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UNDERGROUND GASIFICATION FOR STEEPLY DIPPING COAL BEDS

Quarterly Progress Report for July 1–September 30, 1978

MASTER

October 1978

Work Performed Under Contract No. EF-77-C-03-1472

Gulf Research & Development Company
Pittsburgh, Pennsylvania

and

TRW, Inc.
Energy Systems Planning Division
McLean, Virginia

U. S. DEPARTMENT OF ENERGY

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UNDERGROUND GASIFICATION
FOR
STEEPLY DIPPING COAL BEDS

QUARTERLY PROGRESS REPORT
FOR THE PERIOD
JULY 1, 1978 – SEPTEMBER 30, 1978

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GULF RESEARCH & DEVELOPMENT COMPANY
PITTSBURGH, PENNSYLVANIA

ENERGY SYSTEMS PLANNING DIVISION
MCLEAN, VIRGINIA

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PREPARED FOR THE DIVISION OF OIL, GAS AND IN SITU TECHNOLOGY
DEPARTMENT OF ENERGY

OCTOBER 1978

DOE CONTRACT NO. EF-77-C-03-1472

GR&DC CONTRACT NO. 600CH101
CHEMICALS AND MINERALS DIVISION REPORT NO. 624RJ044

1.0 ABSTRACT

The emphasis of on-site (North Knobs, Wyoming) activities this quarter centered around geologic and hydrologic drilling and baseline environmental data acquisition. Design of an all-weather access road was completed and construction is pending. An accelerated burn schedule was planned and budget costs were revised to reflect this change. The Permit to Mine application was finished in September and will be filed with the Wyoming Department of Environmental Quality (DEQ) early in October. Research on additional back-up sites continued through this quarter. The Project Data Book (referred to in earlier documents as the Blue Book and the Test Design Criteria Handbook) format was refined and updated copies were issued. Off-site engineering activities included completion of the instrumentation system requirements and development of a preliminary layout of the site. The Fourth Annual Underground Coal Conversion Symposium took place this quarter, in addition to a Gulf Technical Advisory Committee meeting and a TRW conference with the Laramie Energy Technical Center in Hanna, Wyoming.

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3.0 INTRODUCTION

Work operations this quarter advanced in areas of developmental design activities, test planning, engineering, environmental data collection, and fulfilling essential permit requirements. Exploratory well drilling began in mid-July as scheduled. Four core holes, five hydrology wells, and one pump well were drilled; all are functioning according to specification. A master drilling plan was developed which integrates all project wells. A preliminary site layout was also completed.

Surface and groundwater sampling is being conducted in addition to continuation of ambient air monitoring. A 10-meter meteorological collection tower was installed on-site (replacing a 5-meter tower) to conform to the Wyoming DEQ requirements. An auxiliary generator which will provide power to the air monitoring trailer was put into operation, greatly reducing the possibility of down-time of the air monitoring equipment.

Air and Water Quality Permits to Construct and the State Engineer Water Appropriation Permit will be applied for concurrently with the Permit to Mine application early in October, 1978. Preparation of the Environmental Impact Assessment for the DOE is well under way. Environmental support data are almost complete for this document and a draft is pending.

The scope of the Project Data Book expanded considerably this quarter; several chapters (including technical design specifications for test Nos. 1 and 2) were issued, and five additional chapters are nearing completion.

Input for the Project Safety Manual was reorganized and many modifications and/or clarifications were made in the text. An updated version of this document will be made available to site personnel shortly. As an adjunct to the Safety Manual, a North Knobs Project Safety Briefing/Lecture booklet was also prepared during this period.

4.0 SUMMARY OF TECHNICAL ACTIVITIES

4.1 Site Characterization

The exploratory drilling program to characterize the North Knobs, Wyoming site is in progress. Four core holes, five hydrology wells, and one pump well have been drilled. Core samples were logged, packaged, and shipped to laboratories for analysis. Contracts were let for coal analysis and for rock mechanics studies. Aerial photography and surface mapping of the area have been completed. Subsurface geologic characterization will not be concluded until laboratory analysis results are available for interpretation. Design of the access road to the site was completed and the drawing and specifications package are ready for procurement.

4.2 Environmental Activities

Acquisition and evaluation of baseline environmental data continues this quarter. A draft of the Environmental Impact Assessment (EIA) will be available for review shortly. Where adequate data bases have been formulated, site characterizations of surface and subsurface geology, climatology, ecology, demographic resources, land uses, aesthetic/historic/archaeological resources and socio-economic resources have been developed.

4.3 Permits

The State of Wyoming's Department of Environmental Quality (DEQ) requires that a Permit to Mine be obtained prior to construction on the site. The baseline environmental data needed for this permit application was

acquired and a draft of this permit will be submitted to the state on October 2, 1978. The Air Quality Permit to Construct, the Water Quality Permit to Construct, and State Engineer Water Appropriation Permits will be applied for in conjunction with the Permit to Mine. A License to Mine will be required at the same time the Permit to Mine is received; no difficulties in obtaining this license are foreseen.

4.4 Test Design

Early review of the completed chapters of the Project Data Book (referred to in earlier documents as the Blue Book and the Test Design Criteria handbook) indicated that a change in format was necessary. Considerable time was expended to translate the document into a more cohesive form. Revised chapters of the Data Book were subsequently issued and future chapters will follow the newly designed format.

4.5 Engineering Design

The decision to relocate several wellheads necessitated alterations in the original site designs. A revised, preliminary site layout was developed to incorporate these changes. Design criteria for the access road to the site are complete. The instrumentation systems' requirements for support of this project have been finalized and preparation of procurement packages is underway. A master drilling plan was developed which integrates all project wells, including hydrology, coring, injection, production, and instrumentation wells.

4.6 Safety

The Project Safety Manual (Issue B) was revised and updated to include new material as well as modifications and clarifications of previously written sections. A UCG Project Safety Briefing/Lecture booklet for test site personnel was also prepared during this quarter.

4.7 Miscellaneous

4.7.1 Site Support Planning

Site support planning activities this quarter were directed toward outlining a Project Activity Network that reflected the recent decision to accelerate Test No. 1. A revised project schedule and deliverable/ document schedule was prepared for review. Due to the accelerated test schedule, it was necessary to initiate preparation of the Site Operations Plan to keep pace with the project.

4.7.2 Software Development

Software packages from LETC and LLL used in the on-site computers for their UCG programs have been obtained. An engineering evaluation of selected subroutines of the LLL subroutine model has been initiated. This task will be completed in the forthcoming quarter.

