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MASTER

TECHNICAL SUPPORT REPORT

PRELIMINARY DESIGN AND ASSESSMENT OF A 12,500-BPD COAL-TO-METHANOL-TO-GASOLINE PLANT

JULY 1982

W. R. GRACE & CO.
AGRICULTURAL CHEMICALS GROUP
P. O. BOX 27147
MEMPHIS, TENNESSEE 38127

GRACE

W. R. GRACE & CO.
Agricultural Chemicals Group
Memphis, Tennessee

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R. M. Stewart — 6/17/82

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UNDER COOPERATIVE AGREEMENT No. DE-FC01-80ET-14759

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*Parsons to Grace Deliverable 36-1 inserted verbatim

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ATTACHMENT

I. INTRODUCTION

This Technical Support Report summarizes the inputs of both first- and second-tier subcontractors required in performance of Cooperative Agreement No. DE-FC01-80ET-14759 (CA) between The Department of Energy (DOE) and W. R. Grace & Co. (Grace). The preliminary design and assessment activities for the Grace Coal-to-Methanol-to-Gasoline Plant (Gasoline Plant) necessitated the subcontracting of certain work to other companies because of subcontractors' expertise in architect/engineering services, specialized technical experience, sole source of required information such as licensors of selected technologies or experience in environmental services. This report explains the technical support supplied from Grace's first- and second-tier subcontractors and deviations from the Technical Support Plan, Deliverable No. 35, (submitted to DOE under cover of Grace/DOE CMG-263 dated December 8, 1981) in terms of changes either in the scope of work of particular subcontractors or changes in subcontractors involved. A subcontractor organizational chart showing the relationship between Grace and its lower-tier subcontractors is presented in Figure 1.

In support of the preliminary design and assessment effort, The Ralph M. Parsons Company (Parsons) supplied architect/engineering and related services as planned. Parsons supplemented their technical efforts with inputs from Texaco Development Corporation (TDC), Mobil Research and Development Corporation (MRDC), and other process technology licensors, both proprietary and nonproprietary, into the Gasoline Plant's overall design. The technologies offered by TDC and MRDC were specified in the

CA for utilization in the Gasoline Plant design effort, while other commercially available technologies were selected following detailed evaluations. Those subcontractors listed in Section II of the Technical Support Plan were used without change.

The conversion of feedstock coal to a raw synthesis gas was accomplished as planned with the Texaco Coal Gasification Process (TCGP) which is licensed through TDC. The fixed-bed version of the catalytic Mobil Methanol-to-Gasoline (MTG) process available through MRDC was used as planned for the conversion of crude methanol to gasoline.

The initial project efforts in the environmental area identified the need to prepare an Environmental Impact Statement (EIS). As such, the U. S. Corps of Engineers (COE), Louisville District, notified Grace that they would serve the role of Lead Federal Agency (LFA) and supervise the environmental consultant, Dames & Moore, in the EIS preparation activities. Dames & Moore provided the technical support necessary to establish environmental baseline conditions for the Baskett, Kentucky, site.

Each of the technical support subcontractors or data inputs is discussed in the following pages, along with deviations from work anticipated in the Technical Support Plan.

II. THE RALPH M. PARSONS COMPANY TECHNICAL SUPPORT

The following portion of this report describes those architect/engineering activities performed by Parsons in a subcontract role to Grace. With the exception of the TCGP and MTG technologies, Parsons developed engineering information through in-house expertise and subcontracted technical support to those companies listed in the Technical Support Plan with the information supplied by process vendors or licensors integrated into the overall Gasoline Plant process design by Parsons. These efforts undertaken by Parsons are described below. The work completed by Parsons' subcontractors are presented as submitted to Grace by Parsons.

A. Design Support

The majority of activities associated with the preliminary design and assessment of the Gasoline Plant involved Parsons. Included in the Parsons scope of work was preparation of the preliminary process and mechanial design, expansion and evaluation of the Baskett, Kentucky, plant site, development of the environmental permitting applications, preparation of operations and capital cost estimates, followed by an economic assessment and the development of the construction and opetating plans. With the exception of the TCGP and the MTG technologies as noted above, all major processes incorporated into the Gasoline Plant design were subject to Parsons' evaluation of alternatives which resulted in preparation of process selection study reports. Specific reports prepared by Parsons are listed below.

