MASTER

FINAL TECHNICAL REPORT

CONCEPTUAL DESIGN OF A HOT DIRTY GAS
CONTROL VALVE TEST FACILITY

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Morgantown, West Virginia.

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BY *R.E. Guha* DATE *4-29-82*

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INTRODUCTION

The Engineering Technology Engineering Center (ETEC) has completed a three-month conceptual design to identify a cost-effective method of providing a test facility capable of imposing coal gasification process conditions on test valves. The design was conducted for the Morgantown Energy Technology Center (METC). With METC's approval, both open and closed loop test facilities were considered. The conceptual design was based on the parameters given in References 1 and 2.

The study involved, but was not limited to the following:

1. Type of carrier gas to use in the loop (inert gas, combustion products, etc.).
2. Method of heating the gas (direct- or indirect-fired heater, etc.).
3. Need for an economizer.
4. Means of contaminant injection, particle size control and contaminant removal. Consider both chemical and abrasive contaminants.
5. Practical limits of temperature/pressure for likely materials of construction.
6. Piping and equipment materials.
7. Flow Diagram and heat balance.
8. Major process equipment and components and required lead time for delivery.
9. Design and analyses to adapt dirty gas loop to existing facilities and define requirement.
10. Estimated cost and schedule for analysis, design, construction, and operation.
11. Conceptual design report, documenting the analysis and design efforts.

SUMMARY

The Energy Technology Engineering Center has conducted a study of hot dirty gas test facilities for the METC using requirements specified by METC for the testing of valve types destined for coal conversion plants. A variety of open- and closed-loop facility concepts, operating at both high (50 psig) and low (atmospheric) pressure, were investigated.

A high-pressure, open-loop system was chosen as being the most reliable of the choices studied and most nearly meeting the test requirements. A schematic is shown in Figure 1. All equipment required for this loop is either of the off-the-shelf variety or a modification thereof, or is of contemporary state-of-the-art and characterized by ETEC experience with similar hardware. Combustor and sulfur dioxide removal systems are modifications of existing designs.

The system operates at nominal parameters of 1650°F and 50 psig at the test section, and is fueled by natural gas. Inconel 100 is the primary material of construction for the hot portion of the loop. The majority of the auxiliary piping systems are carbon steel. A compressor provides 60 psig air to the high pressure burner. Sulfur in either solid or liquid form is injected upstream of the test valve to produce hydrogen sulfide. Downstream of the test valve, the hydrogen sulfide is oxidized to sulfur dioxide using a bypass air stream from the compressor. The sulfur dioxide is removed by a modified conventional scrubber system.

Open loops are characterized by a low-capital/high-operating cost while the converse is true for the closed loop. The design confidence and operational reliability of a closed loop is judged much lower than for an open loop because of the complexity introduced by an indirect-fired heater and by a heat exchanger required to cool the process gas prior to compressor entry.

FIGURE 1.

The selected loop was designed to be erected out-of-doors, immediately adjacent to the ETEC's existing Transient Test Facility (TTF), which would provide the necessary utilities, manpower, and control room. Based upon this approach, the design and construction cost for the selected facility is \$3.5 million. The operating costs for two 2000-hour test programs ranges from \$3 million to \$4.5 million. The lower number assumes concurrent testing at TTF and the higher number assumes operation of the hot dirty gas loop only. The construction costs are based on rates predicted for the midpoint of construction (assumed December, 1981), and oversized exhaust clean-up equipment. Operating costs are based on the midpoints of each test program.

A schedule for the design, fabrication, and test is given in Figure 2. The assumed starting date is June 2, 1980.

HOT DIRTY GAS TEST FACILITY
HIGH PRESSURE - OPEN LOOP

FIGURE 2

DESIGN REQUIREMENTS

The design parameters for the process gas at the test article are taken from References 1 and 2:

Temperature	1650 $\pm$ 100°F
Pressure	50 - 500 psig
Velocity	156 ft/sec
Flow turndown ratio	2:1
Particulates	0.6 weight percent flyash
Particulate distribution:	
Greater than 60 micron	0 weight percent
10 to 60 micron	11 weight percent
5 to 10 micron	40 weight percent
1 to 5 micron	39 weight percent
0.1 to 1 micron	9 weight percent
Less than 0.1 micron	1 weight percent
Process gas composition:	
N ₂	Less than 0.1 volume percent
H ₂ S	1.1 volume percent
H ₂	44 volume percent
H ₂ O	15.9 volume percent
CO	25.3 volume percent
CO ₂	12.7 volume percent
CH ₄	0.9 volume percent
Process gas molecular weight	16.9

CONCEPTS EVALUATED

The following test facility loops were evaluated during the course of the conceptual study:

1. High Pressure Closed Loop (50 psig)
2. Low Pressure Closed Loop (atmospheric)
3. Low Pressure Open Loop
4. High Pressure Open Loop

There are two basic approaches to the design of this test facility, open loop and closed loop. Each has advantages and disadvantages. The significant difference is in the heat addition process. For the closed loop an indirect-fired heater is required, while for the open loop a fuel-rich mixture of natural gas and air is burned directly to create an analog of the desired atmosphere.

For either open or closed loop operation the choice of operating pressure is a major consideration. Obviously operation at atmospheric pressure will be less expensive both in capital cost and operating expense. Pressure containment complexity can be reduced and compressors can be replaced with blowers. However, because of the present lack of knowledge as to what the principal causes of coal gasification component failures are, the test facility should be designed to provide at least the low end of the operating pressure range. It is possible that a test facility could be designed for high pressure operation with the option that it could be operated at low pressure most of the time. A consequent savings in power, fuel and (particularly in the case of the open loop) exhaust gas purification consumables would result.

A major consideration in the design of any of these test loops is the creation and maintenance of the high-dew-point reducing atmosphere. The test atmosphere includes 15.9% H₂O by volume which requires a minimum operating temperature above 160°F to stay above the dew point. Further, the atmosphere is reducing and corrosive. It contains hydrogen, carbon monoxide and hydrogen sulfide in addition to water vapor and carbon dioxide. This mix of compounds requires that the components be designed to operate at high temperatures in both reducing and neutral atmospheres.

Particulate matter injection and process gas composition control is another problem. Injection at high pressure in a dry form requires the use of a pressurized hopper. Removal requires the use of bag houses or filters having upper temperature limits of about 600°F. Control of particulate size requires continuous removal of degraded particles and injection of fresh ones.

The use of an economizer (heat exchanger) was investigated for both the high pressure and low pressure closed loops and found to be impractical for several reasons. Off-the-shelf economizers are not available for operation at 50 psig. The typical approach temperature for a cross-flow economizer is about 300°F. Thus, the 1650°F process gas cannot be cooled sufficiently before entering either the compressor (high pressure loop) or the blower (low pressure loop).