5.0 ENVIRONMENTAL ACTIVITIES

5.1 Baseline Monitoring

5.1.1 General

The three major objectives of this task are:

- To monitor environmental conditions at the UCG test site prior to the field tests.
- To produce environmental data which can be used to define substantive baseline parameters necessary for the Permit to Mine application and also in preparation of the Environmental Impact Assessment for the DOE.
- To assure appropriate regulatory agencies and local citizenry that preservation of environmental quality is an integral part of the UCG test program.

The baseline monitoring task is one component of the environmental activities that are integral to the UCG project. Other environmental tasks that are either on-going or will be conducted later in the project are: preparation of the Environmental Impact Assessment (EIA), Test Monitoring, and Environmental Lab Support.

The test monitoring tasks will be conducted during the period of the three field tests and will provide environmental data that can be compared with data collected during the baseline period. The results of each of the environmental tasks will assist in determining whether UCG is an environmentally acceptable process.

5.1.2 Technical Discussion

During this period, ambient air quality data was collected and analyzed for each of the six criteria pollutants; sulfur oxides, suspended particulate matter, carbon monoxide, ozone, nitrogen oxides, and non-methane hydrocarbons.

A visit to the UCG test site was made by a staff engineer during the week of July 10 for the purpose of reviewing the current ambient air sampling, calibration and maintenance procedures. Based on the findings of the visit, minor modifications were made in record keeping procedures and the frequency in which the strip charts would be analyzed. Also, during the site visit, the nitrogen dioxide analyzer was repaired and has since been operating according to specifications.

A second portable electric generator was placed in operation at the test site to be used when the primary generator is out of service during routine maintenance and unexpected malfunctions. The use of the second generator is expected to decrease the amount of down-time in the air monitoring instruments, thereby increasing data recovery.

In order to conform to the Wyoming DEQ requirements, a 10-meter meteorological tower was placed in operation at the test site to monitor wind speed and direction. This tower replaced the 5-meter unit. Ambient air quality data collected during this period have been summarized in separate reports and are included with this document (Attachment 5.1). Overall data recovery during this period was approximately 85%, as compared with the EPA requirement of 75% data recovery to calculate annual averages.

A document was drawn up which describes the procedures to be used in collecting and preserving groundwater samples prior to laboratory analysis.

The information included in this document for each water quality parameter to be analyzed is as follows: analytical procedure to be utilized, volume of water sample required for analysis, preservatives required, maximum holding time before completing analysis, temperature for shipment, and type of container.

One sample of groundwater was taken from the coal seam at a depth of 639 feet (Well 15) during mid-September utilizing the above handling techniques. The complete results of the water analyses are not yet available. A listing of the water quality parameters measured to date is shown below:

Alkalinity	1485	ppm
Bicarbonate	495	ppm
Carbonate	990	ppm
Calcium	3.4	ppm
Chloride	645	ppm
Magnesium	0.8	ppm
Nitrate	8.0	ppm
Sodium	460	ppm
Sulfate	316	ppm
pH (field measurement)	9.9	pH units
Selenium	< 9	ppb
Arsenic	12.7	ppb

The G seam was also found to have a very low yield. The preliminary pumpdown tests to date show an approximate 0.8 gal/hr recharge rate at a water head of 395 feet and a 2-4 gal/hr recharge rate with a 10-foot head.

5.2 Environmental Impact Assessment

5.2.1 General

Specific sections of the EIA were written during this quarter and a completed draft of this document is scheduled for review late in September. A revised outline (Table 5.1) of the EIA material was prepared to assure consistency with the DOE "Guidelines for Environmental Review" and a copy of this outline follows.

5.2.2 Technical Discussion

Important factors taken into account while formulating the EIA included: 1) identifying data and informational requirements for characterizing and evaluating impacts on various aspects of the environment (these data are summarized in Table 5.2); 2) collecting baseline data and information for each of those aspects; 3) characterizing the existing or baseline environmental conditions of the site; and, 4) analyzing the impacts of the proposed project (i.e., expected changes from the baseline environmental conditions) on each of those aspects.

TABLE 5.1
ENVIRONMENTAL IMPACT ASSESSMENT

1.0 SUMMARY

2.0 INTRODUCTION

2.1 BACKGROUND

2.1.1 Purpose of Project

2.2 BRIEF PROJECT DESCRIPTION

2.3 PROJECT OBJECTIVES

2.4 ENVIRONMENTAL CONSIDERATIONS

3.0 DESCRIPTION OF THE PROPOSED PROJECT

3.1 PROJECT LOCATION

3.2 PROJECT DESCRIPTION

3.3 PROJECT IMPLEMENTATION ACTIVITIES

3.4 PROJECT INPUT/OUTPUT REQUIREMENTS

4.0 DESCRIPTION OF THE EXISTING PROJECT SITE ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

4.1.1. Geology

4.1.1.1 Surface Geology

4.1.1.2 Subsurface Geology

4.1.2 Hydrology

4.1.2.1 Surface Waters

4.1.2.2 Subsurface Waters

4.1.3 Water Quality

4.1.4 Climatology

4.1.5 Air Quality

4.1.6 Noise Quality

4.2 BIOTIC ENVIRONMENT

4.2.1 Terrestrial Ecology

4.2.1.1 Flora

4.2.1.2 Fauna

4.2.2 Aquatic Ecology

4.2.2.1 Flora

4.2.2.2 Fauna

4.3 HUMAN ENVIRONMENT

4.3.1 Demography

4.3.2 Land Use

4.3.2.1 Existing Land Uses

4.3.2.2 Future Land Uses

4.3.3 Transportation

4.3.4 Aesthetic/Cultural/Historic Interests

4.3.5 Socioeconomics

4.3.5.1 Employment

4.3.5.2 Education and Income

4.3.5.3 Housing and Services

TABLE 5.1
(Continued)

5.0 POTENTIAL ENVIRONMENTAL IMPACTS

5.1 EFFECTS OF THE PHYSICAL ENVIRONMENT

- 5.1.1 Geology
- 5.1.2 Hydrology
- 5.1.3 Water Quality
- 5.1.4 Climatology
- 5.1.5 Air Quality
- 5.1.6 Noise Quality

5.2 EFFECTS ON THE BIOTIC ENVIRONMENT

- 5.2.1 Terrestrial Ecology
- 5.2.2 Aquatic Ecology

5.3 EFFECTS ON THE HUMAN ENVIRONMENT

- 5.3.1 Demographic Characteristics
- 5.3.2 Land Use
- 5.3.3 Transportation
- 5.3.4 Aesthetic/Cultural/Historic Interests
- 5.3.5 Socioeconomics
- 5.3.6 Health and Safety

