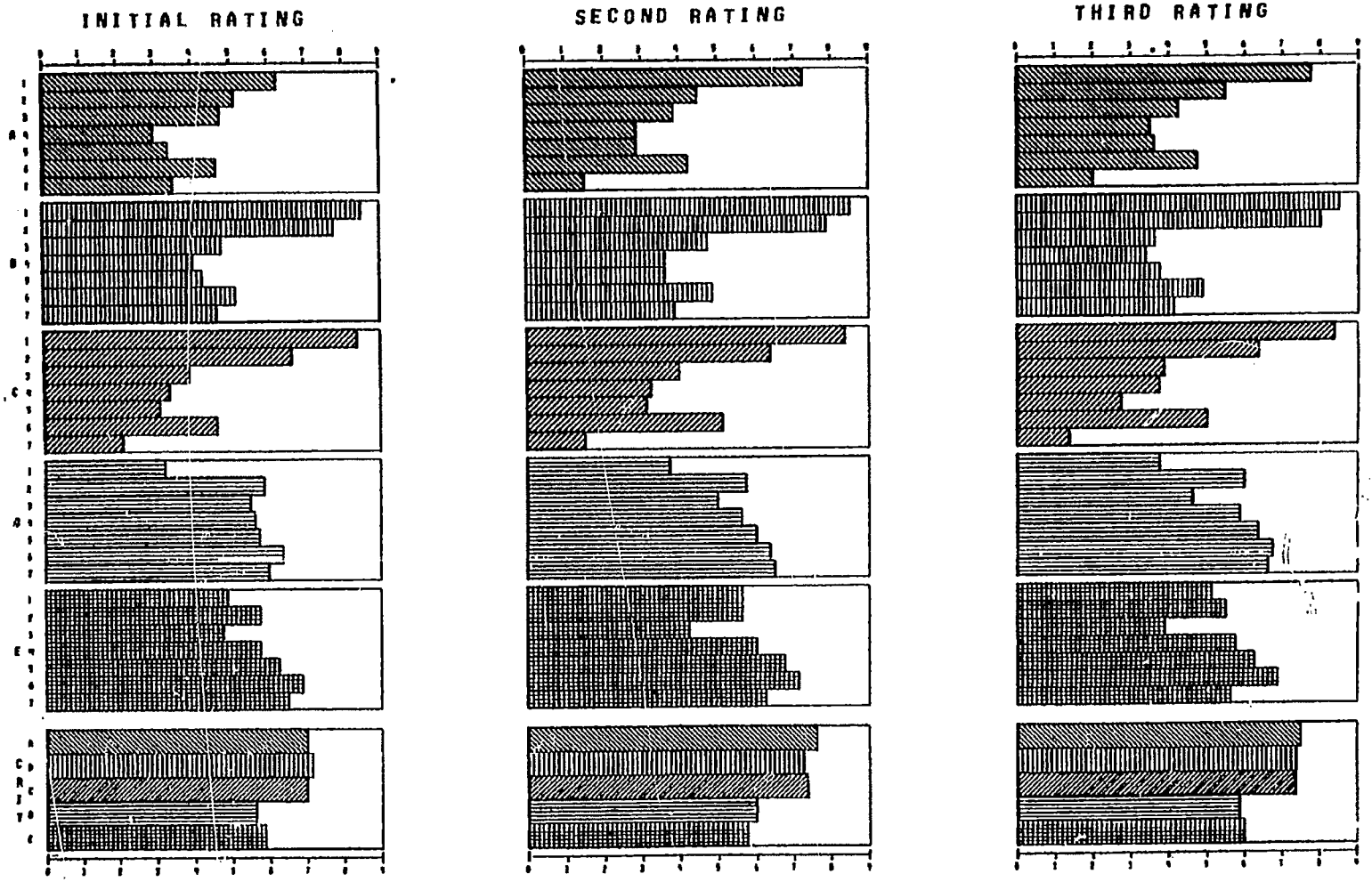
- The interpretation of Fuel Category 1 is coal fired unconstrained by constant emission regulations, with ambient standards maintained as established by proper cost-benefit analyses and allowing for research and development by ERDA to make such cost benefit analyses meaningful.

- In considering Fuel Category 7, pipeline-quality gas, the group's position is to discourage the use of synthetic natural gas as boiler fuel. This fuel category has other applications.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	7.5 (5/9)	7.4 (7/9)	7.4 (6/9)	5.9 (5/8)	6.0 (5/9)	
1. Coal, fired unconstrained by SO_2 regs.	7.8 (6/9)	8.5 (7/9)	8.4 (7/9)	3.8 (1/7)	5.1 (3/8)	10.0
2. Low sulfur coal, fired to meet SO_2 regs.	5.5 (2/7)	8.0 (6/9)	6.4 (6/8)	6.0 (4/8)	5.5 (3/8)	8.9
3. Coal, fired with SO_2 control equipment	4.2 (1/6)	3.5 (1/6)	3.9 (0/6)	4.6 (4/7)	3.9 (1/8)	5.7
4. Chemically cleared coal	3.5 (3/5)	3.4 (2/5)	3.8 (3/5)	5.9 (4/7)	5.8 (3/8)	6.1
5. Synthetic Liquids	3.6 (2/6)	3.8 (2/6)	2.8 (1/5)	6.4 (4/8)	6.2 (4/8)	6.1
6. Low/Intermediate Btu gas	4.8 (3/7)	4.9 (2/7)	5.0 (2/7)	6.8 (6/8)	6.9 (4/9)	7.8
7. Pipeline-quality gas	2.0 (1/3)	4.1 (2/6)	1.4 (0/5)	6.6 (5/8)	5.6 (3/8)	5.0

FINAL EVALUATION MATRIX, ELECTRIC POWER INDUSTRY

ELECTRIC POWER INDUSTRY



*PREFERRED/PREFERRED VOTES

ELECTRIC POWER INDUSTRY

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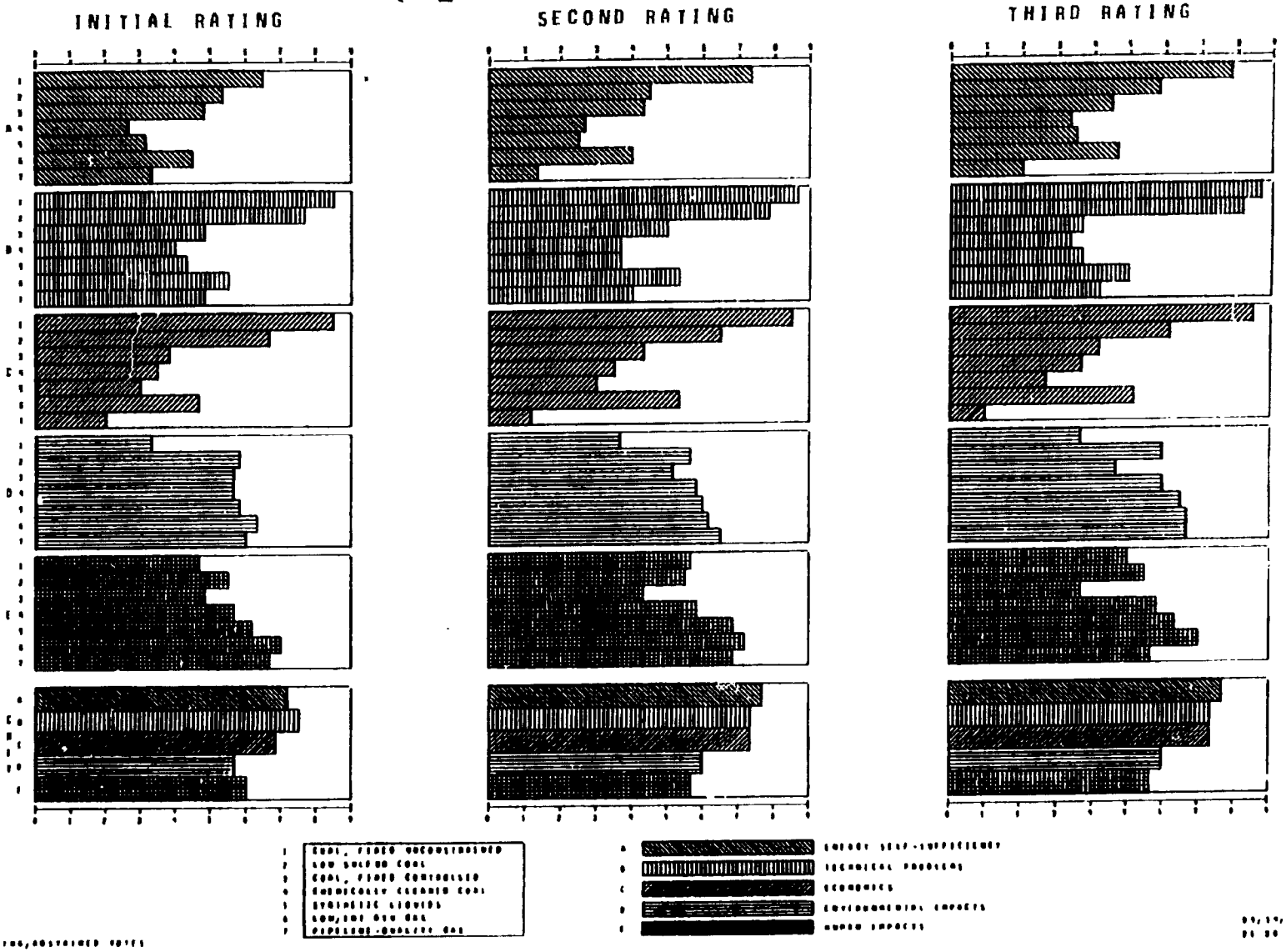
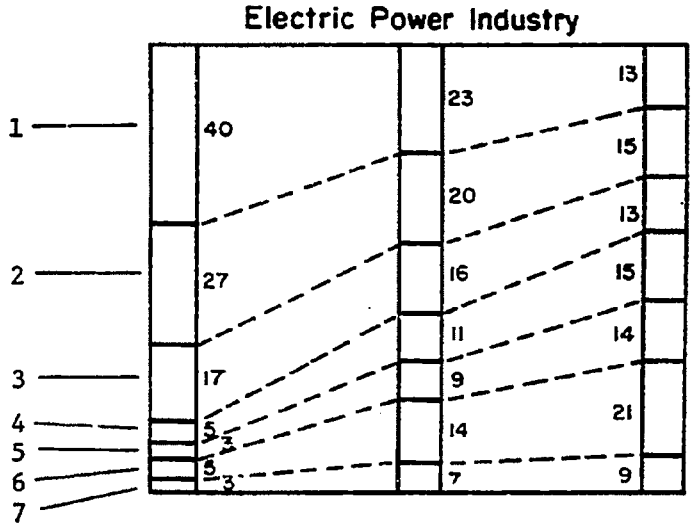


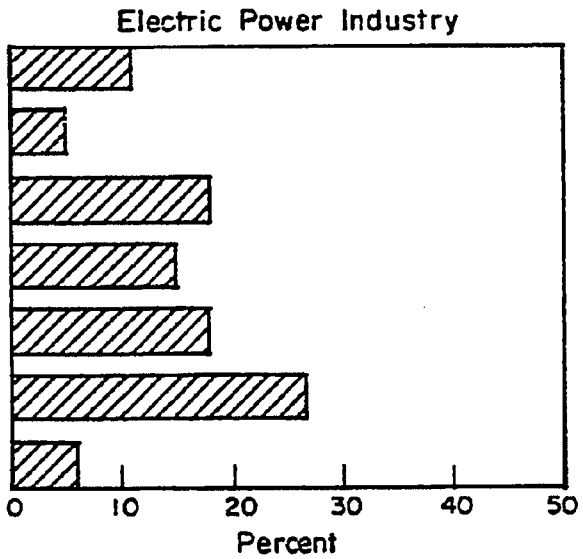
FUEL CATEGORY



FORECAST OF RELATIVE MIX OF FUELS

FUEL CATEGORY

1. Coal, unconstrained by SO_2 Reg.
2. Low sulfur coal, to meet SO_2 Reg.
3. Coal, with SO_2 controls
4. Chem. cleaned coal
5. Synthetic liquids
6. Low/Int. Btu gas
7. Pipeline quality gas



RELATIVE ALLOCATION OF R&D EFFORT

WORKSHOP OF

INDUSTRIAL FUEL USERS GROUP

July 17, 1975

COMPOSITION OF INDUSTRIAL FUEL USERS GROUP

Type of Organization	Description of Representative
• Large integrated steel company. Extensive experience in coal and coal-derived fuels and also operate some coal mines.	Director, Engineering Services. Operating and engineering experience in field of melting and energy utilization.
• Worldwide automobile manufacturing company with 75 coal burning steam plants with usually four 80,000 lb boilers each.	Department Head of 45 technical persons developing processes and equipment for process and power-house energy and environmental control. Experience in manufacturing plant equipment.
• Electrical equipment manufacturer with 60 locations varying from 250,000 to 5,000,000 sq ft. Two of their plants use coal—4 stoker units in one plant and 4 pulverized coal in other plant.	Corporate engineering responsibility for energy use and conservation, as well as boilers and power plants. Experience in design and construction of power plants.
• Engineering and manufacturer of liquid and gaseous fuel combustion systems for industrial and commercial uses. Large manufacturer of industrial oil and gas burners. Supplies burners for producer gas and several synthetic gases; also for by-product and synthetic oils.	Director of Technical Information. Experience in combustion and heat transfer.
• Steam generator manufacturer having one plant for industrial boilers and 2 plants for exchanger type units.	Involved in design performance with experience in steam generators ranging from 1000 #/hr to 450,000 #/hr.
• Large, multinational packaging and consumer products company having more than 100 domestic plants and offices. More than 20 of these using over 100 mm Btu/hr of fossil fuel. Sales over $2 billion annually.	Responsible for technical aspects of corporate energy, conservation programs, and for technical inputs to energy planning. Experience in chemical engineering, R&D process design, process engineering.
• Manufacturer of solid fuel firing equipment for industry and small utilities. Experience in solid fuel firing equipment since 1898. Equipment in use in all 50 states and in export market.	In charge of engineering and on management team. Experience in sales and engineering dealing directly with users and consultants for 22 years.