Outlined below are brief discussions of the various concepts considered.

1. High Pressure Closed Loop

The High Pressure Closed Loop concept, required by the test request, was investigated first. The concept is shown schematically in Figure 3. The following disadvantages became apparent:

FIGURE 3

The design reliability of an indirect-fired heater is estimated to be low. The use of an indirect-fired heater is mandatory. If a direct-fired heater is used, then process gas must be withdrawn from the system at the same rate it is put in. Design of an indirect-fired heater to heat the reducing process gas to 1650°F using an oxidizing radiant firebox was deemed impractical by several heater manufacturers contacted.

The startup of a closed loop is difficult. The loop would have to be precharged with individual gases to makeup the required gas composition. The cooler would require a sophisticated control system so as not to overcool the process gas during its heatup to 1650°F.

The cooler, required to cool the process gas from 1650°F to a temperature suitable for the particle removal system and the compressor, also has low reliability due to the erosive nature of the flyash. Also, the available high temperature alloys all contain a high percentage of nickel which is incompatible with hydrogen sulfide.

The compressor will have to handle flyash fines carryover from the particulate matter separator which reduces compressor life. A spare compressor in parallel is required.

A practical way was not found to remove degraded flyash and introduce fresh flyash so that the required particle distribution can be maintained in the loop during the duration of the test program.

2. Low Pressure Closed Loop

The Low Pressure Closed Loop was the next concept to be evaluated. A high temperature blower (850°F maximum), found in the literature, is substituted for the compressor. The balance of the loop is the same as that given in Figure 4. The same disadvantages given under the High Pressure

1. LOW PRESSURE (10 INCHES H₂O) PARTIAL OPEN
- DIRECT FIRED HEATER HIGH TEMP. FAN
- SCREW FEEDER PLENUM SETTLING CHAMBER
- VENT GAS SCRUBBER VALVE SEAL VACUUM

FIGURE 4

Closed Loop apply to the low pressure loop. An additional disadvantage is that an indirect-fired heater cannot be made to work with only a few inches of water pressure loss through the heater tubes. The low pressure loss implies low velocity through the heater tubes which results in high tube wall temperatures and stresses. The balance of the components present less problems than those listed above for the high pressure closed loop. The advantage of a low pressure closed loop is its ability to operate at a higher blower inlet temperature which requires less system heating and cooling, but this is offset by the lower head rise capability of the blower. There appears to be an insufficient margin between blower lift and system pressure drop. However, low pressure operation would certainly be less expensive than high pressure operation.

3. Low Pressure Open Loop

The problems discussed under 1. and 2. above indicate that a closed loop cannot be made to work with any degree of reliability. The study was then focused on open loop variants. As the cost of a low pressure system was estimated to be lower than a high pressure loop, a low pressure open loop was investigated next, although it does not meet the pressure requirements of the test request. The low pressure open loop is essentially identical to the recommended high pressure open loop except that a blower is substituted for the compressor. A schematic of a low pressure open loop approach is shown in Figure 5.

This concept eliminates all of the disadvantages discussed under closed loops and is estimated to be the lowest cost system.

- a. A direct-fired heater is used in place of an indirect-fired heater.
- b. Loop startup is straightforward.

FIGURE 5

- c. A cooler is still necessary; but it can now be located upstream of the flyash injection point.
- d. The blower is upstream of the flyash injection point and operates at ambient temperature rather than at 850°F.
- e. Fresh flyash with the required particle distribution is continually added.

The only disadvantage to this concept is that it does not meet the test request requirement of 50 psig at the test valve. A vacuum can be applied to the exterior of the valve to produce a delta-pressure across the valve approaching 14 psi.

4. High Pressure Open Loop

A high pressure open loop approach (Figure 6) was investigated to evolve a system that would meet the 50 psig requirement of the test request. The low pressure open loop schematic was used as the basis for the high pressure open loop. Essentially all that is required is to substitute a compressor for the blower. The high pressure open loop is the recommended concept and is detailed in the following section.

FIGURE 6

RECOMMENDED DESIGN

Description

The high pressure (50 psi) open loop concept was selected as offering the highest reliability in meeting the required test requirements and objectives. The system is depicted in the P&I Diagram, and plan and elevation drawings enclosed as Appendix 1 and in the schematic of Figure 7. It will be located adjacent to ETEC's Transient Test Facility, which will provide the necessary utilities, manpower, and control room.

The test valve is located in a 12-inch diameter, Inconel 100 pipe. This diameter was selected to accommodate the maximum expected valve size and to reduce the flow velocity in the pipe. To preclude degradation of the Inconel 100 from hydrogen sulfide, the pipe interior is either aluminized or titanized.

This loop was designed assuming an 8-inch valve in the full open position. Using the flow area of this pipe and the process gas requirements of 156 ft/sec, 1650°F, and 50 psig, the volume and weight flows of process gas were determined. An existing computer program was used to predict the combustion product analysis when burning methane and air. A burner mixture ratio was selected that most nearly duplicated the desired process gas composition and 2:1 CO to CO₂ ratio.

The burner will operate at an air-to-fuel ratio of 11.2 which is the lower fuel-rich combustion limit. Sulfur injected into the combustion stream will combine with the free hydrogen to yield hydrogen sulfide and produce the following gas composition:

HOT DIRTY GAS TEST FACILITY HIGH PRESSURE LOOP CONCEPTUAL

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FIGURE 7

<u>Constituents</u>	<u>Volume Percent</u>	
	<u>Proposed</u>	<u>Required</u>
CO	7.58	25.3
CO ₂	4.38	12.7
H ₂	6.34	44.0
H ₂ O	17.10	15.9
N ₂	63.50	0.1
H ₂ S	1.10	1.1
CH ₄	-	0.9
<u>Parameters</u>		
Combustion temperature (°F)	2900	-
Molecular weight	24.7	16.9
Specific heat (Btu/lb-°F)	0.375	-

It can be seen that the proposed process gas composition does not match the composition of the gas suggested by the test request. It is impossible to operate the burner in any manner to produce the suggested gas composition. The large amount of nitrogen can be eliminated by using pure oxygen in the burner rather than air. However, this would be a costly alternative.

A 600 hp, two-stage centrifugal compressor provides 60 psig air to the high pressure burner. The heat of compression is removed by an intercooler and aftercooler to reduce the impact on the burner design and operation. A plenum chamber is provided to damp out pulsations caused by the cycling test valve. The compressor is placed within a small building to provide acoustic isolation and to reduce the driver costs by allowing the use of an open drip proof motor in lieu of an outdoor, totally-enclosed, fan-cooled motor. The burner is a modified off-the-shelf unit with 2:1 turndown capability that comes complete with all piping and a FIA gas-fired control system. The TTF contains a similar burner that operates at 300 psig using liquid fuel and liquid oxygen. An existing 200 psig natural gas main will be modified by the Southern California Gas Company to provide natural gas at the pressure required by the burner plus line losses. A 4-inch underground pipe, 1000 feet long, will transmit the gas from the gas main to the facility site.

