SECTION 2

SUMMARY

A conceptual design and economic evaluation has been completed for a project to design, engineer, construct, start up, and operate an industrial complex to mine high-sulfur coal and convert it to SNG, LPGs, naphtha, and heavy fuel oil. The results are summarized in this report.

This work was done with the support and guidance of the ERDA - Fossil Energy, Demonstration Plants Division. The design basis, utilizing teachings from the SRC process development program, was developed in cooperation with ERDA.

The scope of the industrial complex is a grassroots facility consisting of a large captive coal mine that produces approximately 47,000 tons per day (TPD) of run-of-mine (ROM) coal supplying the feed material to a coal preparation plant, which in turn supplies approximately 36,000 TPD of clean, washed coal to a hydroliquefaction-based coal conversion plant. In the facility, the feed coal is converted to the above-mentioned product slate; byproduct ammonia and sulfur are also produced. Low-Btu, low-sulfur fuel gas is produced as fuel for process furnaces and for a close-coupled steam and power generation plant that produces all utilities required for the captive use in the complex.

The complex is conceived to be located in the eastern region of the Interior Coal Province. The facility meets desired location criteria consisting of significant resource of high-sulfur coal with a large utility/industrial market nearby and with ecological restrictions on direct consumption of the indigenous high-sulfur coal.

Process flowsheets and accompanying heat and material balances are presented, based on a typical coal analysis that is intermediate between the extreme analyses that might be encountered during a 20-yr project life. The equipment was sized to handle this typical coal. The design provides for the simultaneous mining of five mine faces and the mixing of the resultant coals in a storage pile to produce a relatively uniform feed coal to the process plant.

Products from the process plant include the following approximate quantities:

- 56,000 bbl/day of fuel oil; characteristics are projected to be roughly equivalent to low-sulfur bunker C.
- 10,000 bbl/day of naphtha.
- 10,000 bbl/day of LPG (C_3 and C_4).

- 165 MM SCFD of SNG.
- 1,300 ST/D of sulfur.
- 90 ST/D of anhydrous ammonia.

The estimated fixed capital investment for the complex is $1.25 billion; all estimates are in fourth-quarter 1975 dollars. The total capital investment is estimated to be $1.4 billion, which includes the cost of initial raw materials, catalysts and chemicals, allowance for startup and land acquisition, and initial working capital.

The fixed capital investment estimate was independently evaluated by the U.S. Army Engineer Division (USAEDH), Huntsville, Alabama. This work was done under contract to ERDA, Contract No. EX-76-C-01-1759. The USAEDH estimate was approximately 4% lower than Parsons, and they report an indicated overall estimate confidence factor of ±4%.

A representative project schedule for design, engineering, construction, and startup is given; a 56-month schedule to mechanical completion is projected, and a probable fund drawdown schedule is presented.

ECONOMIC PROJECTIONS

The population of the complex is estimated to be about 2,350. Operating costs are projected to be about $195 million per year. The required plant revenue for a 12% discounted cash flow (DCF) rate of return with 65% debt at 9% interest is $395 million per year. The predicted required product selling price for these financial parameters is $1.80/MM Btu.

The design is considered to be workable with the understanding that the estimated costs that are reported here have the probability of being greater than if additional information were available, which is often the case for first-generation plants.

Predicted required product selling prices, expressed in dollars per million Btu, for 100% equity financing and a nonprofit (0% DCF) or breakeven boundary case in addition to the 65/35 debt equity case described previously are:

Financing Method	Selling Price, $
100% equity	2.35
Debt/equity ratio = 65/35	1.80
Break-even	1.15

These values correspond to approximately $10.80/bbl and $14.10/bbl of oil equivalent for the 65/35 debt/equity ratio and 100% equity cases, respectively; values are based on a heating value of 6 million Btu/bbl.

Using an arbitrary SNG selling price of $2.50 per M SCF would generate the required $395 million revenue with a liquid products sales value of $10.00/bbl of the 65/35 debt/equity case. Another alternative, using a recently published allowable price for coal-derived SNG of $4.20, will generate the required revenue with an average liquid products selling price of $6.50.

The sensitivities of required selling prices and profitability to key economic parameters are presented. The selling prices are highly capital sensitive.

The 3:1 solvent-to-coal ratio of feed to the coal dissolvers in Unit 12 in this design may be conservative. Recent pilot plant data indicates that a ratio as low as 1.5:1 could be used. This lower rate is a potential improvement and could reduce the fixed capital investment and required product selling prices by approximately 6% and 5%, respectively.

Methods of scale-up were carefully considered. The scale-up factor from the SRC pilot plant to this conceptual design was of the order of 400. However, the scale-up factor for the critical dissolver, which liquefies the coal by reaction with hydrogen, is approximately 135. The dissolver vessels specified are the largest that can be fabricated with existing materials, fabrication, and coding practices. Methods of scale-up were selected to provide efficiency, operability, and process control.

The design represents an assessment of a proposed configuration and potential economics for this type of technology. It projects a total thermal efficiency of approximately 77%, which means that more than three-quarters of the energy (Btu) contained in the feed coal is converted to low-sulfur fuel products. This efficiency is higher than predicted by earlier designs and is the result of detailed analysis of the efficiencies in all major plant units.

The design conceives operation in the mid-1980s and therefore proposes use of certain equipment and techniques that require further development prior to commercial operation. To accomplish this objective, the use of engineering judgment for the scale-up and the selection of the equipment was required. The design also represents an exposition of factors required to integrate the coal conversion plant with a large coal mine and a closely coupled electrical power generation facility for internal power requirements. The development of the interfaces between the coal mine, process plant, and power plant has defined a number of the design and operational options that exist to maximize efficiencies and profitabilities.

The design is considered to be workable. The projected plant performance is discussed and suggestions for improvements are presented.