Technology	Vendor Recommended
Air Separation	Air Liquide
Acid Gas Removal	Lotepro
Sulfur Removal	Parsons
Sulfur Recovery	Parsons
Methanol Synthesis	Lurgi
Alkylation	Phillips
Flue Gas Desulfurization	Research Cottrell

Engineering trade-off studies were compiled by Parsons to determine the best combination of steam versus electric power for major drivers and solid by-product mode of conveyance to the on-site disposal areas. Technology selected as a result of these trade-off studies was developed further by Parsons in-house. The process selection study reports and trade-off studies contained Parsons recommendations and were reviewed by Grace prior to making a final selection. Selection of particular processes recommended resulted in Parsons subcontracting or establishing a work relationship for the preparation of process design information with the various process vendors. A description of the Parsons subcontractor efforts begins on page 1-1 of this report.

Major in-house design efforts completed by Parsons, except for sulfur removal technology which is described later in this section, included:

- Coal receiving, storage and reclaiming
- CO shift
- Fractionation
- Gasoline blending

- Product and by-product storage
- Solid by-product disposal
- Process water treatment
- Raw water treatment
- Raw water treatment
- Cooling water
- Steam generation
- Fire protection
- Plant services and utilities

As of the date of this report, all process schemes have been selected for the Gasoline Plant and data developed to support these processing systems.

B. Deviations

No deviations have occurred by Parsons or its subcontractors in development of data for the 50,000 BPD Gasoline Plant. Additions to Parsons' scope of work above that noted in the Technical Support Plan have occurred in that preliminary design information was developed to support the capital and operating cost and economic assessment of a 12,500 BPD plant.

SECTION 1

INTRODUCTION

The preliminary design and assessment of the W. R. Grace & Co. (Grace) Coal-to-Methanol-to-Gasoline Project was performed by The Ralph M. Parsons Company (Parsons) as a subcontractor to Grace under Cooperative Agreement No. DE-FC01-80ET-14759 between Grace and the U.S. Department of Energy. In the performance of this work, it was necessary to obtain technical support from other companies because of the need for data on proprietary processes or other specialized expertise.

Grace, prior to award of the subcontract to Parsons, had selected Texaco Development Corporation to supply the basic data for the Coal Gasification and Waste Heat Recovery, Coal Grinding and Slurry Preparation and the Effluent Water Treatment Facilities. They also had selected Mobil Research and Development Corporation to provide a process design and engineering data package for the Methanol-to-Gasoline, Heavy Gasoline Treating and the Mobil Wastewater Treatment Facilities.

This report describes the technical support provided to Parsons from process licensors, equipment suppliers, and consultants for use in the preliminary design of the Gasoline Plant. Prime consideration was given to the selection of processes and equipment that have been proven commercially.

SECTION 2

PROCESS TECHNICAL SUPPORT

2.1 AIR SEPARATION

The Gasoline Plant requires large quantities of high purity and high pressure oxygen for the gasification of coal. The technology is well known and plants are available from several companies on a turnkey basis.

The largest plants built to date are 2,500 tons per day (tpd) and 11 plants of this size have been installed and operated for South African Coal, Oil and Gas Corp., Ltd. (SASOL) in South Africa.

Technical proposals were obtained from Al E. & C. Ltd. (subsidiary of Air Liquide); Air Products and Chemicals, Inc.; Airco Energy Company, Inc.; Lotepro Corporation (subsidiary of Linde AG); and Union Carbide Corporation.

Due to the lack of commercial experience in compressing oxygen to 1135 psia by centrifugal compression, the preliminary design is based on compressing to 625 psia by centrifugal compression and to 1135 psia by reciprocating compressors. In the final design, the compression level by centifugal compressors will be reexamined in light of commercial experience at that time.

The design offered by Al E. & C. Ltd. (Air Liquide) was utilized for the preliminary design as they built the 2500-tpd plants for SASOL, however, there is no obligation to utilize Air Liquide in the final design.

A subcontract was issued to Al E. & C. Ltd. to furnish the process design, flow diagram, overall material balance, equipment descriptions and sizes, and estimated costs for the plants exclusive of the oxygen and air compression equipment. The compression equipment was specified and selected by Parsons.

2.2 ACID GAS REMOVAL

Commercially proven proprietary processes using selective physical solvents for the removal of H_2S, COS, and CO_2 from the shifted and unshifted gas offered by the following licensors were evaluated:

(1) Lotepro Corporation, Subsidiary of Linde AG - Rectisol Process

(2) Lurgi Kohle Und Mineralöltechnik GmbH - Rectisol Process

(3) Allied Chemical Corporation - Selexol Process

Each licensor made a non-proprietary technical presentation and provided data for Parsons use in preparation of the process comparison report. Lotepro was selected to provide technical support to Parsons and was awarded a subcontract for their services.