INDUSTRIAL FUEL USERS

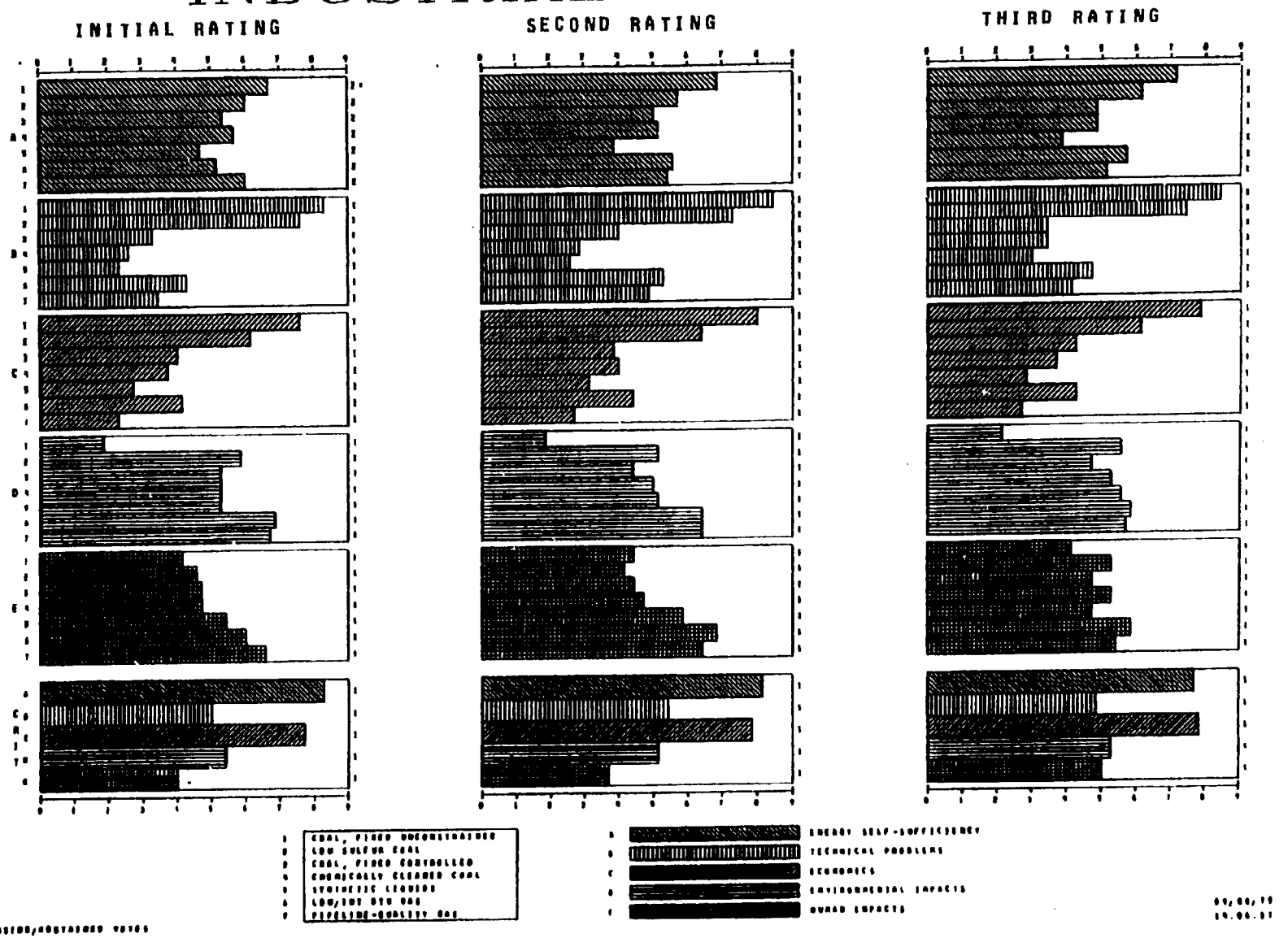
Relevant Comments From Tape

- Coal and oil are our heavy fossil fuel sources and where our equipment is set up to burn these fuels, we are not at this point interested in converting to coal as a fuel. We may desire finding ways to use the derivatives from coal in order to continue to use a material similar to current use. This is where ERDA should be most important to us in developing synthetic fuel from coal, rather than direct conversion to coal.
- There are difficult problems in transporting and storage and turndown in many industries that are not able to use low-BTU gas around the clock. These are major technical, economic problems.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	7.7	4.9	7.9	5.3	5.0	
1. Coal, fired unconstrained by SO_2 regs.	7.1	8.4	7.9	2.1	4.1	10.0
2. Low sulfur coal, fired to meet SO_2 regs.	6.1	7.4	6.1	5.6	5.3	9.8
3. Coal, fired with SO_2 control equipment	4.9	3.4	4.3	4.7	4.7	7.1
4. Chemically cleaned coal	4.9	3.4	3.7	5.3	5.3	7.2
5. Synthetic Liquids	3.9	3.0	2.9	5.6	4.7	6.3
6. Low/Intermediate Btu gas	5.7	4.7	4.3	5.9	5.9	8.4
7. Pipeline-quality gas	5.1	4.1	2.7	5.7	5.4	7.1

FINAL EVALUATION MATRIX, INDUSTRIAL FUEL USERS

INDUSTRIAL FUEL USERS



INDUSTRIAL FUEL USERS

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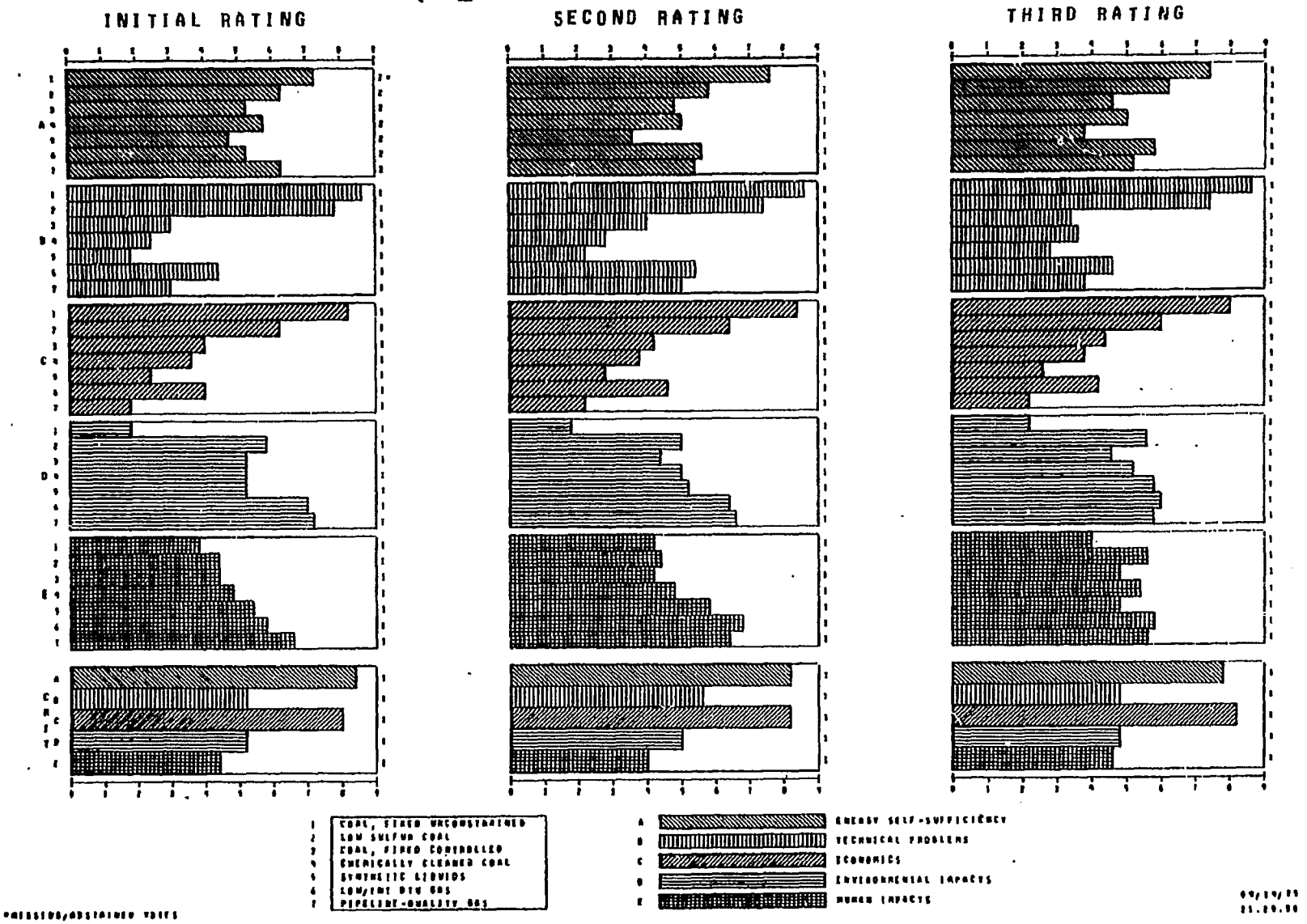
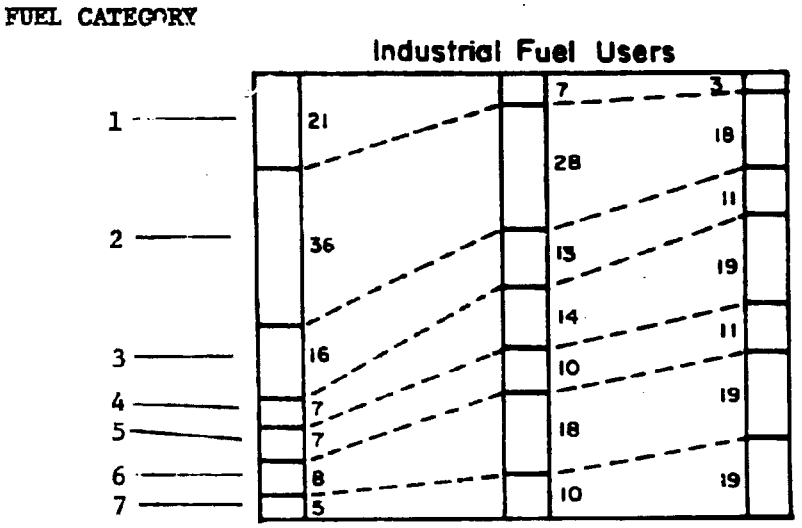
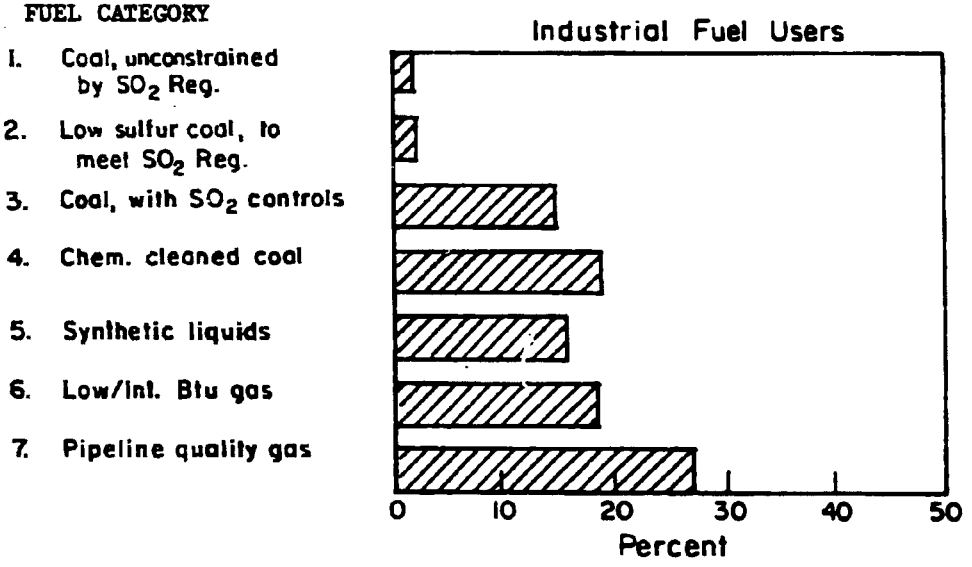


*HIGHEST/LOWEST VOTES



FORECAST OF RELATIVE MIX OF FUELS



RELATIVE ALLOCATION OF R&D EFFORT

WORKSHOP OF

PUBLIC INTEREST GROUP

July 22, 1975

COMPOSITION OF PUBLIC INTEREST GROUP

Type of Organization	Description of Representative
• American Public Health Assn. Professional association with 50,000 members and 400 organization members.	Designee formerly Director of Professional Services on APHA Staff. Experience in environmental health sciences. Active in National Clean Air Coalition.
• Common Cause. Nationwide citizens' lobby for accountability and openness in the political process. Approximately 300,000 individual members.	Volunteer intern, doing research on energy policy.
• League of Women Voters of the U.S. 1350 state and local leagues throughout U.S. The league studies land use, environmental issues, human resources, and energy.	Coordinator, Energy Task Force, with experience in political science, energy problems, and policy.
• National League of Cities. Represents cities to federal government and provides assistance and information to cities. Has 15,000 direct and indirect city members. Has general interest in cost, supply, and distribution of fuel, and impacts of fuel use on cities.	Assistant Director, Office of Policy Analysis. Experience in political science, general urban policy analysis.
• National Wildlife Federation. Concerned with conservation education, having approximately 3 million members in all 50 states. Gives opinion on requests to legislatures, litigates environmental issues, contacts executive agencies, and edits a number of periodicals.	Energy specialist, strip mining and energy R&D. Experience in political science—congressional aid, political operatives.
• Public Interest Research Group. Personal staff to Ralph Nader, doing research on various topics in the public interest.	Intern, working on economics of coal and nuclear power plants. Degree in economics.
• Smithsonian Institution. Experience in historical documentation—mining, processing, transportation, and markets.	Curator of mining with experience as mining engineer, coal miner, coal trade journal editor, historian.

