

REMARKS BY GEORGE A. LAMB, DIRECTOR OF COAL RESEARCH, BEFORE THE ANNUAL MEETING OF THE AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, DALLAS, TEXAS, FEBRUARY 26, 1963.

### THE OFFICE OF COAL RESEARCH AND ITS ACTIVITIES

The Office of Coal Research was established by Public Law 86-599, approved July 7, 1960. It was organized upon an operational basis in the spring of 1961, and awarded its first contract in August of that year. It is charged with the development through research of new and more efficient methods of mining, preparing and utilizing coal. This is done through contracts with agencies of Government and with private organizations; OCR does no in-house research.

Private research in the coal industry has been limited to activities by coal associations and by a comparatively few companies. This industry is composed mainly of small business units that are unable to finance laboratory and pilot plant operations. A good deal of coal research has been governmental. Total research, however, has been inadequate and coal resources have not been effectively utilized as a consequence. The necessity for an expanded and more balanced coal research program becomes particularly apparent once consideration is given to future requirements for energy.

#### 1. Future Energy Requirements

Fuel forecasters in estimating long-term energy requirements and supplies have predicted a bright outlook for coal. Some predictions have annual coal output reaching 800 million tons by 1980, almost twice the average of the last five years. The projections reflect advanced statistical techniques in evaluating the prospective growth of the economy and its resulting energy needs. Supplies for the future energy load are distributed between the fuels and hydro. While coal production amounts to new records in the distant years ahead, its share in total energy supply is expected to be near what it is presently.

These projections assume that ultimate consumer energy products will be supplied adequately not only in volume but also by kind and type. The consumer energy schedule shifts continually as it reflects the changing demands for numerous uses. Its appearance, expressed generally in proportions of solids, liquids, gases and electricity, is quite different today from what it was in 1940. It may change even more by

1980. Thus, the shares that coal and the other energy sources will have in total supply will depend upon how well each source can be processed into products that will be accepted by consumers. Product advancement by all of the energy producers will be highly important. Failure in this regard may mean that the economy will be handicapped and its growth retarded, as energy requirements fall below the levels that have been projected.

For illustration, petroleum or coal with no change from their current product offerings likely would lose position in the future energy market. A deficiency product-wise by either might bring about a poor balance and a limitation in resource utilization. On the other hand, an accelerated product development by an energy source may have the reverse effect.

Coal's share in energy supply has been shrinking for a number of years, because the energy products it had to offer have had a diminishing market acceptance. Limited to those product offerings, it will be at a greater market disadvantage in each succeeding year, making unrealistic a goal of 800 million tons by 1980. In 1960, 69 percent of the end-product energy consumption consisted of oil and natural gas products. Another 19 percent was represented by electric power generated by hydro and fuels, including coal, oil and gas. This left only 12 percent for coal solids and other coal derivatives. The latter proportion had dropped from 31 percent to 1950. This trend indicates that coal will need products that can supplement supplies in the oil and gas markets, as well as improved fuel for power generation, if it is to stop its decline in energy supply and establish a firmer position in the energy complex. To advance coal products to this extent will be a formidable undertaking, one that will depend for success upon a vigorous and balanced research and development program. A primary responsibility of the Office of Coal Research is to promote the advancement of such a program.

What must coal do? In delivering more attractive products to the consumer it will need improvements in all phases of production and distribution: mining, processing, transporting and whatever else may be involved. The term "product improvement" is all inclusive in its application.

## 2. Coal Processed Into Oil and Gas

Research to develop synthetic oils and gases from coal has been considerable in the United States as well as in other countries. The U.S. Bureau of Mines did a large amount of work in the late forties and early fifties; the American Gas Association has done research in

coal gasification for some years. Private coal, oil, gas, and chemical companies, together with universities, research institutes, and others have been active in synthetic fuels research. Progress has been made, although gradual, and coal converted to oil or to high Btu has not yet reached commercial reality although it now appears to be close to it.