Lotepro provided a process package consisting of process description, process flow diagrams, head and material balances, plot plans and elevations, equipment lists and specifications, utility and chemical consumptions, and cost estimate.

2.3 METHANOL SYNTHESIS

Commercially proven processes for conversion of synthesis gas from the Acid Gas Removal Unit to Methanol offered by the following licensors were evaluated:

(1) Lurgi Kohle Und Mineralöltechnik GmbH (Lurgi)

(2) Imperial Chemical Industries Limited (ICI)

(3) Haldor Topsoe, Inc. (Topsoe)

Each licensor made a non-proprietary technical presentation and provided data for Parsons use in preparation of the process comparison report.

Lurgi was selected to provide the technical support to Parsons and was awarded a subcontract for their services.

Lurgi provided a process package consisting of a process description; process flow diagrams, overall heat and material balances; produce and by-product stream composition, flow rates, temperatures and pressures; equipment lists, dimensions, design conditions and materials of construction; plot plan and capital cost estimate.

2.4 PRESSURE SWING ADSORPTION (PSA) UNIT

A Polybed HYSIV* Pressure Swing Adsorption Unit is provided to produce 99.9% hydrogen from the methanol synthesis purge stream. The product hydrogen from PSA Unit will be fed to the Heavy Gasoline Treating (HGT) Unit which is designed to hydrotreat catalytically heavy gasoline stream from the Mobil Methanol-to-Gasoline (MTG) catalytic process.

The HYSIV* PSA Process is a proprietary process of Union Carbide Corporation which is commercially proven. Union Carbide has provided 190 PSA hydrogen units worldwide during the past 15 years. Seven of these units have been designed to process a methanol purge stream.

Union Carbide presented a proposal for providing a complete skid-mounted unit that is located in the Methanol Synthesis Unit. They provided process description, process flow diagram, plot plan requirements, utility requirements, and installed cost. These data were utilized in the preliminary design of the Gasoline Plant.

2.5 HF ALKYLATION

The Hydrofluoric Acid (HF) Alkylation Unit converts a mixture of butylenes, amylenes, and isobutane to produce alkylate as a blending component for finished gasoline.

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* Registered Trademark

Processes offered by Phillips Petroleum Company and UOP Process Division of UOP, Inc. were evaluated. The alkylation process using sulfuric acid as a catalyst was not considered. This process is now being operated in older plants, but the trend in the industry is toward the HF process.

Each licensor made a non-proprietary technical presentation and provided data for Parsons use in preparation of the process comparison report. Phillips was selected to provide technical support to Parsons.

Phillips provided a preliminary process design package to Parsons at no cost and Parsons developed the Phillips data in the detail required for the support of the capital cost estimate. Phillips provided process description, overall estimated material balance, estimated utilities, catalyst and chemical consumption, operating manpower and maintenance cost, preliminary equipment list with sizes, duties and metallurgy, simplified process diagram and a preliminary plot plan.

2.6 SULFUR RECOVERY AND SULFUR REMOVAL

The Sulfur Recovery and Sulfur Removal System, incorporated into the design of the Gasoline Plant, recovers and removes the hydogen sulfide from process gases produced in the Acid Gas Removal Unit in a manner that allows only a minimum emission of sulfur compounds to the atmosphere.

The prime criterion for selecting the system was whether the process can meet the environmental restrictions imposed by Best Available Control Technology (BACT) or Least Attainable Emission Technology (LAET) standards. At least +99.9% removal of the sulfur from the process gases is required. The process selected must have been demonstrated commercially with a high reliability for units of comparable capacity.

The H_2S from the Acid Gas Removal Units is recoverd by the Parsons Claus 3-Stage Process for recovery of elemental sulfur. The Claus Sulfur Recovery Process is used throughout the world for bulk recovery of sulfur from acid gases having a wide range of H_2S concentrations and compositions. Parsons Claus Sulfur

Recovery Process is based on a modification of the so-called Claus Process patented late in the 19th century. During the past 30 years, numerous process and mechanical features have been developed and perfected from the design and operations of more than 300 plants ranging in capacity from 5 to 1600 long tons per stream day. Parsons Sulfur Recovery Plants are known throughout the world for their reliability, high recovery of high purity sulfur, efficient control and layout and ease of operation and maintenance.