The combustion gas is cooled from 2900 to 1650°F by a water-to-combustion gas heat exchanger located downstream of the burner and inside the duct. The ducting to and from the test position is water-cooled, eliminating the need for insulation.

The test valve will be cycled in accordance with the test request by a signal generator that provides a cyclic 4-20 ma signal to a current-to-pressure device, which in turn provides a cyclic 3-15 psig pneumatic signal to the valve operator. A test valve position signal is channeled through a ratio controller that modulates both the air bypass valve and the burner fuel valve.

Pre-sized flyash is dry-fed downstream of the burner and gas cooler, and upstream of the test position. Sulfur is injected at the same location and can be either dry-fed or injected in a liquid state. The sulfur is converted to hydrogen sulfide by reaction with the combustion gas. Downstream of the test position, the hydrogen sulfide is oxidized to sulfur dioxide by reaction with bypass air taken from the compressor plenum tank. The amount of excess air provided is controlled by a signal from the cycling test valve. Water is injected into the duct downstream of the test position to cool the process gas to 160°F thereby reducing the volume of gas to be processed by the scrubbing system. The solids knockout tank is designed to reduce the velocity of the process gas so that a major portion of the flyash will drop out by gravity.

The process gas then flows to a conventional sulfur dioxide removal system consisting of a cyclone separator to remove any carried-over flyash fines and a spray absorber that precipitates the sulfur dioxide out as sodium sulfate using a limestone slurry reactant. The condensed water and flyash is collected in one of two settling ponds. One pond is in use while the other is being cleaned out. Overflow from the settling pond is pumped to a cooling tower where cooling of the process water from 160 to 80°F is accomplished. The cooled water is then pumped back into the cooling water loop.

The cooling tower tentatively selected is a Baltimore Aircoil model VXT-800. Although this tower appears excessive in capacity, its large size

is dictated by the water inlet temperature of 160°F which is significantly higher than the temperatures normally seen by this type of unit. Because of the dissolved SO_2 in the process water, it may be necessary to use a stainless clad on the tower interior. Based on an average wetbulb temperature of 74°F at the site, the process water can be cooled from 160 to a minimum of 80°F. Approximately 60 gpm of system makeup water is replaced at the cooling tower using water main pressure in lieu of a pump. The water tower pump, a Weinman model 6GB4A30-4 end-suction centrifugal pump driven by a 30 hp motor, provides 825 gpm at 30 psig. The water system feed pump, a Weinman model 4L1-50-4 horizontal split-case single-stage centrifugal pump driven by a 50 hp motor, provides 825 gpm at 75 psig.

The test loop is operated from the existing TTF control room. Data are recorded on the existing Digital Acquisition System.

Technology Assessment

The proposed high pressure open loop is the only one of the various concepts studied that demonstrates design confidence and high reliability, and makes complete use of demonstrated technology. All of the components of the system are available off-the-shelf except the burner and the sulfur dioxide removal system which are modifications of existing designs.

A test facility operating at 500 psig would be essentially identical to the concept presented for the 50 psig facility with the substitution of higher pressure-rated components. A direct-fired burner, capable of operation at 500 psig, would be a custom design and would have to operate with a liquid fuel. The design of the heat exchanger, used to cool the combustion gas, would be impacted as would the piping.

Component and System Alternatives

The flyash feed system is shown as a mechanical type of feeder utilizing a screw principle. In view of the system pressure of 50 psig, it will probably be necessary to employ a pneumatic feed system utilizing a pressurized lock-hopper. The same philosophy would apply to the sulfur feed system if powdered sulfur is utilized.

It may be more advantageous to inject sulfur as a liquid. A small amount of combustion gas can be utilized as the heat source to liquify the sulfur (246°F), which would then be pumped into the process gas downstream of the burner.

The sulfur dioxide removal system as presented uses limestone as the reactant. Depending on the vendor selected for the system, other reactants such as caustic or amine may be chosen. This would change the handling and mixing operations somewhat.

System Uncertainties

Several system uncertainties evolved during the course of this study:

1. Flyash Handling and Sizing

A positive source of flyash has not been identified. It is not known whether pre-crushed, pre-sized flyash is available to ETEC. If ETEC is to crush and classify the flyash, the following uncertainties arise:

- a. Need to dry flyash before crushing.
- b. Crushing and classifying will have to be a batch operation. The large amount of ash to be processed into five distinct size ranges will be a time-consuming effort as would the subsequent storage, handling, and blending of the five size ranges.
- c. Can particle size distribution be maintained up to the point of injection into the process gas upstream of the test valve?

2. Sulfur Handling

Because of the caking characteristics of elemental sulfur, special handling requirements may exist that have not been addressed in this study.

3. Burner Capabilities

Lacking a detailed burner design, it is uncertain how the burner will respond to the cycling of the test valve. The burner will have a minimum 2:1 turndown ratio; but its response time is unknown. If the burner does not respond quickly enough, an additional complexity will be imposed upon the heat exchanger system to produce a constant 1650°F process gas temperature.

4. Chemical Reactions

The chemical reaction kinetics and residence times will have to be verified for the proposed conversion of elemental sulfur (dry or liquid) to hydrogen sulfide and the subsequent oxidation of the hydrogen sulfide to sulfur dioxide. Potential burner design limitations may affect the former chemical reaction.

5. Burner Aftercooler

Originally, the combustion gas was to be cooled from the 2900°F combustion temperature to 1650°F by means of a water injection system. Because of a possible water-refractory lining incompatibility and the unknown effects of water vapor on the test valve, it was decided to replace the water injection system with a water-to-combustion gas heat exchanger installed in the main pipe run. The simplest system results when the combustion gas is placed on the tube side. However, preliminary calculations indicate that it may be necessary to flow the combustion gas through the shell side in order to balance the film coefficients and reduce the stresses in the tube wall. This would significantly impact the design. Another potential problem area is providing adequate cooling to the tube sheet facing the burner discharge.

The use of methane as a coolant was investigated and discarded because of the additional cost and complexity introduced as the methane would also have to be completely burned during the oxidation of hydrogen sulfide to sulfur dioxide.

6. Construction Materials

Several pipe materials were considered for the test loop; refractory-lined carbon steel, 316 and 310 stainless steel, and Inconel 100. The latter material has the highest reliability. To ensure the highest abrasion

resistance and chemical passivity to hydrogen sulfide, the Inconel 100 will be aluminized or titanized. These coatings are also required for the 316 and 310 stainless steels. Additional analysis is required to ascertain whether the cheaper 300 series stainless steels can be utilized.