6.0 POTENTIAL CUMULATIVE OR LONG-TERM EFFECTS

7.0 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

8.0 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

9.0 COORDINATION WITH FEDERAL, STATE, REGIONAL OR LOCAL PLANS

10.0 ALTERNATIVES TO THE PROPOSED PROJECT

APPENDIX

TABLE 5.2

ENVIRONMENTAL DATA AND INFORMATIONAL REQUIREMENTS

A. <u>Geological Data</u> ● Surface Geology -- solid types/characteristics -- topography/surface contours -- erosion patterns ● Subsurface Geology -- strata characterization (including depths) -- core analysis -- coal seam characterization/analyses -- strata porosity data -- radiological survey data (if applicable) -- seismic mappings B. <u>Hydrological Data</u> ● Surface Water -- existing water courses/storage basins -- flow rate and direction (including seasonal variations) -- current beneficial uses of surface waters or stream classifications ● Subsurface Waters -- near-surface and deep aquifer location -- aquifer flow rate and directions (including seasonal variations) -- subsurface storage basin locations -- groundwater well locations for surrounding area -- current beneficial use of subsurface waters (including wells) -- identification of mineralized water aquifers (if applicable to site)	C. <u>Water Quality Data</u> ● Surface and Subsurface Water -- water quality data for regulated parameters -- other water quality data -- seasonal variations in water quality ● Water Quality Standards (Federal, Wyoming) D. <u>Climatological Data</u> ● General Description of Region's Climatological Conditions (Seasonally) ● Deviations In Site-Specific Climatological Conditions ● Meteorological Data (For 5-10 Year Average) -- wind rose -- wind speeds -- temperature -- humidity -- precipitation ● Lapse Rates or Occurrence of Inversions E. <u>Air Quality Data</u> ● Regional EPA air quality classification/priority ● Regional Air Quality Data -- criteria pollutants ● Site Specific (Baseline Monitoring) air quality data -- criteria pollutants -- process-specific levels ● Air Quality Standards/Regulations (Federal, Wyoming)

TABLE 5.2

ENVIRONMENTAL DATA AND INFORMATIONAL REQUIREMENTS
(Continued)

F. Noise Quality Data

- Noise Standards/Regulations (Federal, Wyoming)
- Site-Specific Noise Data

G. Ecological Data

- Flora
 - indigenous terrestrial/aquatic species for site area
 - economically significant species
 - endangered or threatened species
 - habitat data for economically significant species
- Fauna
 - indigenous terrestrial/aquatic species for site area
 - economically significant species
 - endangered or threatened species
 - habitat data for economically significant species

H. Demographic Data

- Census Data for Area (1960 & 1970)
- Population Data or Estimates (State, County, Local) for Non-Census Years
- Population Projections for Area (Up to 10 Years, if Available)
- Population Distribution (Geographic) for Study Area

I. Socioeconomic Data

- General Economic Data for Area
 - major industries
 - major employers

● Labor Force Estimates

● Labor Force Projections

● Income Data for Area

J. Cultural/Aesthetic Data

- Identify Scenic Areas/Vistas in Site Vicinity

● Archeological Resources in Area

● Historical Sites for Area

K. Land Use Data

- Land Use Maps/Plans
 - existing land uses
 - future land uses/plans

ATTACHMENT 5.1

AMBIENT AIR MONITORING REPORT

PURPOSE:

An ambient air monitoring program is being conducted at the UCG test site for the purpose of establishing baseline air quality prior to the start of the gasification tests. Air quality data will also be collected during the test period for comparison with baseline data to determine if any degradation in air quality occurs as a result of the tests.

SUMMARY:

Air quality data is being collected for each of the six criteria air pollutants, trace elements, and wind speed and direction. The criteria pollutants are: total suspended particulates; sulfur dioxide; nitrogen dioxide; photochemical oxidants; carbon monoxide; and non-methane hydrocarbons.

Ambient air monitoring was started on May 26, 1978, however some malfunctions with the NO_x instrument, and delays in delivery of calibration gases for the hydrocarbon analyzer delayed data collection for these pollutants. The analysis of the air quality data indicate that ambient levels of all pollutants, with the exception of photochemical oxidants and non-methane hydrocarbons, are below the Federal and State standards shown on Table 5.1-1. Since the air monitoring program has been conducted for a period of four months, the trends in air quality levels cannot yet be determined. The primary reason for low levels of pollutants is due to the lack of major emission sources in the area of the UCG test site.

TABLE 5.1-1

UCG AIR QUALITY DATA SUMMARY

AMBIENT AIR QUALITY STANDARDS (μg/m ³)				AIR QUALITY DATA (μg/m ³)			
	FEDERAL		WYOMING				
	<u>Primary</u>	<u>Secondary</u>	<u>Primary & Secondary</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept</u>
<u>Sulfur Oxides -</u>							
Annual Arithmetic Mean	80	--	60	--	--	--	--
3-Hour Concentration*	--	1300	1300	52	35	26	22
24-Hour Concentration*	365	--	260	25	4	4	5
<u>Suspended Particulate Matter -</u>							
Annual Geometric Mean	75	60	60				
24-Hour Concentration*	260	150	150	37	39	33	89
<u>Carbon Monoxide -</u>							
8-Hour Concentration (mg)	10	10	10	--	--	--	--
1-Hour Concentration (mg)	40	40	40	2.9	4.6	1.5	0.1
<u>Photochemical Oxidants (Ozone) -</u>							
1-Hour Concentration*	160	160	160	196	160	160	137
<u>Nitrogen Oxides -</u>							
Annual Arithmetic Mean	100	100	100	--	8.7	11.3	9.6
<u>Non-Methane Hydrocarbons -</u>							
3-Hour Concentration* (6-9A.M.)	160	160	160	459	459	459	450

*Not to be exceeded more than once a year.

Total suspended particulates (Table 5.1-2) and sulfur dioxide are products of stationary fuel combustion sources and industrial processes neither of which are predominant in the Rawlins (North Knobs) area with the exception of the Sinclair Refinery east of Rawlins. The Wyoming Department of Environmental Quality operated a TSP sampling station in Rawlins in 1976 which also showed levels to be well below standards. There are no other data on other pollutants in the Rawlins area for comparison with data collected at the UCG site.