To meet BACT standards, the sulfur in the tail gas from the Claus Unit must be removed. Both the Parsons/Union Oil Company of California Beavon Sulfur Removal Process (BSRP) and Parsons BSR/MDEA Process can meet BACT standards. The BSRP meets both BACT and LART standards and was selected for the Gasoline Plant.

The first BSRU went on stream in 1973 and is still in service. There are more than 50 units built or being built. The units have achieved an on-stream factor of more than 95% and at least one was on stream continuously for more than two years between turnarounds. At the present time, this process is considered not only Best Available Control Technology (BACT), but also Least Attainable Emission Technology (LART).

2.7 FLUE GAS DESULFURIZATION

The Gasoline Plant utilizes coal-fired boilers for the generation of steam. The flue gas from these boilers must be processed in a flue gas desulfurization facilty to reduce the particulates and the SO_2 in the stack gas to environmentally acceptable levels.

Both wet scrubbing and dry scrubbing processes were evaluated as tabulated below:

Wet Scrubbing	Dry Scrubbing
Wellman-Lord	Niro/Joy Lime Spray
Davy S-H	Koch/Mikropul Lime Spray
FMC Double Alkali	
Dowa Dual Alkyali	
Research-Cottrell Double-Loop Limestone	

There was insufficient commercial experience in dry scrubbing to justify its selection. Research-Cottrell Double-Loop Limestone Process was selected for the preliminary design. A waste stabilization system developed by Conversion System, Inc. will be provided to process the wet sludge prior to disposal in a landfill.

In the final design, the dry scrubbing processes may be considered, providing they have gained sufficient commercial experience by that time. Research-Cottrell provided a technical and cost proposal for the facility that included process flow diagrams, plot plans, equipment lists, operating and utility requirements, system descriptions, and cost estimates. Conversion Systems, Inc. provided similar data for the waste stabilization system. These data were provided to Parsons at no cost.

SECTION 3

EQUIPMENT VENDOR TECHNICAL SUPPORT

3.1 COAL GRINDING

In December 1978, Kennedy Van Saun Corporation (KVS) performed open circuit wet grinding tests on Kentucky No. 9 coal as part of the Synthesis Gas Demonstration Plant Program (SGDP).

KVS is approved by Texaco Development Corporation (TDC) as an equipment supplier for grinding mills for the TDC Coal Grinding and Slurry Preparation Section of the plant. Secrecy agreements are in effect between KVS, TDC, Grace and Parsons that allow the transfer of proprietary data among the four parties.

For the preliminary design of the Gasoline Plant, KVS determined the number, size, type, and electrical power requirements of the mills to grind the coal feed to the TDC gasifiers to suit TDC grinding specifications. Two grind distributions were specified that require the installation of two types of mills.

KVS also provided Parsons with cost data for the grinding equipment for use in the capital cost estimate.

No subcontract was required to obtain this technical support from KVS.

3.2 WASTE WATER TREATMENT

The preliminary design of the Gasoline Plant is based on the "zero discharge concept" through the treatment and recycle of the wastewater.

Some of the wastewater streams contain organics, suspended solids, metals, and other materials that must be removed before the water can be recycled. The technologies utilized in the design of the plant for these streams are:

(1) Reverse osmosis and ultra filtration

(2) Vapor-compression evaporation and drying

The Permutit Company, Inc., a well-known company for water and waste treatment, was selected to provide technical support in selecting the reverse osmosis system for the processing of two specific waste streams. They specified the flow scheme, equipment requirements, water analysis profile and cost data for the capital cost estimate.

The product water from the reverse osmosis system is recycled for reuse and the reject water is processed by vapor-compression evaporators and belt presses to reduce the water content to a level where the solids can be disposed of in the land fill. Resources Conservation Company provided technical support in the selection of this equipment and the submitted cost data for the estimate.

In the final design, samples of the waste streams will be obtained and treatability studies performed by laboratory or pilot plant tests to obtain more precise data on which to make the final selection of equipment.

SECTION 4

OTHER TECHNICAL SUPPORT

4.1 SITE DEVELOPMENT AND ENVIRONMENTAL ASSESSMENT

Parsons subcontracted to Dames & Moore certain portions of the work related to site development and environmental assessment. Their overall experience, expertise in this field, and the proximity of their Lexington office to the site were the factors considered in their selection.

The scope of the Dames & Moore subcontract included:

(1) Plant land requirements assistance

(2) Design criteria assistance

(3) Site evaluation assistance

(4) Field investigations including field exploration for foundation design, groundwater investigation, laboratory testing of soil samples, and analysis of data.