COST EVALUATIONS

The cost package, given in Appendix 2, was prepared in accordance with DOE Guideline 1301. The costs were derived from Engineering Department manpower requirements, Engineering-supplied material takeoffs, and the conceptual plan and elevation drawings.

The total cost (capital and operating) for the proposed facility ranges between \$6.57 million and \$7.89 million.

The total capital cost of the facility is estimated at \$3.5 million at the midpoint of construction (December 1981). The operating costs have been assessed in two ways. Assuming that the facility is built adjacent to ETEC's Transient Test Facility (TTF) and is operated concurrently with two other TTF test programs results in an operating cost of \$1.47 million for the first 2000 hour test program and \$1.6 million for the second 2000 hour test program. If the hot dirty gas loop is the only test program operating in the TTF, the operating costs are \$2.12 million and \$2.27 million for the first and second 2000 hour test programs, respectively. There are no plans for recovering either the flyash or the sulfur.

A majority of the equipment costs were obtained directly from outside vendors. The balance of the equipment costs are Engineering estimates. Because of an incomplete definition of the scrubbing system, the Engineering estimated cost for the peripheral tanks and equipment required to produce and transport the SO_2 reactant was arbitrarily doubled from \$50,000 to \$100,000.

Certain potential cost reductions may be achieved:

1. It is anticipated the cost of the scrubbing system peripheral equipment noted above will be closer to \$50,000 than \$100,000.

2. The cooling tower cost of \$75,000 with a stainless steel liner may be reduced to \$28,000 if a standard galvanized liner can be used. The use of a galvanized liner is limited to water solutions containing a maximum of 1 ppm of sulfur dioxide. An analysis is required to determine exactly how much sulfur dioxide will be dissolved in the process water.
3. Additional analyses and working with scrubber manufacturers may provide an alternative process that will reduce the estimated cost of \$288,000 for the limestone reactant in the SO_2 absorbent system.
4. The operating consumables costs presented in Appendix 2 were based on the quantity of process gas required for a full open valve cycling sinusoidally between the full open position and a partially closed position that reduces the flow to one-half of full flow. A significant reduction in the cost of consumables may be achieved if the valve is cycled nearer to its closed position and if the valve is cycled with a step function rather than sinusoidally. The use of a step function will significantly reduce the percentage of cycle time spent at the full flow region.
5. Additional analysis may demonstrate the reliability of using the less expensive 300 series stainless steels in place of the Incoloy 100 material for the main pipe material.

REFERENCES

1. METC/CR-79/8, "Test Plan for a Control Valve for Hot Dirty Gas Service."
2. METC/CR-79/10, "Facility Requirements for Testing Control Valves for Hot Dirty Gas Service."

APPENDIX 1

1. P&I Diagram
2. Plan and Elevation Drawings
3. Plot Plan

HOT DIRTY GAS TEST FACILITY HIGH PRESSURE LOOP CONCEPTUAL

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REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED

NOTES: UNLESS OTHERWISE SPECIFIED ON THIS DRAWING

SECTION B - B
SCALE: 3/8" = 1'-0"

SECTION A - A
SCALE: 3/8" = 1'-0"

CONCEPTUAL
REVISED 3-24-90

ENERGY TECHNOLOGY ENGINEERING CENTER

Rockwell International Corporation
Energy Systems Group

DR BY	BOND	2-2-73
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DESIGN		
SIZE	COOP IDENT NO.	DRAWING NO.
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SCALE	3/8"	(SHEET 1 OF 1)

HOT DIRTY GAS TEST FACILITY
HIGH PRESSURE - OPEN LOOP
SECTIONS

NOTES, UNLESS OTHERWISE SPECIFIED ON THIS DRAWING

CONCEPTUAL
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HOT DIRTY GAS TEST FACILITY
HIGH PRESSURE - OPEN LOOP
PLOT PLAN

DR BY <i>HIRD</i> <i>12-22-79</i> CHK BY		Rockwell International Corporation Energy Systems Group	
<i>HOT DIRT GAS TEST FACILITY</i> <i>HIGH PRESSURE - OPEN LOOP</i> <i>PLOT PLAN</i>		SIZE 1000X1000 H/L DRAWING NO.	
HWP DESIGN		E 09974	
SCALE 1"=20'		SHEET 1 OF 1	

APPENDIX 2

1. Cost Package

HOT DIRTY GAS | EST FACILITY - HIGH
PRESS. / OPEN LOAD - DETAILS OF
COST ESTIMATE - 1301 FORMAT

ENGR. DESIGN & INSPECT.

TITLE I
 " II
 " III

370
 500
 100

970

(\$000)

LAND & LAND RIGHTS

DNA

CONSTRUCTION COSTS

1585

IMPROVEMENTS TO LAND

-0-

BUILDINGS

-0-

OTHER STRUCTURES

-0-

SPECIAL FACILITIES

1585

CIVIL / STRUCTURAL

200

ELEC. / INSTR. & CONTROL

250

EQUIPMENT

755

INSULATION

10

PAINTING

5

PIPING

325

VALVES

40

UTILITIES

-0-

STANDARD EQUIPMENT

-0-

REMOVAL COSTS LESS SALVAGE

-0-

CONSTR. MANAGEMENT

120

PURCHASING

30

CONTINGENCY ALLOWANCE

795

(25% x 2705)

TOTAL PROJECT ESTIMATE:

\$ 3,500

(IN ESCAL. DOLLARS)

MANPOWER LOADING RECEIVED BY TELEPHONE FROM W. ROCK ON 1/18/80					
TITLE I	7220 HR	33 ⁷⁷	1/80 MP	243319 x 1.3*	316965
II	9130			308520 x 1.3	400816
III	1365			46096 x 1.7	78363
				1/80 TOTAL	796144
				FTEC, FEE @ 8%	63699
				TOTAL	859843
* SUPPORT TO DESIGN BASED ON HISTORICAL DATA (Q/A, Q/C, TECH. SERVICES, PROG. ADMIN., PROJ. OFFICE, ETC.)					RD \$860,000
ESCALATED COSTS:					
TITLE I :	316,965 x	1.09 (9/80 MP)	x	1.08 (FEE)	373121
II :	400,816 x	1.16 (4/81)	x	"	502142
III :	78,363 x	1.23 (12/81)	x	"	104097
TOTAL					\$970,000
CODE					
DESIGN & SUPPORT

JOB NO. 56A PROJECT HOT DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/7/80 TAKE-OFF DESIGN PRICED DESIGN CALC. CHKD NLK APPROVED _____ SHEET 3 OF _____

[illegible]

STRUCTURAL COSTS

1. DEMOLISH EXISTING BUILDING	4,000
2. AIR COMPRESSOR BUILDING (336 FT ²)	16,800
3. STRUCTURAL STEEL (55,000 LBS)	69,000
4. CONCRETE (116 CY)	33,800
5. GRATING (1082 FT ²)	17,700
6. HANDRAIL (298 LF)	4,500
7. STAIRS (40 LF)	4,400
8. LADDERS (40 FT)	600

INSTALLED COST \$ 150,800

NO OTHER FACTORS INCLUDED.