Stationary fuel combustion is also a source of nitrogen oxides as are transportation sources, primarily highway vehicles. The low levels of this pollutant, as well as the other fuel combustion related pollutants may increase during the winter months as the use of heating fuel in the area increases. The carbon monoxide level in the area will probably remain low since it is related to motor vehicles and is very source specific.

Photochemical oxidant levels are expected to remain near the standard during the daylight hours of intense sunlight because of the elevation of the test site. In this area, the high readings are probably due to stratospheric concentrations of ozone, and long range transport from other areas.

The EPA regional office in Denver was contacted to determine if high ozone levels are unusual in rural areas such as Rawlins. Although ozone data for these areas are limited, high levels have been recorded in other rural areas in the region and EPA also feels that long range transport may be a significant factor. The EPA Office of Air Quality Planning and Standards in North Carolina is presently conducting several research programs to resolve the questions of ozone transport.

TABLE 5.1-2

TOTAL SUSPENDED PARTICULATE DATA

<u>SAMPLE DATE*</u>	<u>CONCENTRATION ($\mu\text{g}/\text{m}^3$)</u>
5/26/78	24
6/01/78	13
6/07/78	23
6/13/78	23
6/19/78	33
6/25/78	37
7/01/78	24
7/07/78	28
7/13/78	38
7/19/78	39
7/25/78	31
7/31/78	33
8/06/78	89
8/12/78	32
8/18/78	16
8/24/78	21
8/30/78	VOID**
9/05/78	42

* 24-Hour Sample

**Incomplete Sample due to Generator Malfunction

As shown in Table 5.1-3 trace elements sampled at the site also are at low levels. This is due mostly to the fact that particulate levels for the area are low, since the analysis for the elements is based on the high volume sample filters. There are no ambient standards for trace elements although a standard has been proposed for lead for an ambient concentration of $1.5 \mu\text{g}/\text{m}^3$. The lead level at the site was recorded at $0.015 \mu\text{g}/\text{m}^3$.

Wind speed and direction data presented in Tables 5.1-4 and 5.1-5 indicate that the winds have been predominantly from the southwest with an average speed for the period at approximately 11 mph.

TABLE 5.1-3

TRACE ELEMENT ANALYSIS

	<u>CONCENTRATION ($\mu\text{g}/\text{m}^3$)</u>
ALUMINUM	0.049
ANTIMONY	0.026
ARSENIC	<0.0006
BERYLLIUM	0.0018
BISMUTH	0.003
BORON	*
CADMIUM	0.0006
CALCIUM	12.54
CHROMIUM	0.0037
COPPER	0.1
GERMANIUM	*
IRON	0.95
LEAD	0.015
MAGNESIUM	3.33
MERCURY	<0.0006
MOLYBDENUM	<0.0006
NICKEL	0.009
SELENIUM	0.001
TIN	0.008
TITANIUM	<0.06
VANADIUM	<0.0006
ZINC	0.172

*Analysis not completed

Data collected during week of June 19, 1978.

TABLE 5.1-4
WIND DIRECTION DATA
PERCENT OF OCCURENCES

<u>DIRECTION</u>	<u>JUNE</u>	<u>JULY</u>	<u>AUGUST</u>
N	3.8	6.1	6.2
NE	5.4	8.9	6.8
E	17.5	11.0	15.4
SE	13.3	13.0	14.5
S	10.0	11.4	9.9
SW	21.7	22.0	19.4
W	18.3	14.2	14.8
NW	10.0	13.4	13.0

TABLE 5.1-5
WIND SPEED DATA (m.p.h.)

<u>MONTH</u>	<u>AVERAGE SPEED</u>	<u>FASTEST</u>
May	11.4	27
June	11.4	29
July	9.9	26
August	11.2	30

6.0 PERMITS

The Permit to Mine Application, which must be obtained prior to construction on the North Knobs Site, has been completed and will be submitted to the Wyoming Department of Environmental Quality (DEQ) on October 2, 1978. It included detailed information in the following areas:

- Adjudication file
- Area description and maps
- Mine plan
- Reclamation plan
- Construction and operating schedule

Concurrently, the Air Quality Permit to Construct, the Water Quality Permit to Construct, and State Engineer Water Appropriation Permits will be applied for.

7.0 TEST DESIGN

A set of Design Requirements Documents (henceforth to be referred to as the Project Data Book) are being written to guide the design of the UCG facilities, instrumentation systems, and site support plans. The initial format was found to need some revisions and/or clarifications; consequently much time was required to rewrite the chapters already developed. The Project Data Book is divided into four major sections: Test Plan; Activities; Systems Descriptions; and Constraints. A structural outline of the Data Book is included in Table 7.1; Table 7.2 delineates the Table of Contents.

As part of the Test Design function, network diagrams were formulated for various project activities and these are shown in Figures 7.1 through 7.5.

TABLE 7.1
STRUCTURE OF THE PROJECT DATA BOOK

Test Plan		
ACTIVITIES	SYSTEMS	CONSTRAINTS
Site Selection	Geology	DOE Contract
Test Burn No. 1	Hydrology	Lease
Test Burn No. 2	Environmental Monitoring	Regulatory Agencies
Test Burn No. 3	Module Installation	Corporate Policy
Environmental	Facilities Installation	Environmental Impact Assessment (EIA)
Economics Analysis	Reactor	
Pilot Plant Design		Permits
Facilities	Site Operations	OSHA
Site Restoration	Instrumentation	Budget
	Data Acquisition	Climate
	Data Analysis	
	Test Procedures	
	Safety Procedures	
	Permit Acquisition	

TABLE 7.2
PROJECT DATA BOOK
Table of Contents

<u>Chapter</u>	<u>Title/Objective</u>	<u>Status</u>
1.	Test Plan: Translate project objectives to describe project activities.	Completed and issued.
2.	Systems Description: Describe the relationships among the systems within the project.	In progress.
3.	Site Acceptance Criteria: Establish the criteria for an acceptable site for UCG for SDB.	Completed and issued.
4.	Facility Acceptance Criteria: Provide the criteria for TRW to design the test facility.	Completed and issued.
5.	Environmental Requirements: Establish functional require- ments.	Completed and issued.
6.	Test No. 1: Describe Test No. 1 activities and establish technical requirements.	Completed and issued.
7.	Test No. 2: Describe Test No. 2 activities and establish technical requirements.	Completed and issued.