(5) Site confirmation assistance

(6) Floodway analysis

(7) Satellite site investigation for solid wastes

(8) Air quality analyses

(9) Attend meetings with local agencies

4.2 LAND APPRAISALS

Stanley Hoffman, Land Appraisal Consultant, provided appraisals of various parcels of property comprising the site of the Gasoline Plant. These appraisals identified the ownership and estimated value of the land and buildings for each parcel. The appraisals were used in developing the land cost in the capital cost estimate.

4.3 ENVIRONMENTAL COORDINATION

Engineering-Science, Inc., a subsidiary of The Parsons Coporation, was selected to provide an environmental coordinator to direct and coordinate all environmental activities in Parsons offices utilizing Parsons environmental engineers and specialists at Engineering-Science. The coordinator also supervised the environmental related work performed by Dames & Moore.

SECTION 5

DEVIATIONS FROM TECHNICAL SUPPORT PLAN - DELIVERABLE 35-1

The Technical Support Plan included a list of potential subcontracts to be issued to selected licensors of proprietary processes. In addition, it specified the site development and environmental assessment that would be performed by Dames & Moore under subcontract.

The Plan anticipated issuing subcontracts to nine licensors of proprietary processes, however, only two subcontracts were issued: one to Lotepro for the Acid Gas Removal Unit and one to Lurgi for the Methanol Synthesis Unit.

Phillips provided basic data for the Alkylation Unit and Parsons developed the data and issued the required technical documents required by the Statement of Work.

Research-Cottrell provided technical data for the Flue Gas Desulfurization System at no cost to Parsons.

The CO Shift Units were designed by Parsons based on catalyst performance supplied by Catalyst Manufacturers.

The Sulfur Recovery and Removal Units were designed by Parsons based on their well-known technologies.

Ruhrchemie provided a preliminary design for the waste heat boiler at no cost and vendors were not requested to provide any data.

The site development and environmental assessment work anticipated to be performed by Dames & Moore was modified to some extent from the scope outlined in Technical Support Plan, Deliverable 35-1, by the deletion of some tasks and the addition of other tasks. Their final Scope of Work is included in Section 4 of this report.

Subcontracts not anticipated in the Technical Support Plan were:

(1) Engineering-Science, Inc. - Environmental Coordinator

(2) Stanley Hoffman - Land Appraisal Consultant

(3) Al E. & Co., Ltd. - Air Separation Basic Design Data

III. MOBIL RESEARCH AND DEVELOPMENT CORPORATION TECHNICAL SUPPORT

A. Design Support

The Gasoline Plant design utilized MRDC's fixed-bed version of the MTG process. A subcontract was executed in June 1981 between Grace and MRDC for the design effort associated with the MTG process and shortly thereafter an initial design review meeting among Grace, MRDC, and Parsons was conducted. This subcontact clearly defined specific items to be developed as a part of MRDC's SOW with regard to project technical requirements and specifications. MRDC's technical support requirements, as previously documented in Appendix A of the Technical Support Plan, consisted of five tasks which were completed.

The technical activities associated with these tasks were represented primarily by three technical deliverables prepared by MRDC and submitted to Grace. These were the Basis of Design Report (Deliverable No. 5), Process Flow Diagram (Deliverable No. 6), and MTG Preliminary Process Design Package (Deliverable No. 7). These deliverables described in substantial detail the process design criteria and specifications within the MTG battery limits. Specifically discussed within the established battery limits were the MTG, Heavy Gasoline Treating (HGT), and Wastewater Treatment processes.

The first formal document issued to Grace in July 1981 to Grace was the Basis of Design Report which described all process streams entering and leaving the battery limits, and presented a brief description of the operating characteristics and requirements for

the subject processing units. Specific items included in this document were a block flow diagram showing relationships between the other processing units, process descriptions which included an explanation of the chemistry of methanol conversion and a listing of hydrocarbon products. Also discussed were operating conditions for the MTG reaction, heavy gasoline treating, and process water treatment sections. The basis of design portion of this report dictated the number of MTG conversion trains required, along with philosophies associated with determining the required numbers of equipment. Also documented was the composition of methanol feed stock and estimated unleaded gasoline, LPG and butane products. Estimated utility requirements for the MTG and HGT sections were presented in addition to sections which dealt with estimates of catalyst and chemicals requirements, environmental considerations, and plot plan requirements. Because of the well-structured organization of this document, design efforts associated with this portion of the plant were instituted upon receipt of this data source.