Rockwell International
Energy Systems Group

JOB NO. 564 PROJECT HOT DIRTY GAS TF - 1D/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/7/80 TAKE-OFF DESIGN PRICED DESIGN CALC. CHKD NLK APPROVED _____ SHEET 5 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ELEC./INSR. & CONTROL ESTIMATED COSTS PER ATTACHED DATA.						68500	2340		
							@ 38.40/hr*		
						68500	90324	158819	
EJEC FEE @ 8%								12706	
								171530	
DEPT. 720-218 SYSTEMS CHECKOUT								33050	
								171530	
								33050	
								171530	
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6

ET&C CONSTRUCTION COSTS

		<u>MATERIAL</u>	<u>MAN-HOURS</u>
3	CONSOLES	4,000	80
-	WIRE & CABLE	12,000	1000
8	MOTOR STARTERS	8,000	240
1	CYCLE GENERATOR & COUNTER	2,000	80
6	CONTROLLERS	8,000	200
12	INDICATORS	8,000	180
20	TRANSDUCERS	20,000	300
6	SIGNAL CONDITIONING	2,500	100
10	HAND CONTROLLERS	4,000	160
		<u>\$ 68,500</u>	<u>2340 HRS @ 40^{\$}/HR</u>

INSTALLED COST \$ 162,100

NO OTHER FACTORS INCLUDED

Rockwell International
Energy Systems Group

NO. 564 PROJECT HOT DIRTY GAS TF - 4P/OL LOCATION EJEC/SS CLIENT DOL
DATE 1/7/80 TAKE-OFF _____ PRICED _____ CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
<u>SYSTEMS WRINGOUT</u>									<u>75,111.57</u>
<u>D770-218</u>	<u>2000</u>	<u>MH</u>		<u>33⁰⁵</u>	<u>MP 1/30</u>		<u>66100</u>		<u>70000</u>
<u>Notes: Split 50/50 BETWEEN</u>				<u>10⁰⁰</u>	<u>MP 4/82</u>		<u>80360</u>		<u>80360</u>
<u>E.I.C. & Piping and FAC. COSTS.</u>									

Energy Systems
JOB NO. 564 PROJECT HOT DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/7/80 TAKE-OFF DESIGN PRICED DESIGN CALC. CHKD NLK APPROVED _____ SHEET 8 OF _____

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
EQUIPMENT ESTIMATED COSTS PER ATTACHED DATA.							545400			
M	ITEM # 1							80		
R	# 2							16	300 (CRANE)	
	# 3							16	300	"
	# 5							48	900	"
	# 6							16	300	"
	# 7							16	300	"
	# 8							16	300	"
	# 9							16	100	"
M	# 10							24		
	# 11							24		
	# 12							24		
	# 13							40	800	"
	# 14							24	300	"
	# 15							24	300	"
	# 16							40	300	"
							545400	424	4200	549600
								@ 45/HR		
								19080		19080
										568680
FTEC FEE @ 8%										45494
TOTAL (1/80 COS) ROUNDED OFF										614174
										615000
										755000
CODE	EQUIPMENT									

EQUIPMENT COSTS

9

ITEM	COST	FAB TIME
1. C-1 COMPRESSOR, HX-1 EXCHANGER, T-1 TANK (WORTHINGTON)	125,000	6 MONTH
2. T-2 ASH-SULFUR TANK, 500 GAL, WITH MIXER	10,000*	2 MONTH
3. T-3 ASH KNOCKOUT TANK - 15,000	ESG	ESG
4. T-4, T-5, T-6 PONDS - IN STRUCTURAL ESTIMATE	—	—
5. T-7, T-8, T-9 TANKS x 2	50,000*	4 MONTH
6. T-10 ABSORBER (PEABODY)	30,000	4 MONTH
7. F-1 FILTER	8,000*	3 MONTH
8. B-1 COMBUSTOR AND ALL CONTROLS (HIRT ENG. CO.)	30,000	4 MONTH
9. DRY FEEDER (MOYNO P/N 2L4-CDB)	1,500	2 MONTH
10. P-1 FEED PUMP (WEINMAN P/N 4L1-50-4)	3,200	2 MONTH
11. P-2 COOLING TOWER FEED PUMP (WEINMAN 6GB4A30-4)	2,700	2 MONTH
12. P-3 SLURRY FEED PUMP	2,500*	2 MONTH
13. CT-1 COOLING TOWER (BALTIMORE AIRCOIL VXT-800)	75,000	4 MONTH
14. TEST VALVE OPERATOR & CONTROLS (FISHER)	5,000	1 MONTH
15. MONORAIL (WRIGHT P/N 2206390)	2,500	1 MONTH
16. HX-2 GAS COOLER	125,000*	6 MONTH

\$ 470,400

15,000

EST. SHIPPING CHARGES

10,000

FOB ETEC

~~\$ 480,400~~

495,400

+

50,000

\$ 545,400

THE ABOVE ARE VENDOR QUOTES
EXCEPT FOR STARRED ITEMS (*)
WHICH ARE ENGINEERING ESTIMATES.

DOES NOT INCLUDE INSTALLATION
OR OTHER FACTORS.

BAC-PRITCHARD, INC.

BALTIMORE AIRCOIL COMPANY, INC.

FREEZING EQUIPMENT SALES, INC.

To: Rockwell International
Energy Systems Group
P. O. Box 1449
Canoga Park, Ca. 91304

Attention: Bill Rock
Bldg. T211

Project: 2 Pipe Loop Test Facility

Date: January 4, 1980

Terms: Net 30 Days

Delivery: 12-16 Weeks

Gentlemen:

The following is our confirmed quotation for the use of a Baltimore Aircoil Cooling Tower on the subject project:

- (1) Baltimore Aircoil Cooling Tower Model VXT 800. The unit shall have a capacity to cool 825 GPM, with 150° water on, 80° water off, at 72° wet bulb.

The unit is furnished with (2) 50 HP, 230/460 volt, 3 phase, 60 cycle ODP fan motor.

The unit is furnished with 304 stainless steel wet deck fill.

The approximate shipping weight of the unit is 15,790 lbs. The unit ships in (3) pieces, with the heaviest section to rig being 8,650 lbs.