### Synthetic Oil

Of the 14 contracts that have been awarded by OCR, two involve major projects aimed mainly at the production of oils and related products from coal. The projects are to run 30 months.

### FMC

One of these, with FMC, has the objective to determine the possibility of creating synthetic crude oil from coal and then using the oil to help convey the residual coal (char) to industrial consumers. FMC (formerly Food and Machinery Corporation), is a major chemical producer and has developed recognized skills in practical research and development of chemical processes. Its experience in coal process research widened from activities as a phosphorous producer. Because of the need of low cost coke at its Idaho phosphorous plant, FMC developed the FM Coke Process for converting the western "non-coking" coals to be a suitable coke. This development was directed to the output of coke but the company learned a great deal about producing synthetic crude oil, an experience highly useful for its work on the OCR project.

### General Electric

A major contract with General Electric will stress electrochemical processing. Its objective is to study the possibility of extracting as, liquid fuels and chemicals from coal through using, in lieu of a catalyst, an electrical corona created by exceptionally high voltages and frequencies. It is an example of exploratory work needed to complement more proven approaches to chemical processing of coal.

### Related Projects

In addition to these two awards designed specifically to develop oil from coal, OCR has let four contracts to augment and support them. The University of Utah has contracted to investigate reactions of powdered coal in an electric arc and the flash photolysis of coal in hydrogen. Economic yields of useful products will be determined. Another contract has been written with Montana State College to determine the yield and composition of liquid and gaseous components of bituminous coals in a concentric tube coal carbonization pilot plant.

A contract with Spencer Chemical Company is directed to develop processes of producing low-ash, low-sulfur coals by means of

solvation techniques. It relates to all of the projects on liquifaction and gasification because the economics of each of these processes may be significantly altered by using a feed coal from which contaminating mineral matter which adversely affects desired reactions or processing steps has been removed. Spencer, through its subsidiary, the Pittsburgh and Midway Coal Company, has had experience in coal liquifaction and gasification in conjunction with work done with El Paso Gas.

OCR has a contract with Bituminous Coal Research, Inc., dealing with the production and utilization of ultra-fine coal, a project which, if successful, could offer advantages in liquifaction as well as in gasification, transportation, and direct combustion.

#### Proposed Activity on Liquid Fuels

This proposed project is to accelerate development to the point of commercial feasibility for the making of gasoline and other products by the Consol Synthetic Fuel Process. An evaluation of the research already done has been made for OCR through a contract with the Ralph M. Parson Company, who determined that the process has the potential for producing gasoline at competitive costs. In this unique process, coal is dissolved in a coal derived solvent. The extract is separated from the solvent and then hydrogenated. The unextracted solid residue is treated to recover solvent and produce char. The hydrogenated extract is treated by normal petroleum refining techniques to produce maximum gasoline yields. The OCR program proposes construction of a pilot plant feeding about one ton of coal per hour. The result of a successful contract will be a determination of commercial application perhaps ten years ahead of a schedule that might be followed by the Contractor alone.

Consolidation is one of the larger coal companies and has a sizable research budget in the coal industry. This company has already expended over \$9,000,000 on the Consol Synthetic Fuel Process. The success of Consol's development of transportation of coal in a water-slurry pipeline is a well known demonstration of their ability to determine solutions to the problems which retard the expanded utilization of coal.

A number of other proposals have been submitted on coal liquifaction. They include projects for the development of jet fuels and various kinds of oils.

#### Gasification

Gas will be a by-product of the projects on synthetic oil, but OCR does not have a contract for a project that will specialize on

gas output. Three specific contracts are proposed in this field which are related to one another. They will be written to provide close co-ordination on the research so that one project will complement the other and duplication will be avoided. Each is an extension of work performed in the past by the proposed contractors involved and each will accelerate ultimate commercial manufacture of gas from coal.

One proposal is for the development of an economic gas generator for production of water-gas, producer gas, or a solid coal transport gas to improve operation and reduce capital cost for uses ranging from small process heat applications to very large scale generation of gas in which to transport coal.