<u>Chapter</u>	<u>Title/Objective</u>	<u>Status</u>
8.	Test No. 3: Describe Test No. 3 activities and establish technical requirements.	Completed and issued.
9.	Economic Analysis: Describe economic analysis activities and establish data requirements.	To be issued 4/1/79.
10.	Pilot Plant Design: Provide a plan for pilot plant design and cost estimate activities.	To be issued 4/1/79.
11.	Site Restoration: Provide criteria for the site restoration activities.	Completed and issued.
12.	Geotechnical/Hydrology Program: Describe the program with emphasis upon the deliverables.	Completed and issued.
13.	Environmental Monitoring Plan: Describe the air, water, and surface monitoring plan to meet data requirements of project activities.	Completed and issued.
14.	Permits: Present the list, schedule, and the requirements of permits.	Completed and issued.

<u>Chapter</u>	<u>Title/Objective</u>	<u>Status</u>
15.	Facilities Design: Describe the facilities required to meet functional requirements of test program.	In progress; to be issued 1/1/79.
16.	Instrumentation: Describe the instrumentation systems required to meet functional requirements of the test program.	Completed and issued.
17.	Data Analysis: Describe the theory and equations for translating field data into useful information.	In progress.
18.	Data Acquisition:	Completed and issued; incorporated into Chapter 16.
19.	Master Drilling and Well Completion Plan: Plan for the integrated drilling and-completion program for the process and instrumentation wells.	Completed and issued.
20.	Process Well Design: Design process wells to meet functional requirements of the test program.	Completed and issued; incorporated into Chapter 19.

<u>Chapter</u>	<u>Title/Objective</u>	<u>Status</u>
21.	Instrument Well Design: Design instrument wells to meet functional require- ments of the test program.	Completed and issued; incorporated into Chapter 19.
22.	Water Well Design: Plan and design the well required to provide process water for the field test program.	To be issued.
23.	EIA Preparation Plan: Plan and schedule the preparation of the EIA.	Completed and issued.

FLOW CHART OF PROJECT ACTIVITIES
Figure 7.1

Figure 7.2

FLOW DIAGRAM
TEST NO. 1

FIGURE 7.3

TEST NO.3

Figure 7.5

8.0 ENGINEERING DESIGN

8.1 Facilities and Equipment Installation Design

8.1.1 General

The objectives of this task are:

- To design facilities and systems and specify components, equipment and material that will satisfy the operating requirements of the UCG tests.
- To establish performance and physical requirements for the facilities and equipment to be installed at the test site.
- Prepare engineering drawings and specifications adequate in content, detail and quantity to:
 - guide the procurement of systems, equipment, components and materials required to provide an acceptable and operable test site
 - obtain contractor bids for construction and equipment installation at the test site
 - permit construction and installation of equipment to produce an acceptable and operating test site by qualified contractors.

8.1.2 Technical Discussion

Technical activities of this task have centered on the preliminary design phase of the facilities. This entails gathering data required to perform the final design and preparation of the construction drawings and specifications.

Several site visits established topographical features and contributed to clarifying topographical features. Site reconnaissance will help determine the economical location of equipment test and site operation. During one site visit, design personnel expanded their trip and visited the Laramie Energy Technology Center. A day and a half was spent discussing all aspects of the previous Hanna experiments, the site operations, the instrumentation and its uses, and the problem areas and how they were solved.

Several plot plans have been prepared to give the site operators an idea of the potential facility configuration after construction. A cross sectional view of a dipping coal bed along with proposed support facilities is shown in Figure 8.1. Figure 8.2 shows the test site access road connecting Interstate 80 to the site's southern boundary. Figure 8.3 provides a view of the overall site and grading plan and shows the site interior road network.

The design of an all-weather access road has been completed and the drawing and specifications package readied for procurement action.

A preliminary coordination draft copy of the UCG/SDG Facility Design Criteria Document is currently being reviewed. This document will enable the smooth progression of the detailed facilities design and equipment installation packages to be completed.

8.1.3 Instrumentation

The Instrumentation task includes all the work associated with the definition, design, and generation of procurement packages for the sensors, transducers, and data acquisition system to be used on the field tests. This task directly interfaces to the software development, facilities design, and well design tasks.

Figure 8.1

LOCATION PLAN - NTS
(RANGE 89 W, TOWNSHIP 21 N)

FIGURE 8.2 ACCESS ROAD LOCATION PLAN

SITE AND GRADING PLAN

Figure 8.3

The major accomplishment in this task for the last quarter of 1978 defines the instrumentation package for the field tests (Chapter 16 of the Project Data Book). Work on the procurement packages for all aspects of the test 1 instrumentation system has begun.

8.1.4 Well Design

8.1.4.1 General

Well design activity is a subtask of Facility Design and results in drawings, specifications and drilling and well completion procedures necessary for installing the Process Wells (Product, Injection, and Instrumentation). The documentation generated under this task will feed the necessary procurement packages required to secure the drilling, logging, surveying, cementing and well completion contractors and associated materials (casing, centralizers, etc.).

The Process Wells are an integral subsystem of the Test Modules and provide the requisite access to the reactor cavity to introduce compressed air, to remove surplus water and to extract the product gas generated within the reactor cavity. In addition, the instrumentation wells provide a means for inserting key instrumentation to a point where gasification can be monitored as it progresses.

8.1.4.2 Technical Discussion

As a continuation of the investigation into problems generated by the shrinking characteristics of the heated coal and the severe thermal expansion generated by the high gas temperatures in the product well, a trip to the LETC Hanna Site was made to collect technical information on piping, valves, and well heads.

Discussions with several consultants and members of the project staff resulted in the development of several design concepts. These concepts are shown in the following sketches. Concept A depicts a water-cooled jacket near the surface which might prevent the coal from reaching the shrinking temperature near the surface. Concept B incorporates an air jacket insulator which might accomplish the same function as Concept A without the cost of the cooling water system. Concept C depicts a drilling approach posed by a Gulf consultant which essentially eliminates the potential problems by remaining out of the seam for a considerable depth.

Regarding the thermal expansion problem, Concept D displays an expansion bellows approach, and Concept E shows an extended well head design which allows the casing to elongate within a sealed container.

After analyzing these concepts, and recognizing the very limited life of the wells, i.e., Test No. 1 - 20 days, Test No. 2 and No. 3 - 80 days, it appears that the most cost effective approach would be to drill the product well outside of the footwall of the seam and deflect the well bore into the coal at a point which will accommodate the burn cavity location. This is essentially Concept C. Surface piping design analysis will recognize the possibility of some thermal expansion of the well head and accommodate this with proper pipe selection, expansion joints or expansion loops.