Your cost F.O.B. factory Madera, California with full freight allowed to the jobsite, via truck: \$74,310.00

The above pricing does not include motor starters, disconnect switches, structural steel support, vibration isolation, installation, start-up service or any sales taxes.

Very truly yours,

E. D. Drown

EDD/jk

J. E. PHILLIPS CO., INC.

MANUFACTURERS' REPRESENTATIVES

6027 VENICE BOULEVARD

LOS ANGELES, CALIFORNIA 90034

TELEPHONE (213) 931-1429

Rockwell Energy Systems
P. O. Box 1449
Canoga Park, Ca. 91304

January 4, 1980

Attention: Mr. William Rock

Subject: SO₂ Scrubber System

Dear Mr. Rock

Confirming our discussion enclosed is Sketch P-02075 for a Peabody Process Systems Scrubber-Absorber for your valve test system.

The unit as proposed consists of the scrubber with a demister plus a venturi for particulate removal. The unit would be designed for 98% plus efficiency per your specification.

The scrubber is 30" in diameter and seventeen feet high. The venturi is three feet long and mounts in a horizontal position on the scrubber. Pressure drop from inlet to outlet is 50" W. G.. Liquid flow rates are 15 GPM of water for the venturi and 25 GPM of 10% Sodium Hydroxide and water for SO₂ removal.

The unit would be carbon steel construction with a 3/8" thick shell. Shipping weight is 3500 lbs.

A budgetary price for the unit is \$29,850.00 FOB Stamford, Ct.. Freight is estimated to be \$4,000.00 to your facility. The price noted does not include a quencher and we have assumed it will be customer furnished.

I trust the above will be of assistance and will look forward to working with you on this requirement.

Regards

C. E. Andrews

SCALE: 1/2" = 1'-0"

FREDERICK PUMP & ENGINEERING COMPANY

1245 SOUTH BOYLE AVENUE • LOS ANGELES • CALIFORNIA • 90023 •
TELEPHONE 213 269-9466 • 268-9941 • TELEX 67-4881 •

QUOTATION

No. 649

December 12, 1979

ROCKWELL ENERGY SYSTEMS GROUP
PO Box 1449
Canoga Pk, Ca. 91304

Attn: Bill Rock - Bldg. T211

Subj: METC HIGH PRESSURE LOOP

Gentlemen:

Pursuant to our telephone conversation on the above subject job, we are pleased to quote the following equipment:

ITEM 1

Material to be handled

46#/minute water

4#/minute sulphur

1#/minute fly ash (.1-60 microns)

Discharge Pressure

55 psi

pH Range

6-6.5

1 Ea. ROBBINS & MYERS MOYNO Pump Model 2L4-CDB, progressing cavity pump mounted on a fabricated steel base and driven thru a set of V-belts by a 3/4 HP, 1200 rpm, 230/460 volt, 3 phase, open drip proof electric motor. Pump has cast iron construction with tool steel rotor and EPDM stator. Pump to be driven at approximately 350 rpm to give performance as shown on attached curve.

YOUR NET COST.....\$1190.00 Ea.

ALTERNATE:

1 Ea. WARREN RUPP Sandpiper Model SB1½-A, Type S14CI, air operated diaphragm pump with 1½" inlet and discharge connections. Pump metal parts are of cast iron, with wetted diaphragms to be of EPDM elastomers.

YOUR NET COST.....\$820.00 Ea.

Continued...

SUBJECT TO TERMS AND CONDITIONS ON REVERSE SIDE HEREOF

ITEM 2

Material to be handled	Water
Capacity	825 GPM
Discharge	75 psig

- 1 Ea. WEINMAN Model 4L1-50-4, horizontal, split case, cast iron, bronze fitted centrifugal pump, single stage, double suction, bronze enclosed balanced impeller. Bronze case wear rings, 416 stainless steel shaft and mechanical seal. Pump is mounted on a fabricated steel base and driven thru flexible coupling by a 50 HP, 1750 RPM, 230/460 volt, 3 phase, 60 hz TEFC electric motor.

YOUR NET COST.....\$3141.00 Ea.

ITEM 3

Material to be handled	Water
Capacity	825 gpm
Discharge	30 psig

- 1 Ea. WEINMAN Model 6GB4A30-4, bronze fitted, end suction centrifugal pump with mechanical seal of carbon & ceramic with Buna-N elastomers. Pump has cast iron casing, bronze enclosed balanced impeller, bronze shaft sleeve and wear ring. Pump is mounted on a fabricated steel base and driven thru a flexible coupling by a 30 HP, 1750 RPM, 230/460 volt, 3 phase, 60 hz TEFC electric motor.

YOUR NET COST.....\$2668.00 Ea.

ITEM 4

Material to be handled	Water
Capacity	125 gpm
Discharge	50 psig

- 1 Ea. WEINMAN Model 1½KH7½-4, bronze fitted, horizontal, end suction centrifugal Unipump with 2"x1½" 125# ASA flanged suction and discharge connections, bronze enclosed balanced impeller, replaceable bronze suction cover wear ring, leak proof mechanical seal with Buna elastomers and renewable bronze motor shaft sleeve. Pump shall be close coupled and driven by a 7½ HP, 1750 rpm, 3phase, 60 hz, 230/460 volt electric motor in TEFC enclosure.

YOUR NET COST.....\$946.00 Ea.

Continued...

ROCKWELL ENERGY SYSTEMS GROUP
Attn: Bill Rock - Bldg T211

Quote No. 649
December 12, 1979
Page 3

15

ITEM 5

Material to be handled
Capacity
Discharge

Water
125 gpm
30 psi

1 Ea. WEINMAN Model 2K5-4, bronze fitted, horizontal, end suction centrifugal Unipump with 2½"x2" 125# ASA flanged suction and discharge connections, bronze enclosed balanced impeller, replaceable bronze suction cover wear ring, leak proof mechanical seal with Buna elastomers and renewable bronze motor shaft sleeve. Pump shall be close coupled and driven by a 5 HP, 1720 rpm, 3 phase, 60 hz, 230/460 volt electric motor in TEFC enclosure.

YOUR NET COST.....\$630.00 Ea.

Delivery: Approx. 6-8 wks from receipt of order & production release

F.O.B. Manufacturers facility with full freight allowed & prepaid to jobsite

Terms: Net full 30 days
Plus applicable taxes
Prices are firm for 30 days from date of this quotation

We hope this information is helpful. Should you have any further questions or require additional data, please feel free to contact us.

Sincerely,
FREDERICK PUMP & ENGINEERING CO.