PUBLIC INTEREST GROUPS

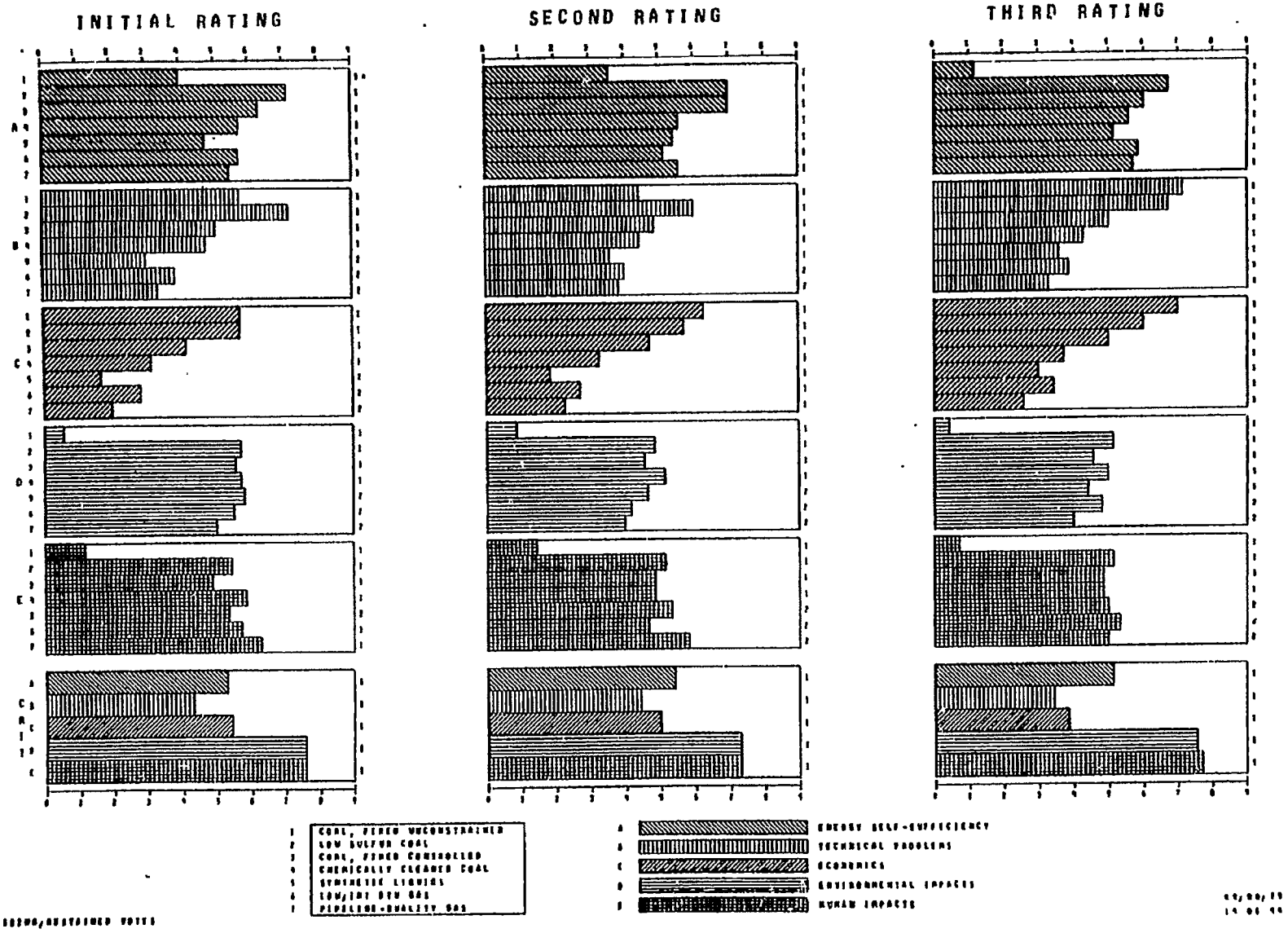
Relevant Comments From Tape

- This group clearly is most concerned about the human and environmental impacts of whatever way of using coal is finally chosen. ERDA should understand that this group's point of view is a concern for such things as long-term land use implications, and such things as internalizing whatever costs, social and environmental, may be associated with any of these fuel categories. It is less important which one is chosen than it is that the one or ones that are chosen meet certain thresholds -- certain criteria of environmental and human impact concern.
- ERDA should be constantly evaluating and re-evaluating the directions of its research programs in light of environmental and social criteria.
- This group can make a very strong case, based on empirical data gained through public opinion polls, that the public is concerned about such things as air and water pollution and does not accept the weakening of environmental standards as the only way to achieve energy self-sufficiency.
- The environmental and human impact areas are the areas of expertise of this group. Some of the other groups participating in this exercise have other interests which may or may not and often do not coincide with the public interest, e.g., economic or personal interests. This group's evaluation of the criteria — environmental impacts and human impacts — probably ought to be more significantly looked at by ERDA that the evaluation of some of the other groups on these same two criteria.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	5.1	3.4	3.9	7.6	7.7	
1. Coal, fired unconstrained by SO_2 regs.	1.1	7.1	7.0	0.4	0.7	4.1
2. Low sulfur coal, fired to meet SO_2 regs.	6.7	6.7	6.0	5.1	5.1	10.0
3. Coal, fired with SO_2 control equipment	6.0	5.0	5.0	4.6	4.9	8.9
4. Chemically cleaned coal	5.6	4.3	3.7	5.0	4.9	8.5
5. Synthetic Liquids	5.1	3.6	3.0	4.4	5.0	7.8
6. Low/Intermediate Btu gas	5.9	3.9	3.4	4.8	5.3	8.5
7. Pipeline-quality gas	5.4	3.3	2.6	4.0	5.0	7.5

FINAL EVALUATION MATRIX, PUBLIC INTEREST GROUPS

PUBLIC INTEREST GROUPS



PUBLIC INTEREST GROUPS

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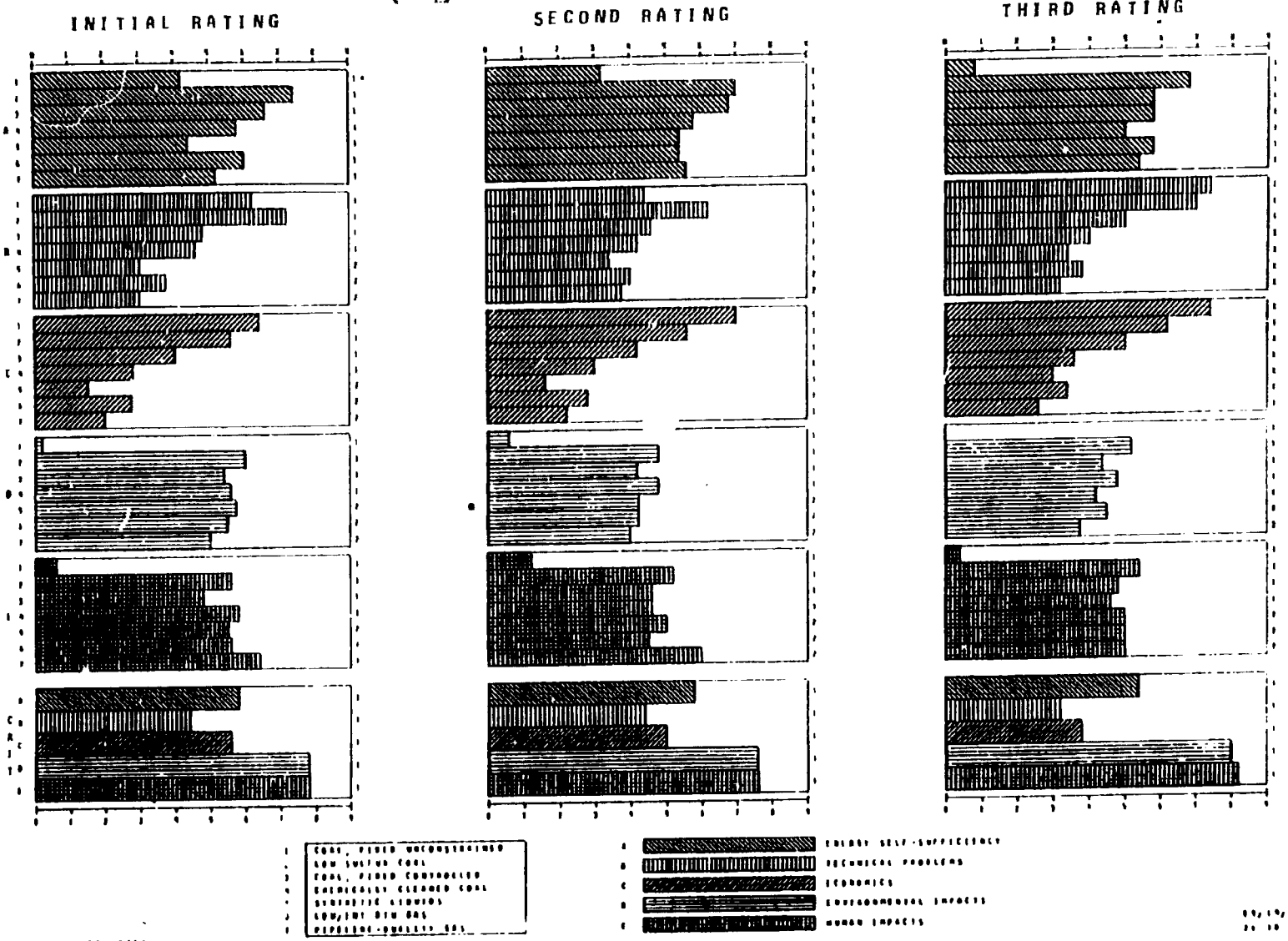
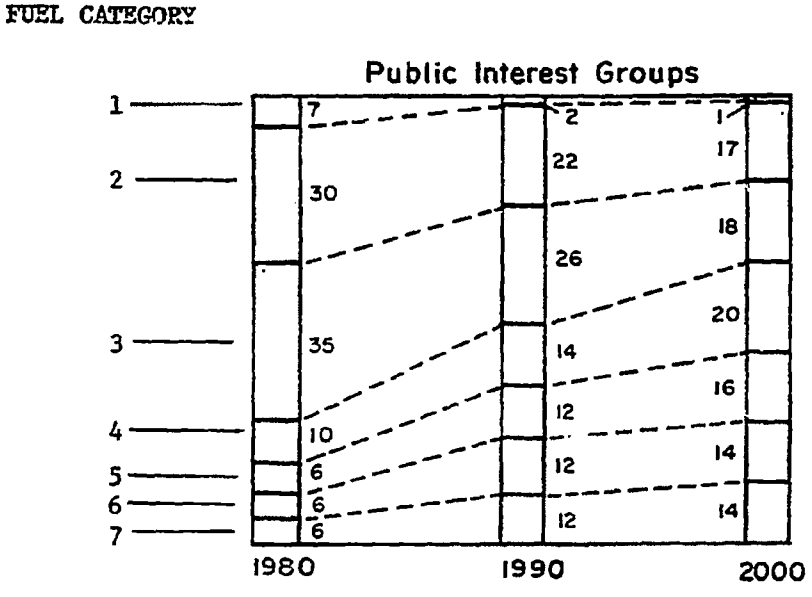
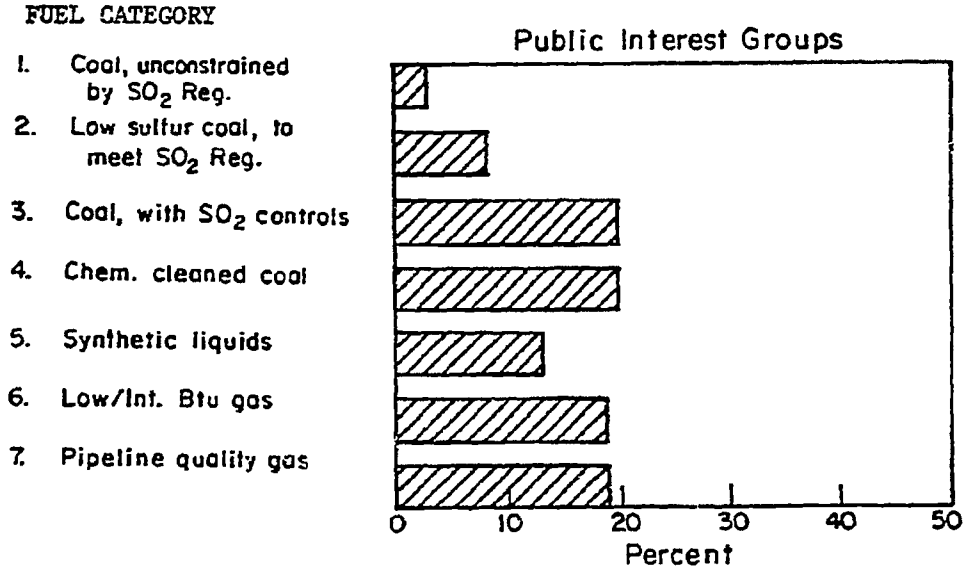




FORECAST OF RELATIVE MIX OF FUELS



RELATIVE ALLOCATION OF R&D EFFORT

WORKSHOP OF

STATE GOVERNMENTS GROUP

July 9, 1975

COMPOSITION OF STATE GOVERNMENTS GROUP

Type of Organization	Description of Representative
• Arizona. Advisor to State.	Professor of engineering and a specialist in energy conversion.
• Colorado. Energy Research and Development, which is a sponsoring and coordinating agency for state. Has small office with staff of 7, having a broad range of coal technology R&D and environmental impacts of development.	Director, having experience in research management and public policy determination.
• Kentucky. Governor's Office.	Governor's energy advisor, specializing in development. Experienced in economic research especially in relation to development.
• Michigan. State Energy Office, administering state and federally delegated responsibilities relating to petroleum products, coal, natural gas, and electricity.	Director, State Energy Office, with 19 years experience in various levels of state government.
• Ohio. State Government.*	Chief Policy Planning with experience in energy.
• Pennsylvania. State Government Energy Policy and Energy Program Coordinating Agency. Develops state coal policy and coordinates coal policy implementation.	Chief of Staff with experience in public administration.
• Utah. State Government.	Science and technology advisory function with experience in R&D, design, sales, academics, consulting, systems.
• West Virginia. Concerned with energy matters and policies having several state agencies with a variety of objectives and duties.	Advisory capacity in energy policy and resource management.

* Representative unable to be present for all 3 ratings, but participated in much of discussion. His ratings are not included in reported averages or scores.