A second proposal under consideration is to investigate a method for gasifying coal using air in lieu of oxygen. The process to be used is proprietary and the work to be done for OCR is an extension of R&D work already accomplished by the proposer. The contractor in this case will also provide engineering design services to BCR and to the Institute of Gas Technology for their contracts with OCR.

The third part of the gasification program would aim at development of the hydrogasification of coal. Process equipment studies will be made to validate the desirability to proceed with construction of a pipeline gas pilot plant.

#### Synthetic Oil and Gas Markets

Synthetic oil and gas, if commercially produced, probably will enter the market as supplemental supplies to petroleum and natural gas in particular areas. Their distribution and marketing likely would be through facilities of the petroleum and natural gas industries. Production might be in plants built by coal interests although conceivably financed at least partly, if not substantially, by companies having the distribution and marketing structures.

Initial market outlets for synthetic oils might be at points where crude costs are relatively high. They would be comparatively small in total oil sales, but could add millions of tons to coal production.

A commercially available high Btu coal gas could benefit both the coal and natural gas industries. Some principal gas markets are distant from the center of natural gas production but adjacent to major coal fields. This situation which involves long distance transmission, pipeline capacity and seasonal demand leaves room for incremental supplies near the market which coal gas could provide. The incremental supplies need represent only a small proportion of total gas sales to give coal a sizeable tonnage outlet.

### 3. Electric Power

The electric power market has been more than doubling per decade, and it will approximate this rate of increase through 1980 according to some forecasters. In such case, they estimate that power generation in that year would require two to three times the volume of coal it burns currently, i.e., it would need 400-600 million tons. It would account for the larger part of the growth in coal production that has been projected for 1980.

Expansion by the electric utility industry reflects its steady technological advancement. Effects of the latter are expressed in an average power rate to the consumer that has declined almost continually. One important advancement has been in steam plant power generation. It takes only about one-fourth as much fuel to produce a kilowatt-hour today as it did 40 years ago. Fuel costs, the large item in steam generation, have been relatively stable to contribute to low power rates. Coal's average mine price has declined in the last 15 years, and its delivered price has had a reduction in recent years with improvements in transportation.

If the expansion that has taken place in the power market has rested on technological advance, then future growth will have to depend upon the same factor. It can be expected that the electric utilities will make further technological progress in all phases of their operations. However, as to thermal efficiency of power plants, utilities are nearing the limits as can be foreseen for conventional equipment. It means there will be added emphasis on the development of new equipment as well as upon lower fuel prices. As to the latter, nuclear fuel proponents are well aware.

OCR has contracts on projects, successful results of which would bring about developments that would make coal products more attractive to the electric utilities. They would make coal more competitive among the raw energies used in power generation.

#### Virginia Polytechnic Institute

OCR has limited research in mining itself, but this contract is of special application. By determining and evaluating the myriad of factors that influence the cost of mining coal, the contractor will be able to establish mathematical models and simulations which can be very rapidly solved by a computer to determine the lowest cost production system for any specified application. Results can be obtained in minutes that years of field experimentation could not secure.

### University of West Virginia

This contract will determine what secondary values exist in or adjacent to coal seams and how to mine and process them at a profit. It is probable that the simulation techniques as developed by VPI will be of extreme value to work under this contract. The recovery of these secondary minerals and values can reduce the cost of mining, increase the quantity of raw materials mined, increase mining employment, and create new mine-mouth industries which will in turn use additional coal directly or in the form of electric energy.

### Westinghouse

The fuel cell has the potential to lower power generating cost with conventional fuels more than any other kind of equipment. This contract seeks to develop a fuel cell for central station use in which the fuel would be powdered coal, gas derived from coal, or a combination.

### Spencer Chemical Company

This project, described earlier, could bring about developments to minimize impurities in coal and reduce air pollution.

### Char Production

The coal residual, or char, which necessarily results from upgrading the raw coal in such projects as Consol Synthetic Fuel Process, the FMC Process and the other processes described previously would be marketed as a solid fuel for electric utility power production at prices below those of the original coal.