FRANK S. RICH

FSR:ca

Performance Data

September 1, 1979

Moyno Models: 2L4, 2J4, 2JS4

Curve 26.00

RPM	200	400	600	800	1000	1200	
NPSH REQ'D	.9	1.7	2.6	3.4	4.8	6.7	
MIN. HP	1/3	1/2	3/4	1	1 1/2	1 1/2

Energy Systems G
JOB NO. 564 PROJECT HOJ DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/8/80 TAKE-OFF _____ PRICED NLK CALC. CHKD _____ APPROVED _____ SHEET 17 OF _____

[illegible]

Energy System

JOB NO. 564 PROJECT HOT DIRTY GAS TF-HP/OL LOCATION EJEC/55 CLIENT DOE

DATE 1/8/80 TAKE-OFF _____ PRICED NLK CALC. CHKD _____ APPROVED _____ SHEET 18 OF _____

[illegible]

JOB NO. 564 PROJECT HOT DIRTY GAS TF - HP/OL LOCATION ETEC/SS CLIENT DOE
DATE 1/4/80 TAKE-OFF DESIGN PRICED NLK CALC. CHKD _____ APPROVED _____ SHEET 1 OF 4

[illegible]

Energy Systems
JOB NO. 564 PROJECT HOT DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/4/80 TAKE-OFF DESIGN PRICED NLK CALC. CHKD _____ APPROVED _____ SHEET 2 OF 4

[illegible]

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
FITTINGS CONTINUED										
TEE		8"	1	EA	182	5.3	182	5	3	
		6"	6		66	3.6	396	19	6	
		4"	20		35	2.7	700	54	2	
		3"	4		26	2.3	104	9	3	
		2"	11		19	2.1	209	23	1	
		1"	15		15	0.5	225	7	1	
RED. - CONC.		14" x 10"	1		195	5.5	195	5	2	
		10" x 8"	1		73	3.8	73	3	8	
		6" x 4"	6		32	2.1	192	12	10	
		6" x 3"	4		40	2.0	160	8	6	
		6" x 2"	4		49	1.9	196	7	15	
		3" x 2"	7		12	1.5	84	10	5	
		2" x 1"	2		15	0.9	30	1	8	
		12" x 6"	1		125	5.0	125	5	10	
		8" x 6"	3		42	3.0	126	9	10	
FLGES. - 150# RF - A105 C.S.										
		24"	4		1078	4.3	4312	17	2	
		14"	1		309	2.4	309	2	2	
		12"	3		223	2.1	669	6	11	
		10"	2		157	1.9	314	3	18	
		8"	4		85	1.5	340	6	2	
		6"	22		52	1.1	1144	24	15	
		4"	12		35	0.8	420	9	13	
		3"	14		32	0.7	448	9	13	
		2"	24		22	0.3	528	7	12	
							11481	269		
PIPE, FITGS., SUPTS., ETC.										

Energy Systems Group
JOB NO. 564 PROJECT Hot Dirty Gas TF - HP/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/4/80 TAKE-OFF DESIGN PRICED NLK CALC. CHKD _____ APPROVED _____ SHEET 4 OF 4

[illegible]

Rockwell International

Energy Systems Group

JOB NO. 564 PROJECT Hot DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOLDATE 1/7/80 TAKE-OFF _____ PRICED _____ CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL		LABOR	SUB-CONTRACT	TOTAL
SYSTEMS WEINGOUT											
D720-218		2000	MH		33 ⁰⁵	MP 1/30			66100		70000
NOTE: SPLIT 50/50 BETWEEN					10 ⁹³	MP 4/82			20360		30000
E, I & C & Piping on FAC. COSTS.											

PIPE (CARBON STEEL ASTM A53 OR A106 GRADE B)

30'	24" x .250" WALL
20'	14" x .250" WALL
10'	8" x .250" WALL
126'	6" x .280" WALL (20' UNDERGROUND)
1070'	4" x .237" WALL (UNDERGROUND, WRAPPED) ^{1055'}
70'	3" x .216" WALL
350'	2" x .154" WALL (200' UNDERGROUND, WRAPPED)
140'	1 1/2" x .145" WALL
100'	1" x .133" WALL (80' UNDERGROUND, WRAPPED)
50'	1/2" x .109" WALL

30' 12" x .406" WALL (316 SS)

FITTINGS (CARBON STEEL, ASTM A234, GRADE B, BUTTWELD)

3	14" 90° LR ELL	x .250" WALL
3	8"	.219"
15	6"	.280"
30	4"	.237"
8	3"	.216"
50	2"	.154"
10	1 1/2"	.145"
20	1"	.133"

1	8" TEE	x .250" WALL
6	6"	.280"
20	4"	.237"
4	3"	.216"
11	2"	.154"
5	1"	.133"

1	14" x 10" REDUCER	x .250" WALL (LARGE END)
1	10" x 8"	.250"
6	6" x 4"	.280"
4	6" x 3"	.280"
4	6" x 2"	.280"
7	3" x 2"	.216"

2 2" x 1" REDUCER X .154" WALL (LARGE END)
 1 12" x 6" .250"
 3 8" x 6" X .250

25

FLANGES (CARBON STEEL ASTM A105, WELD NECK, RAISED FACE)

1	14"	150 [#]
2	10"	}
4	8"	
22	6"	
12	4"	
24	2"	
4	24"	
3	12"	}
14	3"	

CONVEYORS (SCREW OR BELT ENCLOSED)

140'

PIPE HANGERS

4 SIZE 10, FIG 82, TYPE A, SPRING HANGERS, GRINNELL

Energy Systems Group
JOB NO. 564 PROJECT HOT DIRTY GAS TF - HP/OL LOCATION ETEC/55 CLIENT DOE
DATE 1/4/80 TAKE-OFF DESIGN PRICED DESIGN/NK CALC. CHKD. _____ APPROVED _____ SHEET 26 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
							MANHOURS:		
VALVE REQMTS. / ATTACHED LIST.									
HAND-OP. - FLGD.									
} { }	6"	6	EA	4.0			24		
	4"	3		3.0			9		
	3"	4		2.3			9	2	
	2"	9		1.5			13	3	
CONTROL	4"	2		5.0			10		
	3"	1		4.0			4		
STRAINERS	6"	2		4.0			8		
	3"	1		2.3			5	1	
HAND-OP SCRD.	1 1/2"	6		0.6			3	1	
	1"	1		0.4			0	1	
							84		
							@ \$26/Hr		
SUBTOTAL							20000	5376	25376
EXEC FEE @ 8%									2030
Total							(1/80 cost ROUNDED TO)		27406
(12/81 " " ")									\$5000
									40000
CODE	VALVE SUMMARY								