STATE GOVERNMENTS

Relevant Comments From Tape

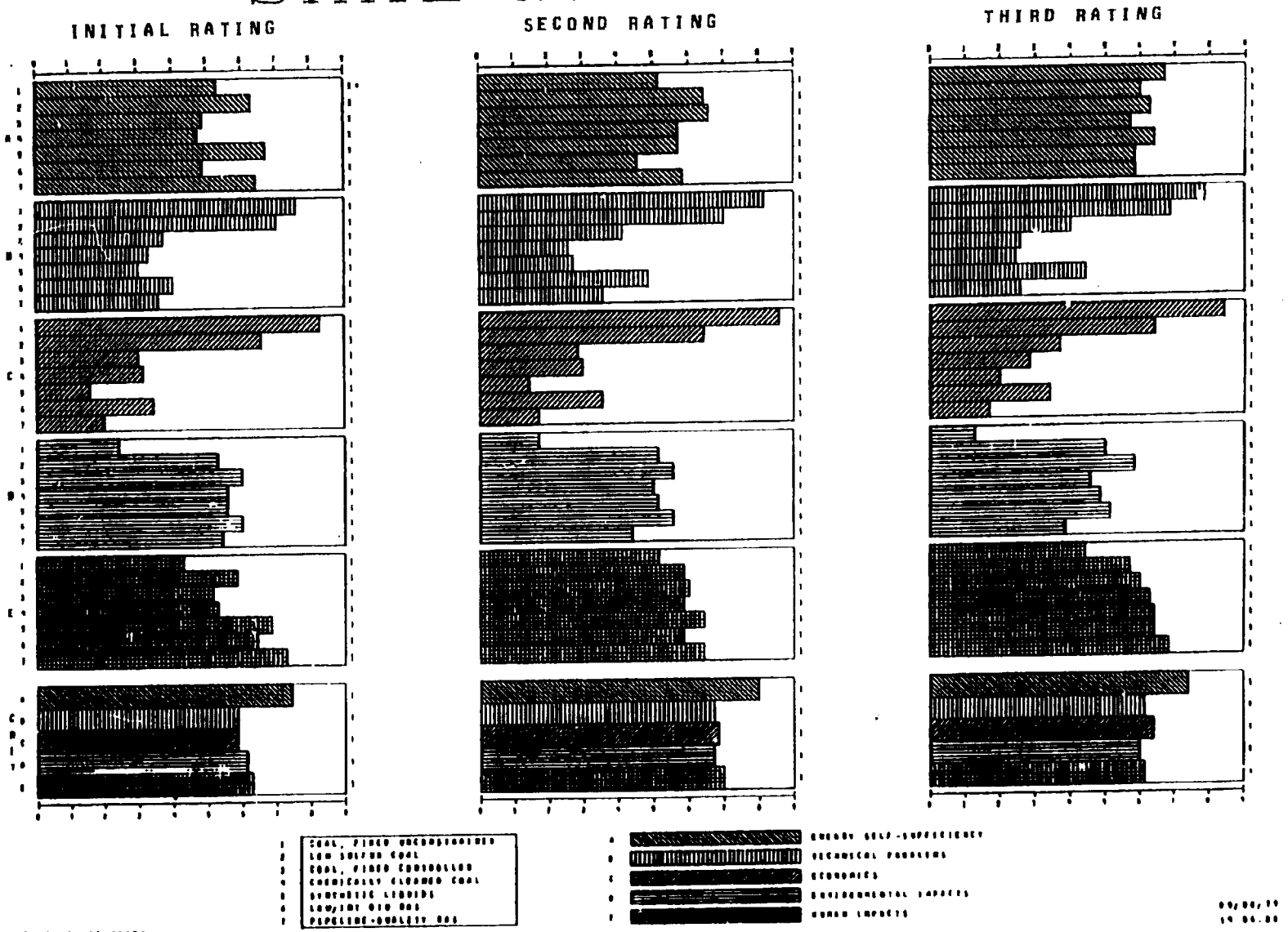
- The group agrees to consider the time frame for the exercise as from present to 1990.
- The definition of energy self-sufficiency is: the ability to balance by choice the nation's consumption, production, exports and imports of energy resources.
- The group desires to delete the "score" column of the evaluation matrix because this column is a numerical or quantitative attempt to assess the collective, the evaluative, qualitative judgments of all the factors discussed. If it is used in that way it can only lead to the wrong solutions.
- The rating system appears to be indicating that the two highest rated fuel categories are the two that are the most impractical to pursue.
- The rating system should be revised preferably to a ranking system in which there is a forced discrimination allowing for an allocation of a portion of points to each fuel category for each criterion.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Enviromental Impacts	E) Human Impacts	Score *
Weights	7.4	6.1	6.4	6.0	5.8	
1. Coal, fired unconstrained by SO_2 regs.	6.7	7.9	8.4	1.3	4.4	9.8
2. Low sulfur coal, fired to meet SO_2 regs.	6.0	6.9	6.4	5.0	5.7	10.0
3. Coal, fired with SO_2 control equipment	6.3	4.0	3.7	5.9	6.0	8.4
4. Chemically cleaned coal	5.7	2.6	2.9	4.6	6.3	7.0
5. Synthetic Liquids	6.4	2.4	2.0	4.9	6.4	6.9
6. Low/Intermediate Btu gas	5.9	4.4	3.4	5.1	6.4	8.1
7. Pipeline-quality gas	5.9	2.6	1.7	3.9	6.9	6.5

FINAL EVALUATION MATRIX, STATE GOVERNMENTS

* See reservations on scoring procedure expressed by Group (previous page).

STATE GOVERNMENTS



STATE GOVERNMENTS

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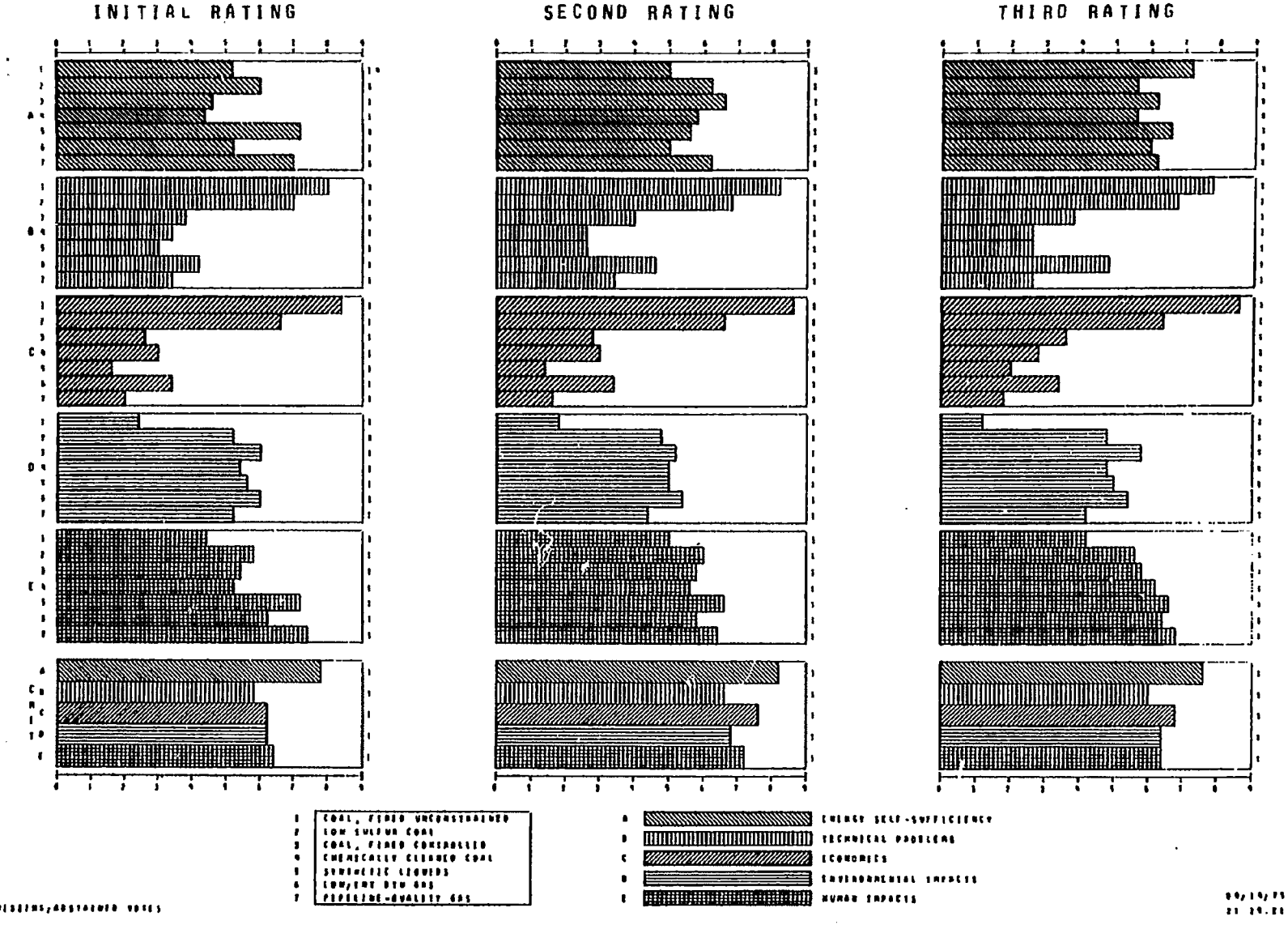

*MISSING/ABSTAINED VOTES

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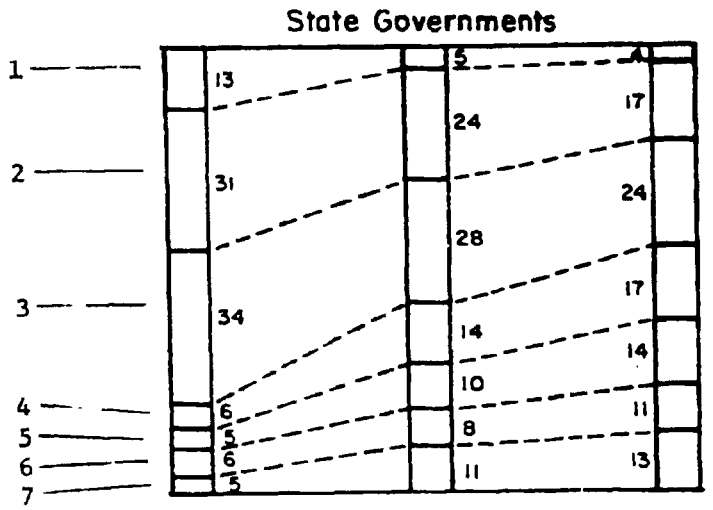
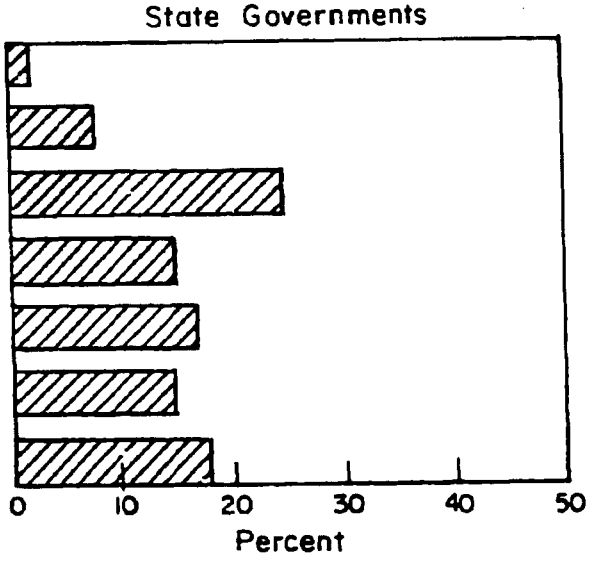
FUEL CATEGORY



FORECAST OF RELATIVE MIX OF FUELS

FUEL CATEGORY

1. Coal, unconstrained by SO_2 Reg.
2. Low sulfur coal, to meet SO_2 Reg.
3. Coal, with SO_2 controls
4. Chem. cleaned coal
5. Synthetic liquids
6. Low/Int. Btu gas
7. Pipeline quality gas



RELATIVE ALLOCATION OF R&D EFFORT

WORKSHOP OF

FEDERAL GOVERNMENT AGENCIES GROUP

August 6, 1975

COMPOSITION OF FEDERAL GOVERNMENT AGENCY GROUP

Type of Organization	Description of Representative
• Environemntal Protection Agency. Energy Processes Division of R&D Office of Energy, Minerals, and Industry. Main activity: power utility and new energy sources, environmental R&D.	George Rey. Senior Staff Advisor, Energy Processes Division. Past experience as Chief Industrial Pollution Control and Senior Research Engineer.
• Federal Energy Administration. Office of Coal, ERD. Main activity: concern over coal supply.	George W. Sall. Acting Deputy Associate Assistant Administrator, Coal. Mining engineer with coal mining experience.
• Federal Power Commission. Office of Energy Systems. Review and development of commission policy for environmental quality, fuel resources, systems planning, energy utilization and R&D.	Richard F. Hill. Chief Engineer and Director of the Office of Energy Systems. Education in engineering. Experience in environmental research and management and in systems engineering.
• General Services Administration. Office of the Administrator. Main activity: agency policy on all energy problems.	Lance B. Swann. Assistant to the Deputy Administrator—Energy Office. Coordinates all energy activities of GSA. Experienced in resource analysis and crisis management (energy), procurement policy-life cycle costing, transportation, and buildings management.
• U. S. Department of Commerce. Institute for Materials Research in the National Bureau of Standards. Main activity: standards, measurement methods, materials properties.	A. William Ruff. Chief, Microstructure Characteristics Section, Institute for Materials Research. Physical scientist with main experience as line administrator, R&D experience in coal.
• U. S. Department of Defense. Directorate for Energy in Office of the Secretary. Main activity: management of energy.	Walter C. Christensen. Assistant for Energy Resources. Experienced in energy research development and demonstration (general), heat and power, nuclear physics, industrial engineering, political science.
• U. S. Department of the Interior. Division of Interfuels Studies of the Office of Assistant Director—Fuels, U.S. Bureau of Mines. Main activity: "In-house" evaluation of energy resources, production, and consumption forecasting.	Mark Wesley A. Edwards. Industry Economist, Division of Interfuels Studies. About 30 years experience in senior staff position, responsible for analysis of production and use of coal, competitive fuels, and related labor-management problems.