### Transportation Proposals

Transportation charges have represented half or more of the delivered price of coal in important markets. During recent years, considerable improvement has been made in coal transportation through the development of pipelines, long-distance high voltage power transmission, and railroad train load and shuttle train movements. There is room for further improvement in transportation and proposals received on this subject are under review.

## 4. Coal Solids and Other Derivatives

This consumer area gives little promise for increased tonnages but every effort should be made to bring about developments that will hold the present tonnage if not increase it. Success here will call for developments in mining, transportation, and other areas previously summarized.

### Pope, Evans and Robbins

OCR has a contract with Pope, Evans and Robbins, a New York engineering firm, to design and develop a totally new, completely automatic coal-fired industrial heating plant in the intermediate size range. Such a unit would find rapid acceptance and increase coal utilization if the project specifications for minimum space, maximum efficiency, minimum attendance, and lower initial and operating costs are achieved.

## 5. Exports

### Robert R. Nathan Associates, Inc.

This export study is to identify what constructive action can be taken to expand the marketing of coal in other countries. It will study all phases of the export trade, including possible Government action involving trade policy and technical assistance.

Annual overseas exports of American coal have fluctuated between two and 60 million tons since World War II. In recent years, they have run between 15 and 20 million tons.

American coal, because of its high mining productivity rate, can be quoted at prices that make it competitive in most countries of the free world. Presently, it appears that opportunities are increasing for expanding the coal export trade.

## 6. Integrated Programs

The 14 contracts awarded by OCR represent an integrated program in which one project complements another.

These projects originated with 240 proposals submitted by 135 private and governmental organizations including universities and companies in the coal, oil, gas and chemical industries. OCR's comparatively small organization is equipped to administer its program by means of contract research and development. The OCR program is aimed to activate the experience and facilities of research organizations for the purpose of improving coal products. Its emphasis is on applied research and development leading to large tonnage in this regard. Response to the program has been extremely gratifying. Proposals received from a wide range of sources have made it possible to award contracts to organizations with outstanding research talent and facilities.

Over half of the proposals involve the processing of coal to oil, gas, and chemicals, i.e., upgrading. Another large number deals



with developments helpful in the electric power field. This denotes that research organizations are aware of the three areas with the better tonnage prospects: oil, gas, and power.

Summaries of the particular contracts indicate how one project relates to another to formulate an integrated program. This allows for concentrated research and development while providing a basis for avoiding duplication. Each project rests on its merit, but it gains value as it contributes to the success of additional research and development. Once projects reach commercial feasibility, the basis for a manufacturing complex may be established. It may very well be that this complex with a multitude of products can develop into what may be called a coal refinery, if a term may be borrowed from the oil industry.

OCR's current projects are but a start towards coal product advancement. They may well stimulate activity in research and development, however, which can lead to a balanced and aggressive program that will give coal the essentials for taking a representative place in future energy supply. Only if this occurs is it likely that coal will reach a level of 800 million tons in 1980 as the forecasters have predicted.

It is important that the coal product advancement program establish itself through achievements over the short run. It should be demonstrated within the next five years that coal can be processed commercially into products that are more attractive for the consumer energy schedule. Coal has to make a showing as soon as possible that it is geared to keep pace with changing energy requirements. It cannot look to the growth predicted for it until this is done.

There is a good chance that OCR projects will evolve into commercial operations in the short run. Initial commercial plants for successful oil and gas projects would be sizable, each would consume several million tons of coal yearly. Transportation developments may come about that will increase coal tonnage through reductions in shipping charges. Commercial developments of this kind would afford coal a new image in the energy complex.

#### CONCLUSIONS

1. Coal has the opportunity to increase substantially its market volume in the long run, however:
2. Its success in market expansion will depend upon product advancement realized through applied research and development.
3. Success in product advancement is essential over the short run.
4. Brighter prospects for enlarging tonnage are in the conversion of coal to oil and gas products, and in an improved fuel for electric power generation.