In keeping with the desire to keep process well installation costs within budget and to update well designs, a brief analysis of alternate casing sizes for the injection air wells was conducted.

Originally the wells called for 8" ID casings; however, this size was based on very early design criteria which has subsequently changed.

CONCEPT A
PRODUCT WELL WATER JACKET
THERMAL INSULATOR

CONCEPT B
PRODUCT WELL AIR JACKET
THERMAL INSULATOR

CONCEPT C
PRODUCT WELL OUTSIDE
OF THE COAL SEAM

CONCEPT D

CONCEPT D
PRODUCT GAS WELL
EXPANSION WELL HEAD

SCALE - 1" = 6"

47.

This analysis used a combination of empirical formulas and nomographs based upon Darcey's equation which accommodates turbulent flow, which will be the case in this project.

Several assumptions necessary for the analysis include using clean steel schedule 40 pipe, 125 psia air at the intake end of the well casing, maximum casing length of 815', and a flow rate, Q, of 6 million SCF per day (24 hours).

Because the temperature of the intake air indirectly enters the calculations (viscosity, density), pressure drops under 60°F (standard conditions), 100°F and 200°F (reported in Hanna IV report) were used.

The results of the pressure drop determinations, which are considered the critical casing size criteria, are displayed in Table 8.1.

Shifting from the 8" ID casing size and assuming the total pressure drops are not unacceptable, the following estimated savings in basic casing costs could be realized for 5,183 feet of injection wells:

8" to 6" (Total ΔP @ 200°F of 2 lbs) - \$14,850

8" to 5" (Total ΔP @ 200°F of 7 lbs) - \$20,526

8" to 4" (Total ΔP @ 200°F of 21 lbs) - \$24,568

During the latter part of August a special meeting was convened for the purpose of developing a UCG/SDB Master Drilling and Well Completion Plan which would integrate all of the Project Well requirements and plans. One section of this plan was devoted to process wells (Product, Injection, and Instrumentation), and selected portions are noted in the following:

TABLE 8.1

PRESSURE DROP - P (PSIA) FOR SEVERAL PIPE DIAMETERS

ASSUMPTIONS: Dry Air, Turbulent Flow, 125 PSIA at intake, Sg = 1.0, Schedule 40 Clean Steel Pipe,
Casing Length - 815 Ft.

NOMINAL PIPE ID	4 IN.			5 IN.			6 IN.			8 IN.			10 IN.		
Inlet Temp. °F	60°	100°	200°	60°	100°	200°	60°	100°	200°	60°	100°	200°	60°	100°	200°
Q (Ft ³ /Hr)	250,000			250,000			250,000			250,000			250,000		
f (Friction Factor)	.0162			.0160			.0145			.0144			.0140		
(Density-Lbs/Ft)	.726	.674	.572	.726	.674	.572	.726	.674	.572	.726	.674	.572	.726	.674	.572
(Viscosity)	.018	.019	.021	.018	.019	.021	.018	.019	.021	.018	.019	.021	.018	.019	.021
Re (Reynolds No.)	1,400,000			1,300,000			1,200,000			600,000			450,000		
W (Lbs/Hr)	19,100			19,100			19,100			19,100			19,000		
P (Pressure Drop - psia)/100 Ft	2.10	2.25	2.55	.67	.72	.81	.24	.26	.29	.063	.066	.075	.020	.021	.024

Darcy Formula - Pressure Drop P

$$P = 0.00000336$$

f = Friction Factor

L = Length of Casing

W = Flow (Lbs/Hr)

v = (Specific Volume)

d = Diameter of Casing

8.1.4.3 Well Functional Requirements

Production and Injection Wells

In general terms, the functional requirements of these wells are listed below:

<u>Injection Well</u>	<u>Production Well</u>
(a) Deliver desired air flows to bottom of reactor	(a) Remove product gas from reaction zones
(b) Deliver water with the injection air	(b) Accommodate the high temperatures of the reactor burn front at its base
(c) Allow ignition of coal at its base	(c) Serve as an injection well during linking or in case of unforeseeable operating modes
(d) Serve as a production well during linking operation or in case of unforeseeable operating modes.	(d) Accommodate the thermal regime to be experienced within the well casing and well head
(e) Resist the adverse effects of roof fall	(e) Provide a well bore from which coal seam corings can be extracted
(f) Provide a well bore from which coal seam corings can be extracted	

Specific design parameters which further constrain the well designs are included in Table 8.2.

Instrumentation Wells

The instrumentation well functions are primarily to accommodate the instrumentation packages and to insure that hydraulic isolation is maintained between all penetrated formations. The location of each instrument package within these wells must also be positioned such that the required tolerances are maintained.

TABLE 8.2

PROCESS WELL DESIGN PARAMETERS

DESIGN PARAMETER ⁽¹⁾	TEST 1		TEST 2		TEST 3	
	LINKING	GASIFYING	LINKING	GASIFYING	LINKING	GASIFYING
INJECTION AIR WELL:						
● Air Pressure (Well Head) (psig)	5-350	0-125	5-350	0-125	5-350	0-125
● Air Flow Rate (SCFM)	20-174	500-2800	20-174	500-4200	20-174	500-6250
● Air Temperature (Well Head) °F	0-300	0-300	0-300	0-300	0-300	0-300
● Water Intake Flow Rate (GPM)	----	0-4	----	0-6	----	0-9
● Water Extraction Rate (GPM)	----	(TBD)	----	(TBD)	----	(TBD)
PRODUCTION WELL:						
● Gas Pressure (Well Head) (psig)	0-100	0-100	0-100	0-100	0-100	0-100
● Gas Flow Rate (SCFM)	0-300	1000-5600	0-300	800-8400	0-300	800-12500
● Gas Temperature (Well Head) °F ⁽²⁾	0-500	-50 to +950	0-500	-50 to +950	0-500	-50 to +950
● Water Intake Flow Rate (GPM)	----	----	----	----	----	----
● Water Extraction Rate (GPM)	----	(TBD)	----	(TBD)	----	(TBD)

⁽¹⁾Reference - GR&DC Test Documents, dated 18 August 78, 25 August 78

⁽²⁾The product well head may see temperatures in the vicinity of 1500°F for a 1-2 day period of time after shutdown.