FEDERAL GOVERNMENT AGENCIES

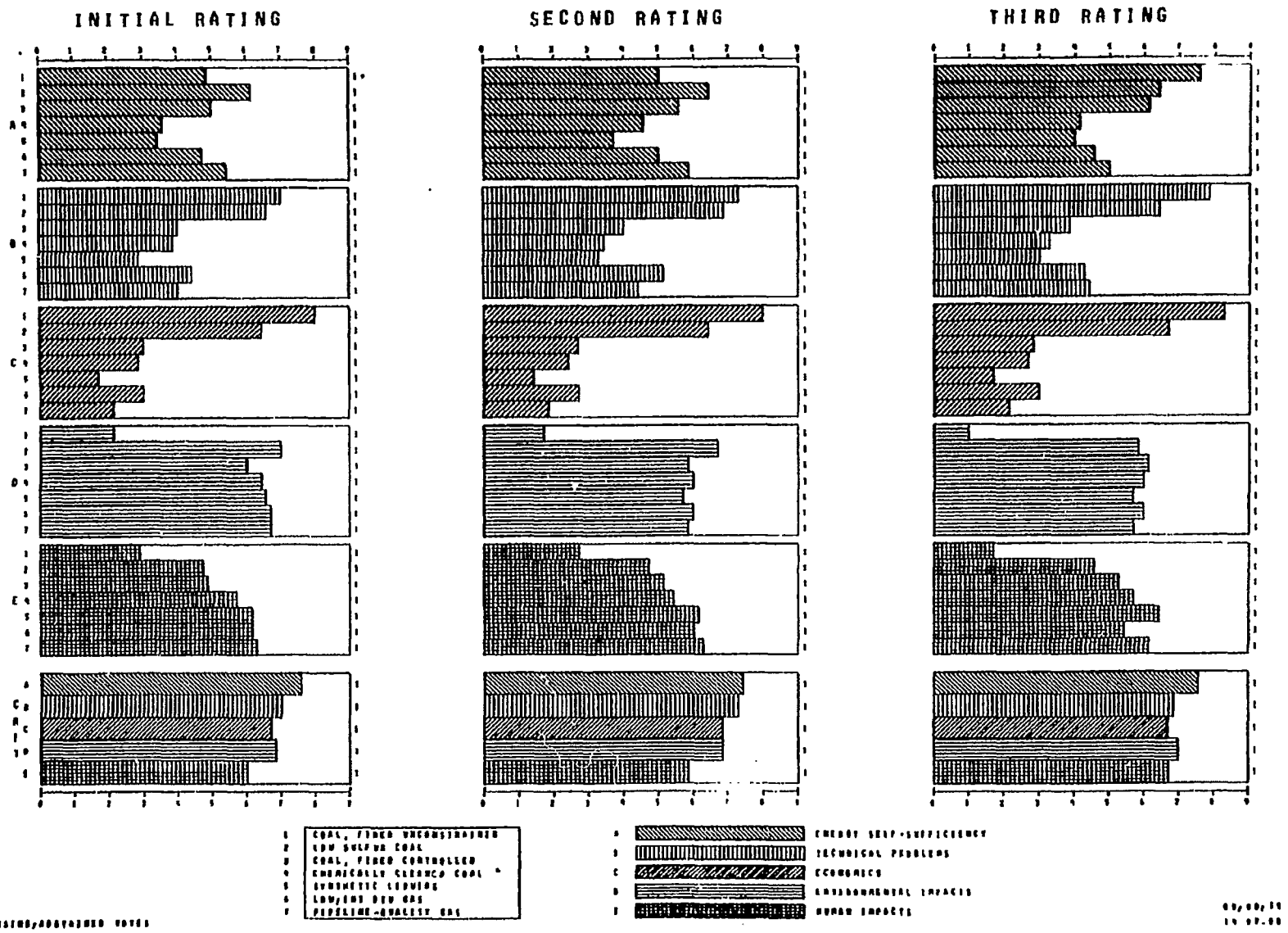
Relevant Comments From Tape

- The group did not agree on using a specified time frame.
- There was a view expressed that it would be inefficient, if by the year 2000, the predominant use of coal would be in boilers with sulfur-oxide controls. A more efficient use would be low-BTU gasification, used in a combined-cycle system, or some equivalent system. Also, other types of coal refining would provide the flexibility needed throughout the various sectors of the economy. Direct firing coal in large boilers would have little "spin-off" advantage, e.g.; supplementing liquids and gases.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	7.6 (6/9)	6.9 (3/9)	6.7 (5/9)	7.0 (6/9)	6.7 (5/9)	
1. Coal, fired unconstrained by SO_2 regs.	7.6 (6/9)	7.9 (5/9)	8.3 (7/9)	1.2 (1/9)	2.0 (1/9)	9.3
2. Low sulfur coal, fired to meet SO_2 regs.	6.4 (5/9)	6.4 (4/9)	6.7 (5/9)	5.9 (4/9)	4.6 (3/9)	10.0
3. Coal, fired with SO_2 control equipment	6.0 (4/9)	3.9 (3/9)	2.9 (2/9)	6.1 (5/9)	5.3 (4/9)	7.8
4. Chemically cleaned coal	4.1 (3/9)	3.3 (2/9)	2.7 (0/9)	6.0 (5/9)	5.7 (4/9)	7.0
5. Synthetic Liquids	4.0 (2/9)	3.0 (1/9)	1.7 (0/9)	5.7 (4/9)	6.4 (5/9)	6.6
6. Low/Intermediate Btu gas	4.6 (3/9)	4.3 (2/9)	3.0 (1/9)	6.0 (5/9)	6.1 (5/9)	7.7
7. Pipeline-quality gas	5.0 (1/9)	4.4 (0/9)	2.1 (0/9)	5.7 (4/9)	6.1 (4/9)	7.5

FINAL EVALUATION MATRIX, FEDERAL GOVERNMENT AGENCIES

FEDERAL GOVERNMENT AGENCIES



*MISSING/ABSTAINED VOTES

FEDERAL GOVERNMENT AGENCIES

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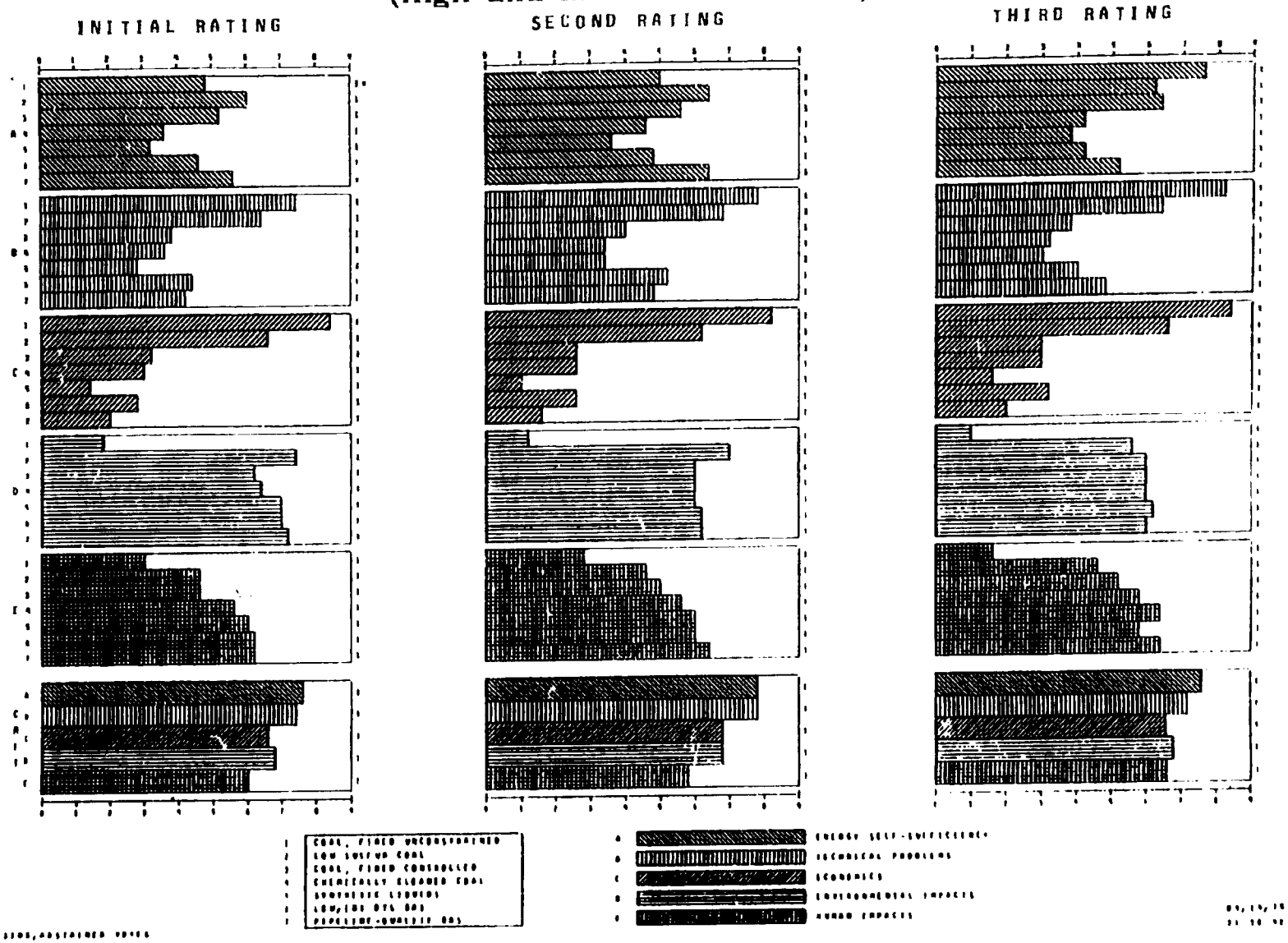
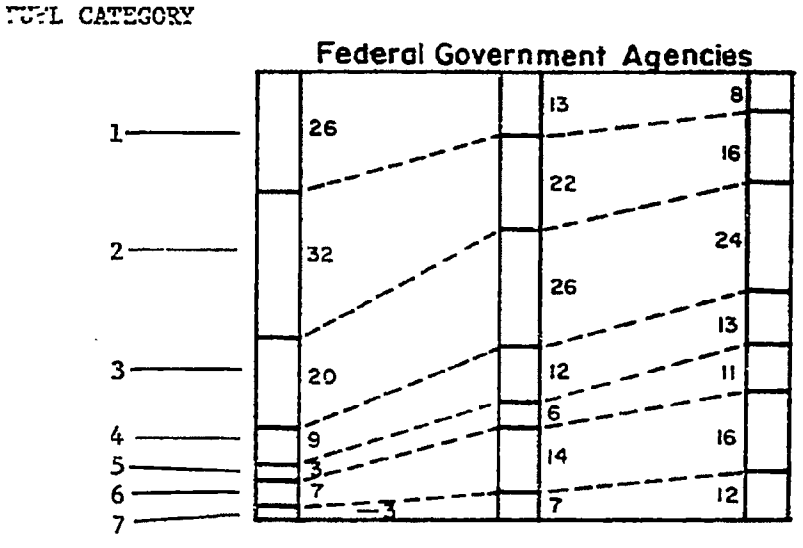
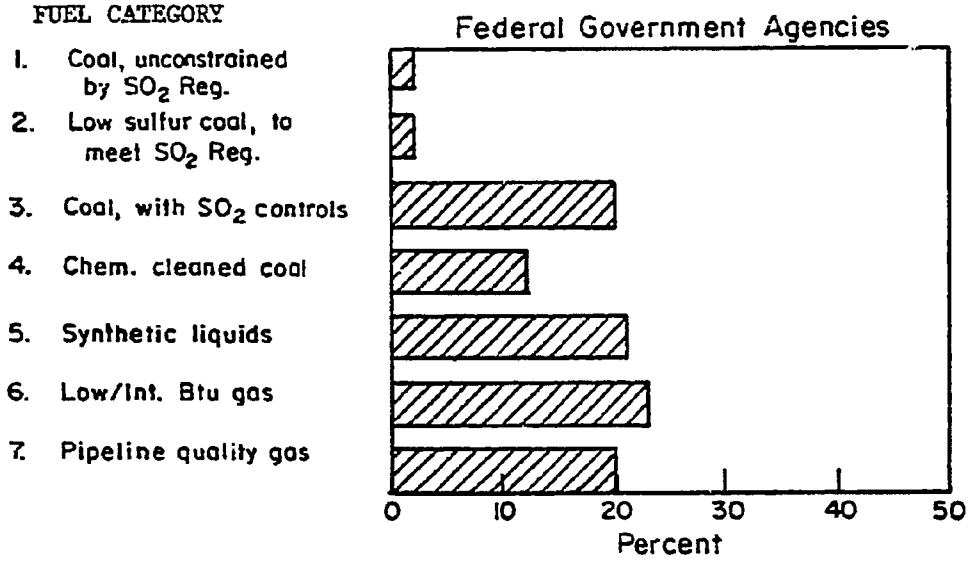




FORECAST OF RELATIVE MIX OF FUELS



RELATIVE ALLOCATION OF R&D EFFORT

WORKSHOP OF

COMPOSITE GROUP

July 24, 1975

COMPOSITION OF COMPOSITE GROUP*

Type of Organization	Description of Representative
• American Gas Association, Energy trade association. Has 300 member companies and represents over 90 percent of gas movers. Involved in synthetic gas research since 1943.	Douglas T. King. Director of research.
• American Petroleum Institute. Energy trade association, representing oil industry in technical and public affairs.	Mike Rusin. Economist—policy. Major experience in petroleum. Had 6 years experience in coal and coal-derived fuels R&D.
• Bituminous Coal Research, Inc. Industry organization for coal research. Long experience in coal and coal conversion.	J. R. Garvey. President and Director of Research.**
• Electric Power Research Institute. Research organization for the electric power industry, directing research programs in coal utilization and conversion for electric power production.	Bert Louks. Consultant. Experienced in economics of energy and chemical systems. Former EPRI staff member.
• National Association of Manufacturers, Trade Group, including general manufacturing. 13,000 manufacturing and mining companies and a few associate members in research, engineering/construction.	Stanley M. Berman. Responsible for all energy and natural resource programs and policy activities. Experienced in economics and public policy assessment in natural resources.
• National Governors Conference. Gives energy project support to 50 governors on national resources. Presently involved in policy resolution on leasing Western coal.	James Baroff, Science Advisor. Physics background, presently working on scrubbers.
• National Science Foundation. Overview of private and federal R&D.	Len Topper. Staff specialist with experience in energy R&D.

* A representative of a national consumer-interest group was invited to participate in this workshop, but did not attend.

** Unable to attend, but sent initial ratings and comments later. His ratings were not averaged with those of attendees that participated in the discussion.