The Process Flow Diagrams and MTG Preliminary Process Design Package were combined and formally submitted to Grace in February 1982 as the "Process Design Document for a 50,000 BPD MTG Plant." Several draft portions of this work had been delivered to Grace for use in design activities prior to the submission date. This rather extensively detailed document provided design and operating data which was readily incorporated into the design efforts for the methanol conversion section of the Gasoline Plant. Of the numerous items presented, the most major included a process description which specifically addressed feed stocks and products, internal process

flows, basis of the plant design, utilities, and process water treatment facilities. Discussed as a part of all the operating units were specific unit process descriptions, plant design philosophies, operating procedures, catalyst and chemicals consumption rates, environmental data, and support facility requirements. The information contained in this report was presented upon at least twenty-three process flow diagrams and supporting equipment data sheets.

In support of the design information prepared, MRDC attended several design review meetings in conjunction with Grace and Parsons. These meetings provided a forum for interpretation of some of the specifics as depicted by MRDC in their project documentation and presented opportunities whereby any outstanding topics were clarified and resolved. Parsons prepared project documentation in the form of process and utility flow control diagrams, plot plans, process descriptions, and risk analyses which were reviewed by MRDC for technical comment, verification, and approval as nonproprietary documents prior to eventual submittal to DOE. Process areas reviewed by MRDC included MTG, HGT, process water treatment and overall wastewater management sections. Much of this information will be included as a part of the Gasoline Plant Process and Mechanical Design Report, Deliverable No. 14.

1. Foster Wheeler

The detailed process design and engineering work required by the MTG process design document mentioned above was supplied through MRDC by Foster Wheeler, the architect/engineering firm subcontracted to MRDC. The comprehensive process design

information developed by Foster Wheeler and relayed to Parsons enabled direct use of this information for obtaining vendor quotes for most of the equipment within the MTG section battery limits.

B. Deviations

There were no deviations by either MRDC or Foster Wheeler with regard to the previously submitted Technical Support Plan, Deliverable No. 35, or the SOW for the MRDC Subcontract.

IV. TEXACO DEVELOPMENT CORPORATION TECHNICAL SUPPORT

A. Design Support

The Texaco Coal Gasification Process (TCGP) was selected by Grace as the technology for generating a raw synthesis gas from high-sulfur agglomerating Kentucky No. 9 feedstock coal. A subcontract between Grace and TDC was executed in May 1981 which required TDC to supply technical expertise and engineering design data in support of the preliminary design of the synthesis gas generation section of the Gasoline Plant.

TDC's efforts were characterized by four distinct stages encompassing preliminary estimates of operation, bases of design, detailed material balances and supporting information, and review of design documentation related to the gasification area generated by Parsons. The estimates of operation were furnished after preliminary inputs were discussed during the initial technical review meeting between Grace, Parsons, and TDC conducted in May 1981. The design bases and preliminary input data for the estimates of operation of the gasifier included of the normal operating conditions (NOC) and design operating conditions (DOC) coal compositions, quantities of synthesis gas required to permit downstream production of 50,000 BPD unleaded gasoline, and associated operating requirements. These studies were developed to show the relationships between operating state functions and associated variables dependent on design coal variations and physical property characteristics, slurry compositions, oxygen requirements, gasifier residence times, numbers of gasifiers, and other pertinent operating considerations. Resultant information

furnished as a part of these engineering type trade-off studies compared required feedstock quantities, compositions for the major components in the gas, requirements for pure oxygen, slurry water concentrations and nonhazardous slag generated as a result of this high-temperature process. These studies permitted a direct comparison of the major variables involved in the gasification process so that more detailed information suitable for the Gasoline Plant design requirements could be generated.

The second and more specific level of design data detail for the NOC and DOC cases developed by TDC was the conceptual basis for design. As most of the major variables, such as coal composition and characteristics, number of gasifiers, slurry composition and required quantities of synthesis gas, were fixed in the estimates of operation, more detailed stream compositions and feedstock requirements were determined. The previously developed information was expanded to include more specific compositions of feedstocks in terms of carbon, hydrogen, nitrogen, sulfur, oxygen, ash and water; to slurry grind size distribution requirements; specific oxygen feedstock rates; gasifier cooling water requirements; and operating temperatures and pressures associated with the major pieces of equipment in the gasifier area. Streams exiting the gasifier area were represented with specific compositions and rates of synthesis gas exiting the gasifier, slag discharge rates, including quantities of unconverted carbon, and process water blow-down rates. This information was input into Parsons' process design efforts for the coal grinding and slurry preparation area, coal gasification and wastewater treatment processing units. The design criteria

established as a result of this work enabled the interested parties to meet with Kennedy Van Saun, a vendor of size reduction technology to discuss the most appropriate coal grinding and slurry preparation scheme. This meeting, which included Grace, Parsons, and TDC, enabled detailed technical discussions concerning the commercial standards for grinding the large amounts of coal required to the specified design grind-size specifications. Design information as related to particular size reduction equipment supplied by Kennedy Van Saun were incorporated into the Gasoline Plant design. The determination of the scheme for the slurry preparation unit permitted progression of activities to the next level of design data preparation.