8.1.4.4 Well Design Engineering Sketches

Translation of the well functional requirements into engineering sketches resulted in a series of drawings, samples of which are included in this report. Figure 8.4 shows a cross section view of the well module configurations for Test No. 1 including coring zones and the adopted Concept C drilling technique for avoiding well bore leaks due to the shrinking nature of the coal. Figure 8.5 provides essentially the same information for well modules 2 (Test No. 2) and 3 (Test No. 3). The major distinction between module 2 and 3 is the second injection air well to be incorporated in module 2. Drawing Figure 8.6 provides information on the casing and cementing method to be used and Figure 8.7 depict well head hardware and a charcoal injector. Figure 8.8 shows the use of a 600 pound ASA raised face well neck flange which will be the basic casing head.

During the next quarter, well designs will be finalized, specifications for a well materials will be developed, and a cost estimate will be prepared for incorporation into the various well installation procurements packages.

Figure 8.4

Figure 8.6

Figure 8.7

Figure 8.8

9.0 SAFETY

9.1 General

The major objectives of this task are to:

- Develop a test site safety plan/manual
- Review facility and test designs for compliance with appropriate safety regulations and requirements
- Identify test site safety equipment requirements and prepare procurement packages
- Develop a safety training plan and schedule
- Prepare appropriate test site safety procedures.

Project Safety planning, documentation equipment and monitoring activities impinge on all facets of the project including design, construction, procurement and test operations.

Because the UCG/SDB process system design is in preliminary stages and because certain site activity must occur simultaneously, the first safety effort has been devoted to a site safety manual and providing personnel safety equipment. Future safety efforts will include reviews of designs and test operation plans.

9.2 Technical Discussion

During this quarter an updated, revised and expanded version (Issue B) of the UCG Project Safety Manual was completed and circulated to project personnel for review, critique and coordination.

Due to the early release of the interim manual (Issue A) extensive modifications and clarifications were needed. In addition, the outline of the safety manual was revised to eliminate some redundancy and present the material in a more logical sequence.

An outline of the revised UCG Project Safety Manual is included for informational purposes in Table 9.1. An asterisk indicates those sections which are yet to be fully developed and require additional identification prior to incorporation into Issue C.

Review and evaluation of documents related to safety practices and regulations have continued throughout this Quarter. The GR&DC Accident Prevention Manual, the TRW Health and Safety Manual and the Wyoming Occupational Health and Safety (WOHS) General Rules and Regulations were utilized as prime references and resources for this manual revision. Further review and evaluation is continuing to identify data appropriate to the UCG project.

As an adjunct to the safety manual, UCG Project Safety Briefing/ Lecture booklet was prepared during this reporting period. This booklet will be used as a handout at indoctrination lectures for test site project personnel. An outline of the Lecture Booklet is included for informational purposes in Table 9.2.

TABLE 9.1

UCG PROJECT SAFETY MANUAL OUTLINE

1.0 INTRODUCTION

- 1.1 Purpose
- 1.2 Scope
- 1.3 Objectives
- 1.4 Applicability

2.0 SAFETY CODES

- 2.1 General
- 2.2 Federal
- 2.3 State
- 2.4 Corporate

3.0 SAFETY MANAGEMENT, RESPONSIBILITY & AUTHORITY

- 3.1 Management
- 3.2 Responsibilities
- *3.3 Authority

4.0 TEST SITE SAFETY REQUIREMENTS

- 4.1 General
- 4.2 Hazards Identification & Analysis
- 4.3 Adverse Weather Conditions
- 4.4 Personnel Safety & Safety Equipment
- 4.5 Facility Safety & Safety Equipment
- 4.6 Motor Vehicles & Powered Equipment
- 4.7 Fire Prevention and Protection
- 4.8 Materials Handling and Storage
- 4.9 Process Equipment/Test Site Facilities Maintenance, Servicing and Checkout
- 4.10 Occupational/Environmental Health & Services
- 4.11 Emergency Evaluation
- 4.12 Review of Designs and Procedures

TABLE 9.1

UCG PROJECT SAFETY MANUAL OUTLINE
(Continued)

5.0 SAFETY TRAINING

- 5.1 General
- 5.2 Training Courses
- 5.3 Certification of Personnel
- 5.4 Emergency Assistance
- 5.5 Safety Consultants

6.0 INVESTIGATION & ANALYSIS OF INCIDENTS/ACCIDENTS

- 6.1 Types of Accidents & Mishaps
- *6.2 Responsibility & Authority for Investigation
- *6.3 Investigation & Analysis of Incidents/Accidents
- *6.4 Review Board
- *6.5 Investigation Follow-up

7.0 DOCUMENTATION

- *7.1 Requirements
- 7.2 Types
- 7.3 Publication and Distribution

A. APPENDIX

- A.1 Definitions of Terms
- A.2 References

B. BULLETINS/DATA SHEETS

TABLE 9.2

UCG PROJECT SAFETY LECTURE OUTLINE

I	PROJECT DESCRIPTION
II	SCOPE
III	SITE SAFETY HAZARDS
IV	PERSONAL SAFETY EQUIPMENT
V	FACILITY SAFETY EQUIPMENT
VI	WEATHER
VII	VEHICLE SAFETY
VIII	SPECIFIC SAFETY RULES
IX	SAFETY MANAGEMENT RESPONSIBILITIES
X	ACCIDENT REPORTING & INVESTIGATION
XI	EMERGENCY FIRST AID & MEDICAL CARE
XII	SAFETY TRAINING

10.0 TECHNOLOGY TRANSFER

Personnel from Gulf and TRW attended the Fourth Annual Underground Coal Conversion Symposium in Steamboat Springs, Colorado sponsored by the DOE in July. The symposium serves as a forum for the exchange and review of the most recent developments in underground coal gasification technology. Progress and problems encountered in the MERC research program, the LLL project, and the LETC experiments were discussed, along with reports on the joint Gulf/TRW UCG program.

Early in August, Gulf and TRW met with several consultants and members of the project staff of the LETC in Hanna, Wyoming. The main purpose of this visit was to discuss problems generated by the shrinking characteristics of heated coal. Development of several well-head design concepts resulted from this conference and are included in Section 8.0; Engineering Design.

The third meeting of the Technical Advisory Committee also took place in August. Economic and scheduling problems associated with accelerating Test No. 1 were reviewed, documentation planning for the project and target completion dates were laid out, and possible UCG test site proposals were discussed.