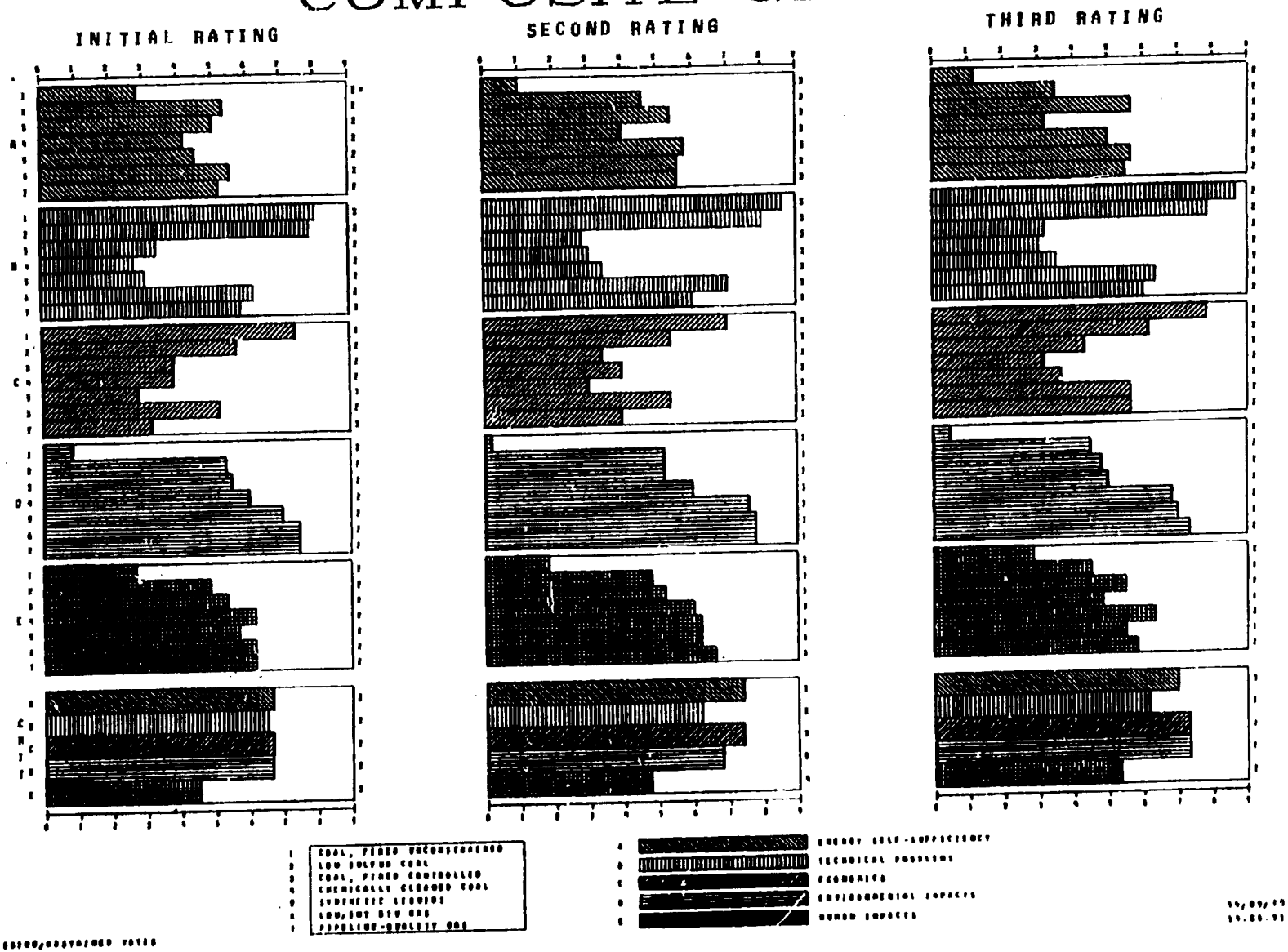
- The Lurgi process is expensive, but research promises to reduce the cost. This process is a valid target for ERDA activity. (IP)
- In the low/intermediate-BTU gas system there is a need to operate the gas producer at a constant rate. There are two ways of handling this. One way is to store the gas produced in the evening or turn it in to compressed air or to steam for use in the day. The other is to have a storage system and convert the stored portion to pipeline quality gas on a continuing basis.
- The largest users of low-BTU gas will be power plants and these gas plants will be on-site. The gasification plant will be run at a constant rate and the clean gas could be run through a liquid synthesizer with sufficient conversion, once through. This would then be used to supply intermediate and peak load facilities. The cleaned liquids could be fired in combined-cycle systems. This will prove to be a very clean, economic way to fire generating systems, as opposed to conventional firing.

* IP = view expressed by individual participant.

	A) Energy Self-Sufficiency	B) Extent of Technical Problems	C) Economics	D) Environmental Impacts	E) Human Impacts	Score
Weights	7.0	6.2	7.3	7.3	5.3	
1. Coal, fired unconstrained by SO_2 regs.	1.2	8.7	7.8	0.5	2.8	6.6
2. Low sulfur coal, fired to meet SO_2 regs.	3.5	7.8	6.2	4.5	4.5	8.6
3. Coal, fired with SO_2 control equipment	5.7	3.2	4.3	4.8	5.5	7.9
4. Chemically cleaned coal	3.2	3.0	3.2	5.0	4.8	6.3
5. Synthetic Liquids	5.0	3.5	3.7	6.8	6.3	8.4
6. Low/Intermediate Btu gas	5.7	6.3	5.7	7.0	5.5	10.0
7. Pipeline-quality gas	5.5	6.0	4.8	7.3	5.8	9.7

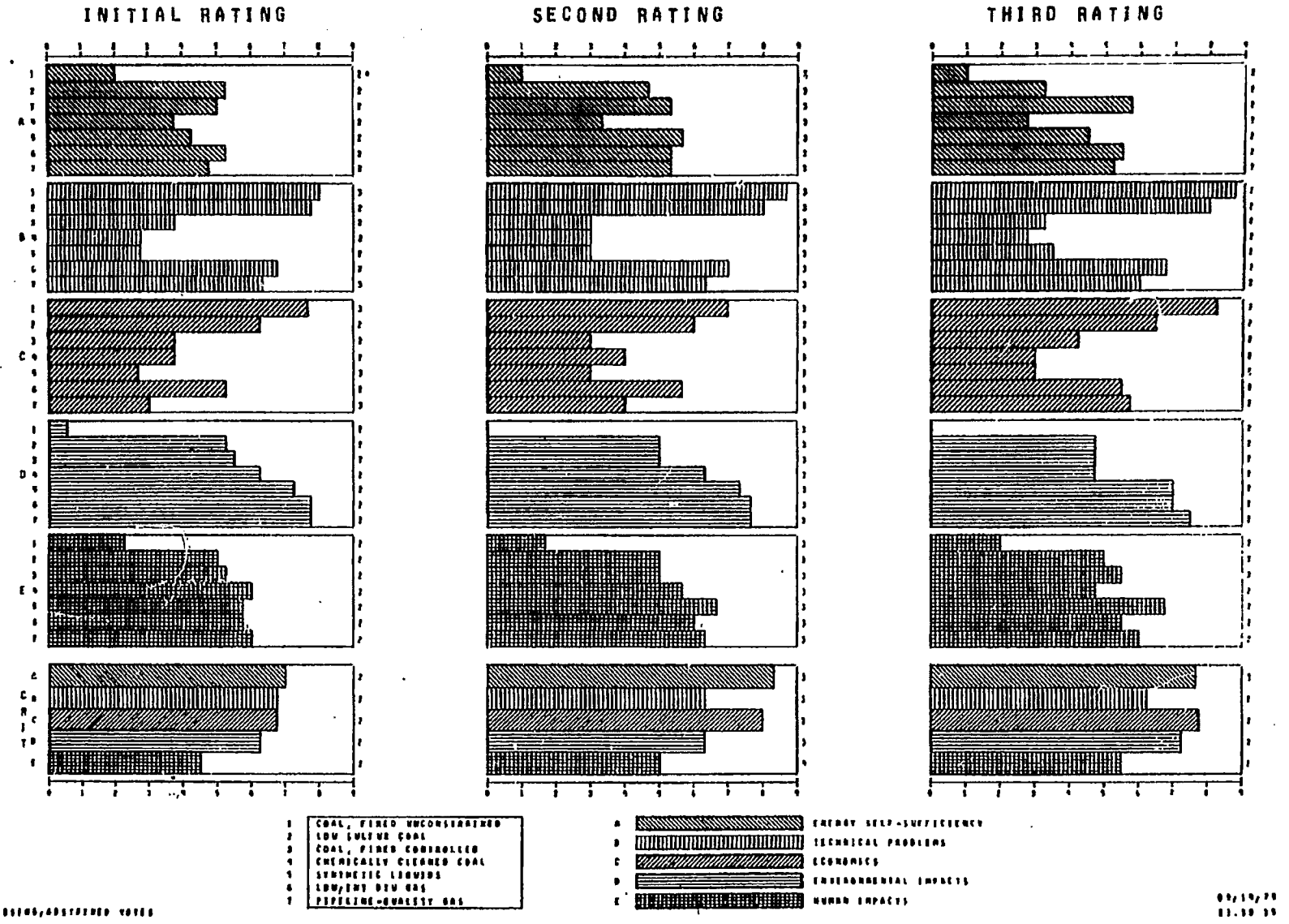
FINAL EVALUATION MATRIX, COMPOSITE GROUP

COMPOSITE GROUP

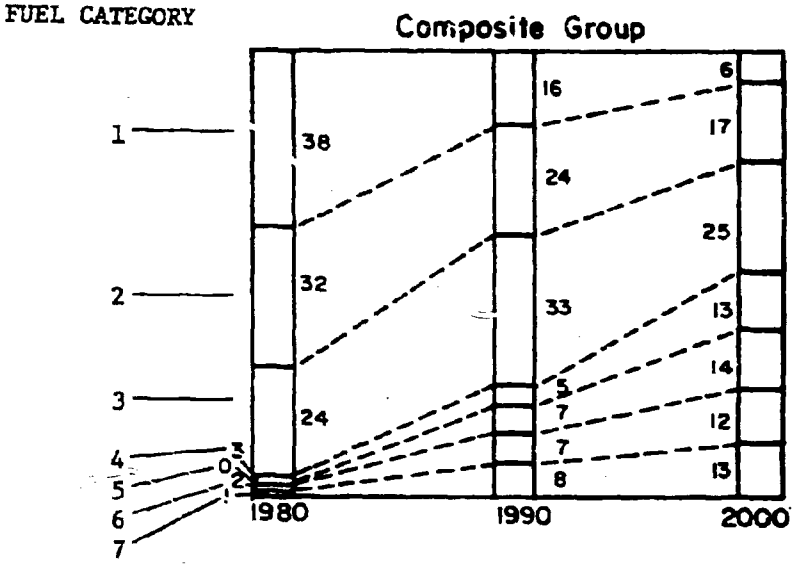


COMPOSITE GROUP

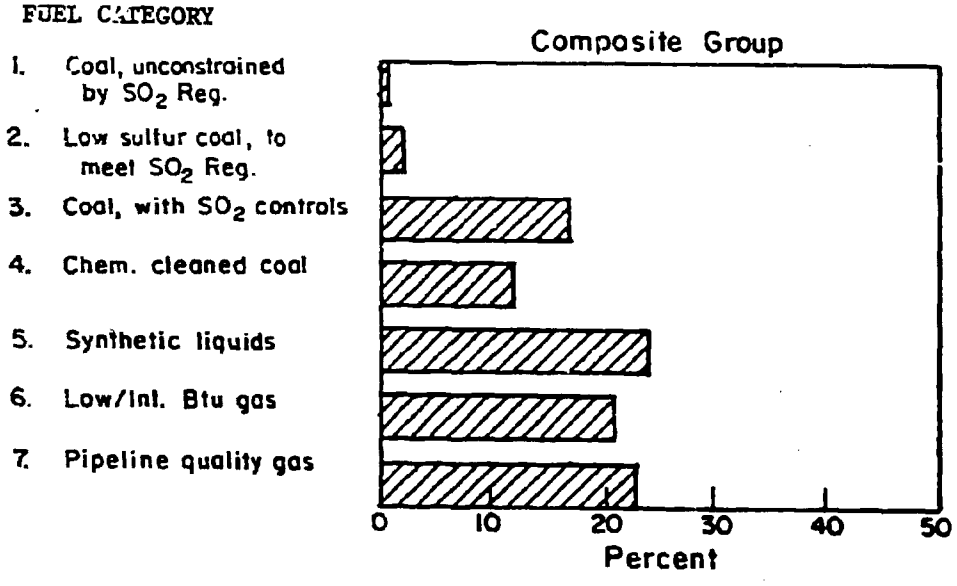
(High and low votes removed)



*MISSING/ABSTAINED VOTES



FORECAST OF RELATIVE MIX OF FUELS



RELATIVE ALLOCATION OF R&D EFFORT

APPENDIX D

ADDITIONAL SUMMARIES OF RESULTS ACROSS GROUPS

The following tables display the results of ratings and weighted scores across groups. (The ratings are expressed on a 0 to 9 scale.)

Table D-1. Final Rating and Ranking of Criteria

Table D-2. Final Rating and Ranking of Fuel Categories (For Each Criterion)

a. Energy Self Sufficiency
b. Extent of Technical Problem
c. Economics
d. Environmental Impacts
e. Human Impacts

Table D-3. Weighted Scores and Rankings of Fuel Categories for all Groups (Scale 0 to 10).

TABLE D-1. FINAL RATING AND RANKING OF CRITERIA

Numbers in italics refer to rank order of ratings within groups.

Evaluation Criteria	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
A. Energy Self-Sufficiency	8.1 *1*	7.9 *1+*	6.4 *2*	7.5 *1*	7.7 *2*	5.1 *3*	7.4 *1*	7.6 *1*	7.0 *3*
B. Extent of Technical Problems	6.5 *2*	6.4 *3*	6.1 *3*	7.4 *2+*	4.9 *5*	3.4 *5*	6.1 *3*	6.9 *3*	6.2 *4*
C. Economics	6.4 *3*	7.9 *1+*	8.0 *1*	7.4 *2+*	7.9 *1*	3.9 *4*	6.4 *2*	6.7 *4+*	7.3 *1+*
D. Environmental Impacts	5.6 *5*	5.0 *5*	4.9 *5*	5.9 *5*	5.3 *3*	7.6 *2*	6.0 *4*	7.0 *2*	7.3 *1+*
E. Human Impacts	6.0 *4*	5.1 *4*	6.0 *4*	6.0 *4*	5.0 *4*	7.7 *1*	5.8 *5*	6.7 *4+*	5.3 *5*

TABLE D-2a. FINAL RATINGS AND RANKING OF FUEL CATEGORIES--CRITERIA A. ENERGY SELF-SUFFICIENCY

Numbers in italics refer to rank order of ratings within groups.

Fuel Category	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
1. Coal, fired unconstrained by SO_2 regulations	7.5 *1*	7.8 *1*	1.9 *6*	7.8 *1*	7.1 *1*	1.1 *7*	6.7 *1*	7.6 *1*	1.2 *7*
2. Low sulfur coal, fired to meet SO_2 regulations	5.1 *2*	7.0 *2*	1.6 *7*	5.5 *2*	6.1 *2*	6.7 *1*	6.0 *4*	6.4 *2*	3.5 *5*
3. Coal, fired with SO_2 control equipment	3.6 *5+*	5.9 *3*	3.1 *4*	4.2 *4*	4.9 *5+*	6.0 *2*	6.3 *3*	6.0 *3*	5.7 *1+*
4. Chemically cleaned coal	4.0 *4*	3.0 *7*	2.6 *5*	3.5 *6*	4.9 *5+*	5.6 *4*	5.7 *7*	4.1 *6*	3.2 *6*
5. Synthetic liquids	3.5 *7*	4.8 *5*	6.6 *2*	3.6 *5*	3.9 *7*	5.1 *6*	6.4 *2*	4.0 *7*	5.0 *4*
6. Low/intermediate Btu gas	3.6 *5+*	5.2 *4*	5.0 *3*	4.8 *3*	5.7 *3*	5.9 *3*	5.9 *5+*	4.6 *5*	5.7 *1+*
7. Pipeline-quality gas	2.5 *8*	4.4 *6*	7.2 *1*	2.0 *7*	5.1 *4*	5.4 *5*	5.9 *5+*	5.0 *4*	5.5 *3*
8. Mixed fuels	4.4 *3*								

TABLE D-2b. FINAL RATINGS AND RANKING OF FUEL CATEGORIES--CRITERIA B. EXTENT OF TECHNICAL PROBLEMS

Numbers in italics refer to rank order of ratings within groups.