The most in-depth information developed by TDC for this project was the calculation of detailed heat and material balances associated with approximately 50 streams internal to the TCGP. This information supplied for both NOC and DOC presented detail stream compositions, operating temperatures and pressures, flow rates, heat content, and other physical operating characteristics. Steps toward finalization of gasification area design were instituted upon receipt of this information in conjunction with related TDC-prepared process flow diagrams.

Detailed heat and material balance information in total was discussed as a part of a final design review meeting between Grace, TDC, and Parsons. These discussions centered around numbers of specific operating and spare pieces of equipment required for the slurry preparation, coal gasification, and process water treatment areas. This permitted equipment sizing by Parsons for all the major

processing equipment and translation of this information into equipment specification sheets. In order to obtain accurate cost information for most major and specific pieces of equipment in a timley manner, TDC supplied preferred equipment suppliers with the necessary secrecy agreements already in place. As such, a rapid transfer of information from vendors to the Gasoline Plant project was realized.

In its utilization of the above-mentioned data developed by TDC, Parsons developed nonproprietary project documentation in the form of process and utility flow diagrams, process descriptions, risk analyses, and other material that is to be included as portions of Deliverable No. 14, Process and Mechanical Design Report. This information was in turn furnished to TDC for design verification and approval as nonproprietary documents. Information submitted to TDC dealt with those process areas associated with coal grinding and slurry preparation, coal gasification, TDC process water treatment, and ammonia recovery/affluent water treating.

B. Deviations

1. As a part of the coal gasification process, it was decided that a radiant waste heat recovery boiler would be incorporated into the design. The design selected was the property of Ruhrchemie AG (Ruhrchemie) and, as such, design information was procured from them. Ruhrchemie supplied the requested information in the form of detailed design specification sheets, complete with operating conditions for the NOC and DOC case and specifications associated with sizing of this particular piece of equipment. A design review meeting was held between Grace, Parsons, and

Ruhrchemie, which included review of the waste heat recovery scheme and a tour of the Oberhausen-Holten coal gasification facilities to view the waste heat recovery boiler operations. This design information is solely the property of Ruhrchemie and was supplied outside of the subcontract with TDC; however, no additional expenditure of funds was required to obtain this data.

2. TDC complied with the SOW previously presented in the Technical Support Plan, Deliverable No. 35, and, at the time of this writing, had delivered all the information specified except for capital cost and materials of construction reports. With regard to metallurgy necessary for this processing area, Parsons had developed the materials of construction for the gasification section and sent this information as a part of a process flow diagram to TDC for review. TDC's comments were utilized in specifying those materials required for fabrication purposes.

V. DAMES & MOORE TECHNICAL SUPPORT

A. Environmental Baseline Support

The original SOW for the 50,000 BPD Gasoline Plant environmental analysis effort called for the preparation of an environmental report. The intent of this report was to provide data that could be incorporated into an EIS; however, work performed in the finalization of Deliverable No. 22 - Environmental Permitting Requirements, established the need for an EIS as a prerequisite to the construction and operation of the 50,000 BPD Gasoline Plant. While no EIS is being prepared for the 12,500 BPD plant, the work done by Dames & Moore as regards site baseline conditions is also applicable to the smaller plant. A discussion of the baseline studies follows.

As such, Dames & Moore completed site-related data studies, established baseline conditions, and reviewed previously established environmental work. Those items completed for the site data procurement effort included spring-seasonal biological and quality-of-life work, and aquatic and terrestiral surveys. Work completed prior to the Gasoline Plant project had defined air quality baselines fo the Baskett site; however, questions remained concerning air emission particulate characteristics. Air quality particulate samples, in the form of air filters, were recovered from storage, disected and analyzed in laboratory conditions in order to refine the air quality baseline. This work has been completed. Additional site work completed by Dames & Moore included determination of sound level baselines and an archaeological and historic survey. The archaeological and historical work was

subcontracted to Janzen, Inc., which completed the work on schedule. Site-specific work of a continuing nature is the procurement of groundwater data which will be used to define the area's water table. Additional work to be completed includes surface water, hydrology evaluation, and urban center computer study.