11.0 MISCELLANEOUS

11.1 Site Support Planning

11.1.1 General

Site Support Planning includes those efforts required to plan, coordinate and integrate site support activities throughout the test program. It also includes the development and maintenance of appropriate documentation for implementing these efforts. Site Support Planning activity will peak during Phase II due to extensive site preparations and will continue through Phase III, as necessary revisions to the construction and operating plans become apparent. Sub-elements of this task are: Scheduling, Site Acceptance and Transfer and Operation Planning. Each sub-task is periodic in nature and will involve frequent updating of associated documentation.

Prior to this reporting period, emphasis has been given to the Scheduling Sub-task. An Activity network was prepared and iterated several times to surface sub-task interfaces. The network was then utilized as an interim project schedule until a milestone schedule could be prepared.

11.1.2 Technical Discussion

Site Support Planning this quarter has involved scheduling and Operations Planning sub-tasks. Initial efforts were directed at iterating the Project Activity Network with emphasis on Phase II activities. The refined network was subsequently used, to determine the feasibility of accelerating Test No. 1 to October 1, 1979. The results of this study indicated that schedule acceleration was feasible but with attendant high risks.

The mid quarter go-ahead decision for accelerating the test schedule required the preparation of a total project activity network to reflect the impact of this decision. Utilizing the revised network, a preliminary project schedule and deliverable/document schedule were prepared for review. Each of these documents reflects the effort required to achieve the accelerated test schedule.

Due to the accelerated test schedule, preparation of the Site Operations Plan was initiated this quarter. Table 11.1 is a tentative outline that will be utilized to structure the plan.

11.2 Software Development

11.2.1 General

The Software Development task includes all work associated with the definition, development, and documentation of the software for use in the on-site computer. This software supports the data acquisition and process control functions required during the tests. It also provides some real time data analysis to support the Data Analysis task.

11.2.2 Technical Discussion

Software packages from LETC and LLL used in the on-site computers for their UCG programs have been obtained. An engineering evaluation of selected subroutines of the LLL subroutine has been initiated. This will be completed in the next quarter.

TABLE 11.1

SITE OPERATIONS PLAN
UNDERGROUND GASIFICATION FOR STEEPLY DIPPING COAL BEDS

I. INTRODUCTION**A. Purpose and Scope**

States purpose of this document and states effectiveness, i.e., starts at first test and extends through site restoration and turnover of the Rawlins site.

B. Project Description

- Provides overview on SDB project
- Project objectives
- Locates Rawlins site
- Describes contractor/operations team
- Overall project schedule

II. APPLICABLE DOCUMENTS

- A. Lists Federal documents and regulations
- B. Lists State documents and regulations
- C. Lists Project documents
- D. Lists industrial codes and regulations

III. SITE OPERATIONS**A. General****1. Site Layout**

- Describes site layout at Rawlins
- Includes sketch from Phase I Report

TABLE 11.1
(Continued)

2. Facilities

Details description and intended use of this support facilities at the site.

- Shops and Labs
- Office
- Tool Room

3. Operational Systems

- Describes process systems with sketch
 - Instrumentation
 - Data Acquisition and Analysis
 - Utility
 - Process
 - Injection
 - Production
 - Water
 - Fuel Oil
- Established operational constraints and restraints.
- Specifies maintenance philosophy

4. Test Descriptions

- Describes each test burn
- Duration of test
- Configuration of systems

TABLE 11.1
(Continued)

B. Management Roles and Responsibilities

1. Organizational Assignments

- o Defines management assignments for project during operational periods.
- o Presents organizational diagrams

2. Project Schedule

Provides detailed project schedule for site operation phase.

3. Progress Reviews/Status Reporting

Establishes briefing/status meeting methodology for progress reporting on a scheduled basis.

4. Performance Assurance

Establishes what the quality control functions on the site operations and systems are and how they will be performed.

5. Special Boards and Committees

Establish the methodology for convening special boards/committees for specific needs as they arise.

6. Data Management

Defines the accountability and distribution of data generated via project site operations.

7. Public Affairs

Establishes the interface with the public for meeting public requests for representatives/interviews, etc.

8. Administrative Services

Describes what services are available and how each is provided/obtained at the test site.

a. Medical

b. Visitor Access Control

TABLE 11.1
(Continued)

- c. Technical Library
 - d. Mail
 - e. Communication
 - Telephone
 - FAX
 - Teletype
- C. Operations and Maintenance
- Establishes overall site operations and maintenance approach and procedures and how implemented.
 - Defines spares/repairs flow
 - Normal operations
 - Adverse weather operations
 - Turnover to test operations
1. Site Acceptance
 2. Facilities and Process Systems Operations
 - a. Approach
 - b. Non-Test Burn Phases
 - c. Test Burn Phases
 - d. Adverse Weather Operations
 - e. Emergency/Contingency Operations
 - f. Operations Logs and Data
 3. Maintenance Operations
 - a. Approach
 - b. Calibrations and Standards
 - c. Bench Test Equipment
 - d. Repairs, Refurbishment and Retest

TABLE 11.1
(Continued)

e. Maintenance Data

f. Spares Lists

4. Test Readiness Review

5. Site Turnover

6. Post Test Review

D. Site Engineering

1. Technical Services

Details technical services provided at the site and who operates them.

- Photography
- Calibrations
- Recording
- Computation
- Displays
- PA

2. Field Engineering

Establishes field engineering for modification designs and data analysis relative to:

- Facilities
- Process Systems
- Equipment

3. Environmental Monitoring

Describes what parameters will be monitored, how they are monitored, and the schedule for these activities.

4. Site Restoration and Turnover

Describes what will be the basis for site restoration, how it will be done, and preparation necessary for return of site to owner.

TABLE 11.1
(Continued)

E. Logistics Support

3.5.1 Utilities

Defines what the utility interfaces with the site are and how they will be operated and controlled.

3.5.2 Site Security

Establishes what security is provided and maintained on site.

3.5.3 Transportation

Defines transportation provided at site for personnel and equipment.

3.5.4 Personnel Training

Establishes procedure and scope of training of technical support and operations personnel.

3.5.5 GFE Control and Accountability

Establishes procedures and methodology for control for any government furnished equipment on site.

3.5.6 Material

Defines the provisioning methodology for materials used at the site.

3.6 Safety

3.6.1 Responsibility

Defines organizational responsibilities for safety at the site.

3.6.2 Standards and Guidelines

Delineates applicable standards and establishes overall guidelines for safety.

TABLE 11.1
(Continued)

3.6.3 Implementation

Describes how safety requirements will be implemented.

3.8 Installation and Checkout

Details the installation and checkout of on-going site installations, subsequent modifications, and site demobilization and restoration.

- Facilities
- Process System
- Equipment