Fuel Category	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
1. Coal, fired unconstrained by SO_2 regulations	8.0 *1*	8.0 *1*	8.5 *1*	8.5 *1*	8.4 *1*	7.1 *1*	7.9 *1*	7.9 *1*	8.7 *1*
2. Low sulfur coal, fired to meet SO_2 regulations	6.8 *2*	7.2 *2*	7.8 *2*	8.0 *2*	7.4 *2*	6.7 *2*	6.9 *2*	6.4 *2*	7.8 *2*
3. Coal, fired with SO_2 control equipment	2.6 *7*	4.6 *5*	5.6 *3*	3.5 *6*	3.4 *5t*	5.0 *3*	4.0 *4*	3.9 *5*	3.2 *6*
4. Chemically cleaned coal	3.0 *6*	2.2 *7*	2.5 *5*	3.4 *7*	3.4 *5t*	4.3 *4*	2.6 *5t*	3.3 *6*	3.0 *7*
5. Synthetic liquids	2.5 *8*	3.4 *6*	1.9 *7*	3.8 *5*	3.0 *7*	3.6 *6*	2.4 *7*	3.0 *7*	3.5 *5*
6. Low/intermediate Btu gas	3.9 *5*	5.9 *3*	3.5 *4*	4.9 *3*	4.7 *3*	3.9 *5*	4.4 *3*	4.3 *4*	6.3 *3*
7. Pipeline-quality gas	4.4 *4*	4.9 *4*	2.1 *6*	4.1 *4*	4.1 *4*	3.3 *7*	2.6 *5t*	4.4 *3*	6.0 *4*
8. Mixed fuels	5.9 *3*								

TABLE D-2c. FINAL RATINGS AND RANKING OF FUEL CATEGORIES--CRITERIA C, ECONOMICS

Numbers in italics refer to rank order of ratings within groups.

Fuel Category	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
1. Coal, fired unconstrained by SO_2 regulations	8.5 *1*	7.8 *1*	3.0 *4*	8.4 *1*	7.9 *1*	7.0 *1*	8.4 *1*	8.3 *1*	7.8 *1*
2. Low sulfur coal, fired to meet SO_2 regulations	6.6 *2*	6.4 *2*	2.4 *5*	6.4 *2*	6.1 *2*	6.0 *2*	6.4 *2*	6.7 *2*	6.2 *2*
3. Coal, fired with SO_2 control equipment	3.1 *4*	4.5 *3*	1.4 *6*	3.9 *4*	4.3 *3+*	5.0 *3*	3.7 *3*	2.9 *4*	4.3 *5*
4. Chemically cleaned coal	2.9 *5*	3.2 *5*	0.8 *7*	3.8 *5*	3.7 *5*	3.7 *4*	2.9 *5*	2.7 *5*	3.2 *7*
5. Synthetic liquids	2.4 *7*	1.9 *7*	6.8 *3*	2.8 *6*	2.9 *6*	3.0 *6*	2.0 *6*	1.7 *7*	3.7 *6*
6. Low/intermediate Btu gas	2.8 *6*	3.6 *4*	7.0 *2*	5.0 *3*	4.3 *3+*	3.4 *5*	3.4 *4*	3.0 *3*	5.7 *3*
7. Pipeline-quality gas	1.4 *8*	2.1 *6*	7.9 *1*	1.4 *7*	2.7 *7*	2.6 *7*	1.7 *7*	2.1 *6*	4.8 *4*
8. Mixed fuels	5.1 *3*								

TABLE D-2d. FINAL RATINGS AND RANKING OF FUEL CATEGORIES--CRITERIA D. ENVIRONMENTAL IMPACTS

Numbers in italics refer to rank order of ratings within groups.

Fuel Category	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
1. Coal, fired unconstrained by SO_2 regulations	2.8 *8*	2.6 *7*	1.0 *7*	3.8 *7*	2.1 *7*	0.4 *7*	1.3 *7*	1.2 *7*	0.5 *7*
2. Low sulfur coal, fired to meet SO_2 regulations	6.9 *1*	5.5 *4+*	4.5 *6*	6.0 *4*	5.6 *3+*	5.1 *1*	5.0 *3*	5.9 *4*	4.5 *6*
3. Coal, fired with SO_2 control equipment	5.8 *6*	5.8 *2+*	5.0 *5*	4.6 *6*	4.7 *6*	4.6 *4*	5.9 *1*	6.1 *1*	4.8 *5*
4. Chemically cleaned coal	6.0 *4*	4.8 *6*	5.4 *4*	5.9 *5*	5.3 *5*	5.0 *2*	4.6 *5*	6.0 *2+*	5.0 *4*
5. Synthetic liquids	5.9 *5*	5.5 *4+*	6.4 *2*	6.4 *3*	5.6 *3+*	4.4 *5*	4.9 *4*	5.7 *5+*	6.8 *3*
6. Low/intermediate Btu gas	6.1 *3+*	6.4 *1*	6.2 *3*	6.8 *1*	5.9 *1*	4.8 *3*	5.1 *2*	6.0 *3+*	7.0 *2*
7. Pipeline-quality gas	5.4 *7*	5.8 *2+*	8.0 *1*	6.6 *2*	5.7 *2*	4.0 *6*	3.9 *6*	5.7 *5+*	7.3 *1*
8. Mixed fuels	6.1 *3+*								

TABLE D-2e. FINAL RATINGS AND RANKING OF FUEL CATEGORIES--CRITERIA E. HUMAN IMPACTS

Numbers in italics refer to rank order of ratings within groups.

Fuel Category	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
1. Coal, fired unconstrained by SO_2 regulations	4.1 *8*	3.8 *7*	2.4 *7*	5.1 *6*	4.1 *7*	0.7 *7*	4.4 *7*	2.0 *7*	2.8 *7*
2. Low sulfur coal, fired to meet SO_2 regulations	6.0 *1*	6.6 *1*	4.6 *6*	5.5 *5*	5.3 *3+*	5.1 *2*	5.7 *6*	4.6 *6*	4.5 *6*
3. Coal, fired with SO_2 control equipment	4.9 *3+*	6.0 *3+*	5.2 *4*	3.9 *7*	4.7 *5+*	4.9 *5+*	6.0 *5*	5.3 *5*	5.5 *3+*
4. Chemically cleaned coal	4.9 *3+*	5.2 *6*	4.9 *5*	5.8 *3*	5.3 *3+*	4.9 *5+*	6.3 *4*	5.7 *4*	4.8 *6*
5. Synthetic liquids	4.6 *6*	6.0 *3+*	6.0 *3*	6.2 *2*	4.7 *5+*	5.0 *3+*	6.4 *2+*	6.4 *1*	6.3 *1*
6. Low/intermediate Btu gas	4.9 *3+*	6.4 *2*	6.1 *2*	6.9 *1*	5.9 *1*	5.3 *1*	6.4 *2+*	6.1 *2+*	5.5 *3+*
7. Pipeline-quality gas	4.2 *7*	6.0 *3+*	7.4 *1*	5.6 *4*	5.4 *2*	5.0 *3+*	6.9 *1*	6.1 *2+*	5.8 *2*
8. Mixed fuels	5.6 *2*								

TABLE D-3. WEIGHTED SCORES* AND RANKINGS OF FUEL CATEGORIES

Numbers in italics refer to rank order of scores within groups.

Fuel Category	Group: Coal Industry	Oil and Chemical Industry	Gas Industry	Electric Power Industry	Industrial Fuel Users	Public Interest Groups	State Governments	Federal Government Agencies	Composite Group
1. Coal, fired unconstrained by SO_2 regulations	10.0 *1*	9.9 *2*	5.2 *6*	10.0 *1*	10.0 *1*	4.1 *7*	9.8 *2*	9.3 *2*	6.6 *6*
2. Low sulfur coal, fired to meet SO_2 regulations	9.4 *2*	10.0 *1*	6.0 *4*	8.9 *2*	9.8 *2*	10.0 *1*	10.0 *1*	10.0 *1*	8.6 *3*
3. Coal, fired with SO_2 control equipment	5.8 *6*	8.0 *3*	5.6 *5*	5.7 *6*	7.1 *5+*	8.9 *2*	8.4 *3*	7.8 *3*	7.9 *5*
4. Chemically cleaned coal	6.1 *5*	5.3 *7*	4.3 *7*	6.1 *4+*	7.2 *4*	8.5 *3+*	7.0 *5*	7.0 *6*	6.3 *7*
5. Synthetic liquids	5.5 *7*	6.0 *6*	8.6 *2+*	6.1 *4+*	6.3 *7*	7.8 *5*	6.9 *6*	6.6 *7*	8.4 *4*
6. Low/intermediate Btu gas	6.2 *4*	7.9 *4*	8.6 *2+*	7.8 *3*	8.4 *3*	8.5 *3+*	8.1 *4*	7.7 *4*	10.0 *1*
7. Pipeline-quality gas	5.1 *8*	6.5 *5*	10.0 *1*	5.0 *7*	7.1 *5+*	7.5 *6*	6.5 *7*	7.5 *5*	9.7 *2*
8. Mixed fuels	8.1 *3*								

* Maximum value of score is 10.0.

APPENDIX E

STATISTICAL ANALYSES OF RESULTS

APPENDIX E

STATISTICAL ANALYSES OF RESULTS

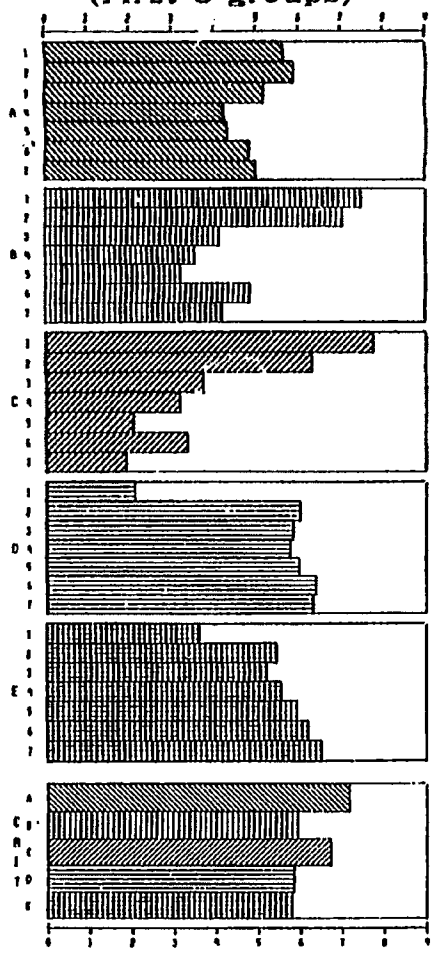
This appendix contains selected analyses of the results of the study. These are:

- Graphical Comparison of Integrated Group Responses vs Composite Group Responses
- Graphical Comparison of Integrated Group Responses vs Composite Group Responses (High and Low Votes Removed)
- Analysis of Variance (ANOVA): Comparison of Mean Ratings of Criteria Within Interest Groups
- Conclusion of Comparison of Fuel Ratings by Interest Groups Within Criterion and Round of Ratings.

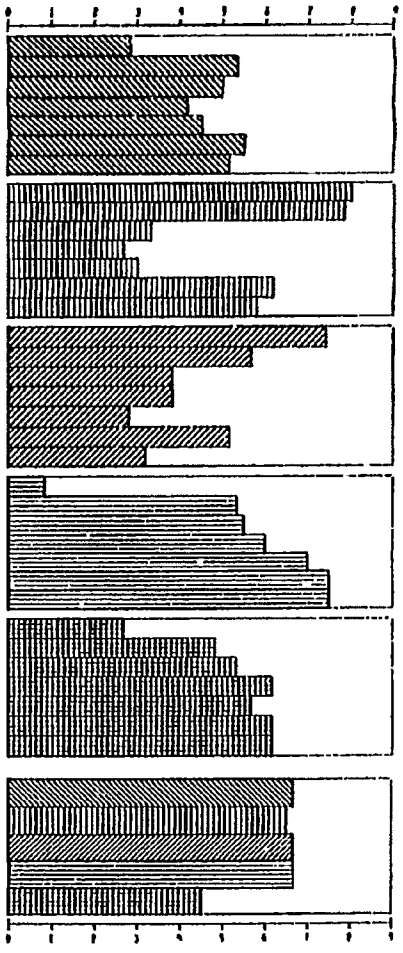
INITIAL RATING

Integrated Responses

(First 8 groups)



Composite Group

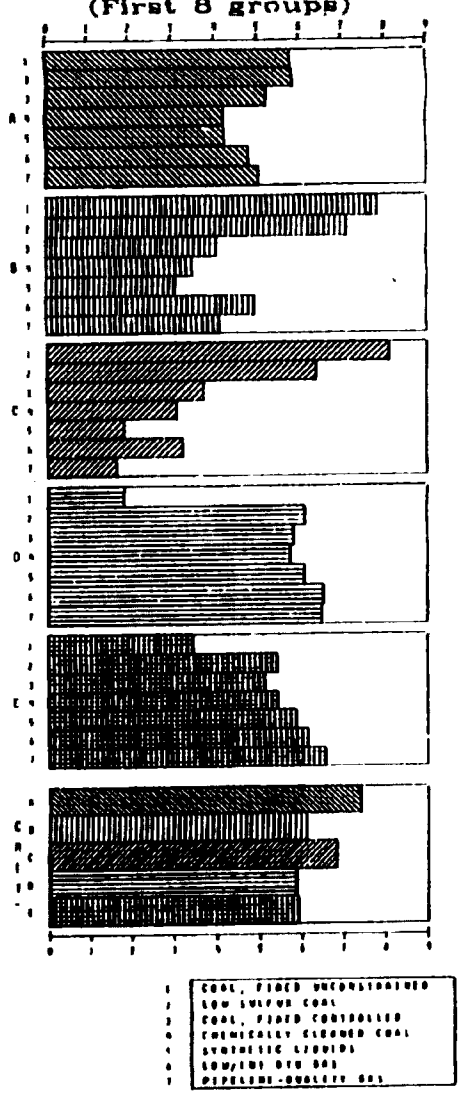


1. COAL, FIXED UNCONSTRAINED
2. LOW SULFUR COAL
3. COAL, FIXED CONTROLLED
4. CHEMICALLY CLEANED COAL
5. SYNTHETIC LIQUIDS
6. LOW/INT BTU GAS
7. PIPELINE-QUALITY GAS