HOT DIRTY GAS TEST FACILITY

• REV: 1-2-8

VALVE LIST.CAST STEEL, OS&Y, 150[#] RF FLANGE

SIZE	TYPE	RATING	END CONNS.	MFGR. NO.	COST	QTY.
4"	GLOBE	150 [#]	FLG.	PACIFIC 160-1	610	1
4"	GATE			POWELL 1503	830	2
4"	CONTROL			PACIFIC 160-1 + ACTUATOR + I/P	5000	2
3"	GLOBE			POWELL 1531	420	1
3"	GATE			POWELL 1503	710	2
3"	CHECK			POWELL 1561	290	1
2"	GLOBE			WALWORTH 5275F	1930	6
2"	GATE			POWELL 1503	740	3
3"	CONTROL			POWELL 1531 + ACTUATOR + I/P	1500	1
1 1/2"	GLOBE		SCRD.	VOGT 12141	520	6
1"	GATE		SCRD.	VOGT 12111	40	1
6"	GLOBE		FLG.	WALWORTH 5275F	1840	2
6"	GATE			POWELL 1503	1330	2
6"	CHECK			POWELL 1561	1200	2
6"	STRAINER	150 [#]	FLG.	ARMSTRONG BIFL-150*	2310	2
3"	"			ARMSTRONG BIFL-150*	430	1
* FOB MICHIGAN - \$300 ALL OTHERS FOB LA					19,700

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
<u>CONSTR. MGMT.</u>	2773	MH		35 ²⁰	NP 1/80		97720		27720
NOTE: MANHOURS BASED ON A SEVEN (7) MO. CONSTR. PERIOD WITH TWO (2) EP'S FULL TIME FOR EIGHT (8) EQUIV. MOS.									
<u>PURCHASING - D763</u>	1050	MH		21 ¹⁴	NP 1/80		22197		22197
NOTE: GRAPH ATTACHED FOR APPROX. MANHOURS.									
<u>ESCALATED COSTS:</u>									
<u>CONSTR. MGMT.</u>	2773	MH		42 ⁶⁷	12/31		118324		118324
<u>PURCHASING</u>	1050			75 ⁷⁶	\$		27006		27006
CODE	CONSTR. MGMT. & PROCUREMENT								

ESG PURCHASING MANHOURLY FACTORS (EXCEPT ESMC, ROCKY FLATS, AND HANFORD)

Rockwell I

ditional

Energy Systems

Energy Systems
JOB NO. 564

PROJECT

PROJECT HOT DIRTY GAS TF - HP/OL

LOCATION

ETEC/55

CLIENT

Done

DATE 1/10/80

TAKE-OFF

PRICED DZ/NLK

CALC. CHXD

APPROVED

SHEET 50

OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TEST NO. 1									
ASSUMING THREE (3) PROGRAMS IN TTF						(COST SHARING)			1/80
915,684 / 3 =							305228		305228
720-203 SUPPORT	4960	MH		3415			169384		169384
CONSUMABLES / ATTACHED						620000			620000
MISC. FACILITY MAT'L'S.	1	LS				25000			25000
							TOTAL		1119612
							Rounded to		1120000
Escalated To 12/82 MP									
1,151,898 / 3 =							383966		383966
720-203 SUPPORT	4960	MH		4299			213230		213230
CONSUMABLES: 620,000 x 1.35						837000			837000
MISC. FAC. MAT'L'S.: 25,000 x 1.35						33750			33750
							TOTAL		1467946
							Rounded to		1470000
OPERATING COSTS - COST SHARING

DATE _____ TAKE-OFF _____ PRICED DL / NLR CALC. CHKD _____ APPROVED _____ SHEET 51 OF _____

[illegible]

OPERATING COSTS

FOR EACH 2000 HR RUN:

• NATURAL GAS; 27×10^6 SCF @ \$3/MSCF	\$ 81,000
• WATER; — @ 6¢/FT ³	\$ 79,000
• POWER; 1.1×10^6 KW HRS @ 5¢/KW HR	\$ 56,000
• SULFUR; 4.8×10^5 LBS @ 20¢/LB (BULK)	\$ 96,000
• NSH; 1.32×10^5 LBS @ 15¢/LB (BULK)	\$ 20,000
• LIMESTONE; 1.44×10^6 LBS @ 20¢/LB	\$ 288,000

(1979 COSTS)	\$	<u>620,000</u>
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Σ FOR 4000 HRS	\$	<u><u>1,240,000</u></u>
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OPERATING MANPOWER NOT INCLUDED.

JOB NO. 564 PROJECT HOT DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOE
DATE 1/10/80 TAKE-OFF _____ PRICED DE/NLK CALC. CHKD _____ APPROVED _____ SHEET 33 OF _____

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
CURRENT TTF OPERATING PERSONNEL										
DEPT. 720 - 201		1984	MH		31.19			61331		
- 203		3968			34.15			135507		
- 204		992			27.10			26833		
- 205		198			37.72			7469		
- 211		992			34.23			33956		
- 218		13888			30.98			430250		
- 223		2976			29.69			88357		
- 224		1984			32.79			65055		
704 - 100		1190			34.02			40484		
743		198			33.78			6683		
763		397			19.98			7932		
778		198			19.72			3905		
796		397			18.43			7317		
						TOTAL		915684		
OPERATING COSTS										

JOB NO. 564 PROJECT HOT DIRTY GAS TF - HP/OL LOCATION EJEC/SS CLIENT DOR-

DATE 1/10/80 TAKE-OFF _____ PRICED DZ/NLK CALC. CHKD _____ APPROVED _____ SHEET 34 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TEST NO. 1									
ASSUMING THREE (3) PROGRAMS IN TTF									
975,684 / 3									
720-203 SUPPORT	4960	MH		34.15					1/80
CONSUMABLES / ATTACHED						620000			792756
MISC. FACILITY MATLS.	1	LS				25000			169384
									169384
									620000
									25000
									709150
									1119618
									1119618
									1119618
Escalated To 12/82 MP									
1,151,398 / 3									
720-203 SUPPORT	4960	MH		42.99					1035916
CONSUMABLES: 620,000 x 1.35						837000			1325876
MISC. FAC. MATLS.: 25,000 x 1.35						33750			213230
									837000
									33750
									7167142
									1459600
									2119896
									2119896
									2119896
OPERATING COSTS - NO COST SHARING									

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PROJECT

Hot DIRTY GAS IF - HP/OL

LOCATION

EJEC/SS

CLIENT

DOE

DATE

TAKE-OFF

PRICE

DI/NLK

CALC. CHKD

APPROVED

— SHEET

35

OF

[illegible]

Flockwell International

Energy System

JOB NO. 564

PROJECT

PROJECT HOT DIRTY GAS TF - HP/OK

LOCATION

ETEC/55

CLIENT

DC

DATE _____

1/10/20

TAKE-OFF

PRICED

DT/NCR

CALC. CHKD

APPROVED

SHEET

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_____ of _____

[illegible]