B. Deviations

No deviations have occurred or are anticipated to occur with regard to continuing activities by Dames & Moore.

FIGURE 1

SUBCONTRACT ORGANIZATIONAL CHART

SUBCONTRACT ORGANIZATIONAL CHART
COOPERATIVE AGREEMENT NO. DEAC01-80ET-14759
PRELIMINARY DESIGN AND ASSESSMENT OF
A 50,000 BPD COAL-TO-METHANOL-TO-GASOLINE PLANT

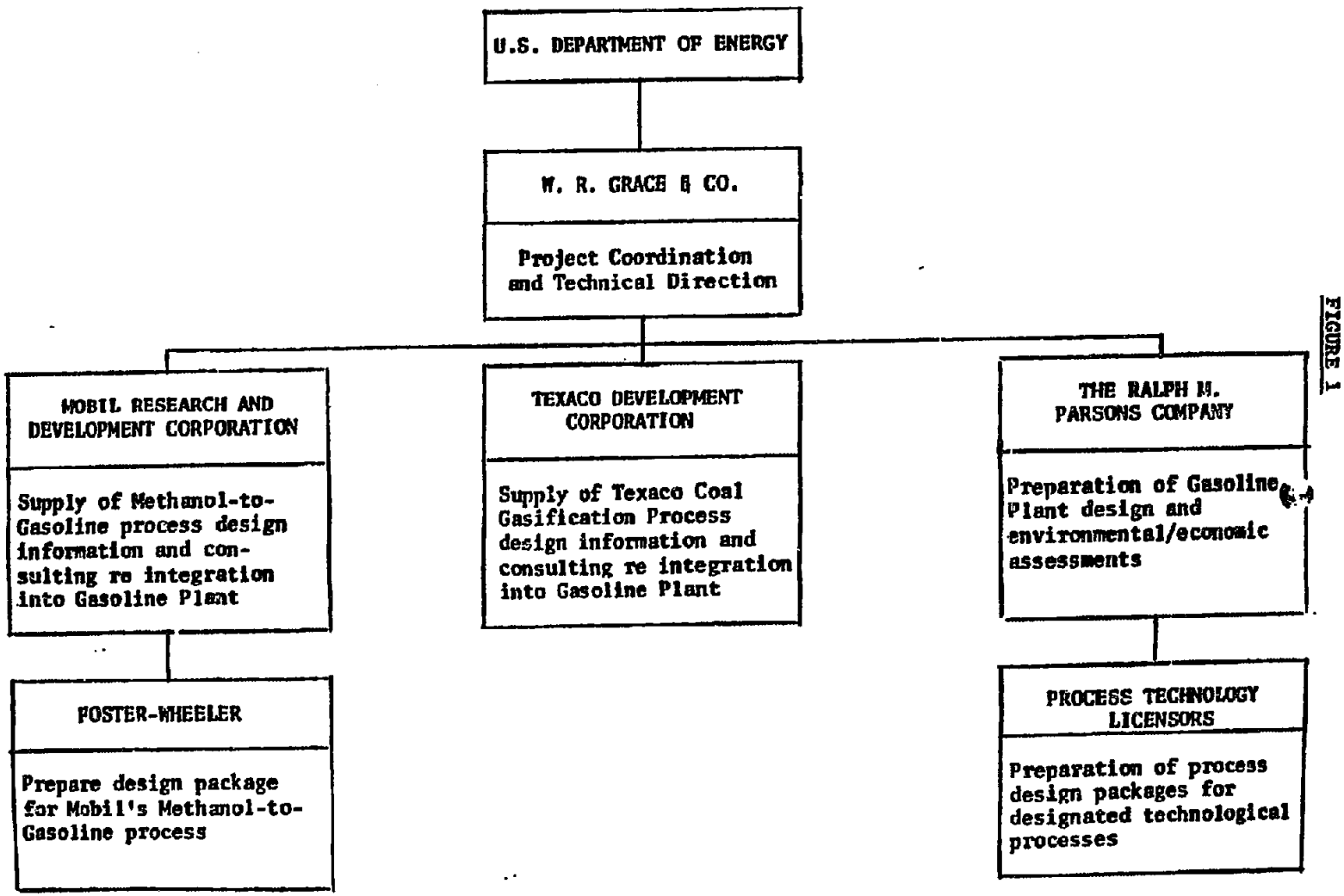

FIGURE 1