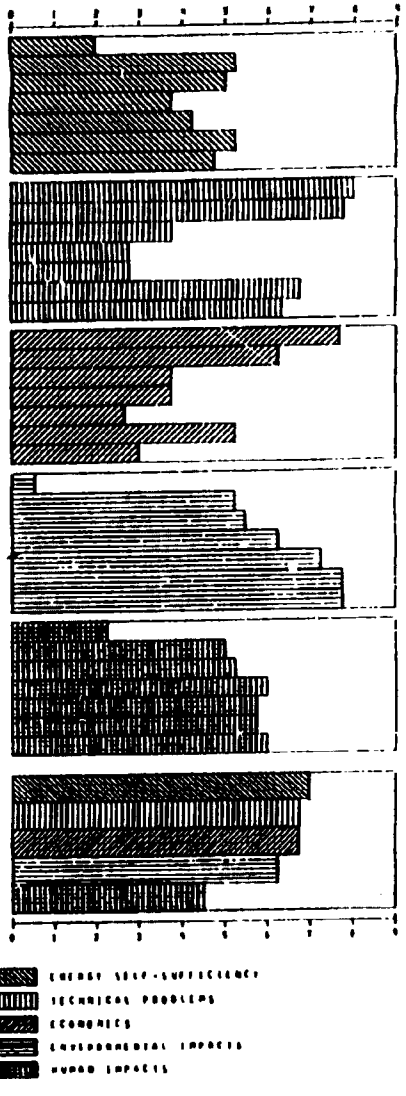
A. ENERGY SELF-SUFFICIENCY
B. TECHNICAL PROBLEMS
C. ECONOMICS
D. ENVIRONMENTAL IMPACTS
E. HUMAN IMPACTS

INITIAL RATING
(High and low votes removed)

Integrated Responses
(First 8 groups)



Composite Group



ANALYSIS OF VARIANCE (ANOVA): COMPARISON OF MEAN RATINGS OF CRITERIA WITHIN INTEREST GROUPS

The results of the analysis are shown on the following computer print-outs. This analysis shows that there are statistically significant differences in the average ratings of the five criteria by six of the nine groups. The groups whose average ratings are not statistically different are: State Governments, Federal Government Agencies, and Composite Group.

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE COAL

- O N E W A Y -

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	29.3500	7.3375	3.441	.018
WITHIN GROUPS	35	74.6250	2.1321		
TOTAL	39	103.9750			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	8	8.1250	.9910	.3504	7.0000	9.0000	7.2965 TO 8.9535
GRP 2	8	6.5000	1.8516	.6547	4.0000	9.0000	4.9520 TO 8.0480
GRP 3	8	6.3750	1.0607	.3750	5.0000	8.0000	5.4883 TO 7.2617
GRP 4	8	5.6250	1.3025	.4605	4.0000	7.0000	4.5361 TO 6.7139
GRP 5	8	6.0000	1.8516	.6547	4.0000	9.0000	4.4520 TO 7.5480
TOTAL	40	6.5250			4.0000	9.0000	
UNGROUPED DATA			1.6328	.2582			6.0028 TO 7.0472
FIXED EFFECTS MODEL			1.4602	.2309			6.0563 TO 6.9937
RANDOM EFFECTS MODEL			.9577	.4283			5.3359 TO 7.7141

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .3216, P = .432 (APPROX.)
BARTLETT-BOX F = 1.148, P = .333
MAXIMUM VARIANCE / MINIMUM VARIANCE = 3.491

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE OIL

ONEWAY

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	63.4000	15.8500	9.619	.000
WITHIN GROUPS	35	56.5000	1.6143		
TOTAL	39	119.9000			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	8	7.8750	.6409	.2266	7.0000	9.0000	7.3392 TO 8.4108
GRP 2	8	6.3750	2.0659	.7304	3.0000	9.0000	4.6479 TO 8.1021
GRP 3	8	7.8750	1.1260	.3981	6.0000	9.0000	6.9336 TO 8.8164
GRP 4	8	5.0000	.9258	.3273	3.0000	6.0000	4.2260 TO 5.7740
GRP 5	8	5.1250	1.1260	.3981	4.0000	7.0000	4.1836 TO 6.0664
TOTAL	40	6.4500			3.0000	9.0000	
UNGROUPED DATA			1.7534	.2772			5.8892 TO 7.0108
FIXED EFFECTS MODEL			1.2705	.2009			6.0422 TO 6.8578
RANDOM EFFECTS MODEL			1.4076	.6295			4.7023 TO 8.1977

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .5288, P = .007 (APPROX.)
BARTLETT-BOX F = 2.513, P = .040
MAXIMUM VARIANCE / MINIMUM VARIANCE = 10.391

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE GAS

ONEWAY

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	40.3500	10.0875	3.221	.024
WITHIN GROUPS	35	109.6250	3.1321		
TOTAL	39	149.9750			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	8	5.3750	1.9226	.6797	3.0000	9.0000	4.7677 TO 7.9823
GRP 2	8	6.1250	1.9594	.6928	2.0000	8.0000	4.4869 TO 7.7631
GRP 3	8	8.0000	1.1952	.4226	6.0000	9.0000	7.0008 TO 8.9992
GRP 4	8	4.8750	1.4577	.5154	3.0000	7.0000	3.6563 TO 6.0937
GRP 5	8	6.0000	2.1381	.7559	3.0000	9.0000	4.2125 TO 7.7875
TOTAL	40	6.2750			2.0000	9.0000	
		UNGROUPED DATA	1.9610	.3101			5.6478 TO 6.9022
		FIXED EFFECTS MODEL	1.7698	.2798			5.7069 TO 6.8431
		RANDOM EFFECTS MODEL	1.1229	.5022			4.8807 TO 7.6693

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .2919, P = .651 (APPROX.)
BARTLETT-BOX F = .704, P = .589
MAXIMUM VARIANCE / MINIMUM VARIANCE = 3.200

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE ELEC

- O N E W A Y -

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	21.1500	5.2875	3.656	.014
WITHIN GROUPS	35	50.6250	1.4464		
TOTAL	39	71.7750			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	8	7.5000	1.3093	.4629	5.0000	9.0000	6.4054 TO 8.5946
GRP 2	8	7.3750	.5175	.1830	7.0000	8.0000	6.9423 TO 7.8077
GRP 3	8	7.3750	1.0607	.3750	6.0000	9.0000	6.4883 TO 8.2617
GRP 4	8	5.9750	1.4577	.5154	3.0000	8.0000	4.6563 TO 7.0937
GRP 5	8	6.0000	1.4142	.5000	5.0000	9.0000	4.8177 TO 7.1823
TOTAL	40	6.8250			3.0000	9.0000	
UNGROUPED DATA		1.3566	.2145				6.3911 TO 7.2589
FIXED EFFECTS MODEL		1.2027	.1902				6.4390 TO 7.2110
RANDOM EFFECTS MODEL		.8130	.3636				5.8156 TO 7.8344

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .2938, P = .635 (APPROX.)
BARTLETT-BOX F = 1.756, P = .136
MAXIMUM VARIANCE / MINIMUM VARIANCE = 7.933

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE IND

O N E W A Y

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	63.7143	15.9286	5.931	.001
WITHIN GROUPS	30	80.5714	2.6857		
TOTAL	34	[illegible]2857			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	7	7.7143	1.1127	.4206	6.0000	9.0000	6.6852 TO 8.7434
GRP 2	7	4.8571	1.4639	.5533	3.0000	7.0000	3.5033 TO 6.2110
GRP 3	7	7.9571	1.5736	.5948	5.0000	9.0000	6.4018 TO 9.3125
GRP 4	7	5.2857	1.9760	.7469	4.0000	9.0000	3.4582 TO 7.1132
GRP 5	7	5.0000	1.9149	.7237	3.0000	9.0000	3.2291 TO 6.7709
TOTAL	35	6.1429			3.0000	9.0000	
UNGROUPED DATA		2.0600	.3482				5.4352 TO 6.8505
FIXED EFFECTS MODEL		1.6338	.2770				5.5771 TO 6.7086
RANDOM EFFECTS MODEL		1.5085	.6746				4.2699 TO 8.0159

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .2908, P = .718 (APPROX.)
BARTLETT-BOX F = .556, P = .695
MAXIMUM VARIANCE / MINIMUM VARIANCE = 3.154

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE PIGS

O N E W A Y

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	114.1143	28.5286	12.128	.000
WITHIN GROUPS	30	70.5714	2.3524		
TOTAL	34	184.6857			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	7	5.1429	1.9645	.7047	2.0000	7.0000	3.4185 TO 6.8672
GRP 2	7	3.4286	.7868	.2974	3.0000	5.0000	2.7009 TO 4.1562
GRP 3	7	3.8571	1.3452	.5084	2.0000	6.0000	2.6131 TO 5.1012
GRP 4	7	7.5714	1.7182	.6494	4.0000	9.0000	5.9823 TO 9.1605
GRP 5	7	7.7143	1.7043	.6442	4.0000	9.0000	6.1380 TO 9.2905
TOTAL	35	5.5429			2.0000	9.0000	
	UNGROUPED DATA		2.3307	.3940			4.7423 TO 6.3435
	FIXED EFFECTS MODEL		1.5337	.2593			5.0134 TO 6.0723
	RANDOM EFFECTS MODEL		2.0188	.9028			3.0362 TO 8.0495

E-10

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .2955, P = .679 (APPROX.)
BARTLETT-BOX F = 1.081, P = .364
MAXIMUM VARIANCE / MINIMUM VARIANCE = 5.615

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE STATE

- O N E W A Y -

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	9.4286	2.3571	.487	.745
WITHIN GROUPS	30	145.1429	4.8381		
TOTAL	34	154.5714			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	7	7.4286	1.7182	.6494	5.0000	9.0000	5.8395 TO 9.0177
GRP 2	7	5.1429	1.8645	.7047	4.0000	9.0000	4.4185 TO 7.8672
GRP 3	7	5.4286	2.2991	.8690	2.0000	9.0000	4.3023 TO 8.5548
GRP 4	7	5.0000	2.9439	1.1127	1.0000	9.0000	3.2773 TO 8.7227
GRP 5	7	5.1429	1.9518	.7377	3.0000	8.0000	4.3378 TO 7.9480
TOTAL	35	5.4286			1.0000	9.0000	
UNGROUPED DATA		2.1322	.3604				5.6961 TO 7.1610
FIXED EFFECTS MODEL		2.1996	.3718				5.6693 TO 7.1879
RANDOM EFFECTS MODEL		.5803	.2595				5.7081 TO 7.1491

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .3583, P = .299 (APPROX.)
BARTLETT-BOX F = .551, P = .699
MAXIMUM VARIANCE / MINIMUM VARIANCE = 2.935

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE FED

ONEWAY

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	3.5429	.8857	.405	.803
WITHIN GROUPS	30	65.4286	2.1810		
TOTAL	34	68.9714			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	7	7.5714	1.1339	.4286	6.0000	9.0000	6.5228 TO 8.6201
GRP 2	7	6.9571	2.1157	.7997	3.0000	9.0000	4.9005 TO 8.8138
GRP 3	7	6.7143	1.4960	.5654	5.0000	9.0000	5.3307 TO 8.0979
GRP 4	7	7.0000	1.0000	.3780	6.0000	9.0000	6.0752 TO 7.9248
GRP 5	7	6.7143	1.3801	.5216	5.0000	9.0000	5.4379 TO 7.9907
TOTAL	35	6.9714			3.0000	9.0000	
UNGROUPED DATA			1.4243	.2407			6.4822 TO 7.4607
FIXED EFFECTS MODEL			1.4768	.2496			6.4616 TO 7.4812
RANDOM EFFECTS MODEL			.3557	.1591			6.5298 TO 7.4131

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .4105, P = .134 (APPROX.)
BARTLETT-BOX F = .903, P = .416
MAXIMUM VARIANCE / MINIMUM VARIANCE = 4.476

FILE NONAME (CREATION DATE = 09/24/75)
SUBFILE COMP

- O N E W A Y -

VARIABLE RATING
BY CRITERIO

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	17.9943	4.4986	1.336	.286
WITHIN GROUPS	24	80.8333	3.3681		
TOTAL	28	98.8276			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP 1	5	7.0000	2.3452	1.0488	3.0000	9.0000	4.0881 TO 9.9119
GRP 2	6	6.1667	1.7224	.7032	4.0000	8.0000	4.3591 TO 7.9742
GRP 3	6	7.3333	1.3619	.7601	4.0000	9.0000	5.3794 TO 9.2872
GRP 4	6	7.3333	1.3663	.5578	6.0000	9.0000	5.8996 TO 8.7671
GRP 5	6	5.3333	1.9519	.7601	3.0000	7.0000	3.3794 TO 7.2872
TOTAL	29	6.6207			3.0000	9.0000	
UNGROUPED DATA			1.8787	.3489			5.9061 TO 7.3353
FIXED EFFECTS MODEL			1.8352	.3408			5.9173 TO 7.3241
RANDOM EFFECTS MODEL			.8693	.3888			5.5413 TO 7.7001

TESTS FOR HOMOGENEITY OF VARIANCES

COCHRANS C = MAX. VARIANCE/SUM(VARIANCES) = .3185, P = .580 (APPROX.)
BARTLETT-BOX F = .307, P = .873
MAXIMUM VARIANCE / MINIMUM VARIANCE = 2.946

CONCLUSION OF COMPARISONS OF FUEL RATINGS BY INTEREST GROUP WITHIN CRITERION AND ROUND OF RATINGS

The Statistical Package for the Social Sciences* (SPSS) was used to analyze the results of the ratings from round to round. The specific analysis performed was a cross tabulation of the fuel categories by interest group within each of the five evaluation criteria, for each round of the ratings.

The overall conclusion is that the ratings within each workshop group were generally similar, category to category, in the first round of ratings, but that dissimilarities became more apparent in the second round of ratings. The third round produced even greater dissimilarities. This means obviously that the sequence of discussions led to more discrimination of the ratings by fuel category. The groups were able to develop group positions as a result of the sequence of discussions and ratings.

* Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., and Bent, D. H., Statistical Package for the Social Sciences, Second Edition, McGraw Hill Publishing Company, New York, New York (1975).

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