APPENDIX A

(From Reference 1 document "Project POGO, Total Coal Utilization, COG Refinery Design Criteria, R&D Report No. 114, Interim Report No. 5")

SECTION 6

PRELIMINARY DESIGN CRITERIA

The preceding process selection led to the preparation of a preliminary design criteria to describe the proposed POGO conceptual commercial plant at the time of start of the directed process design. This section presents the document: "POGO Conceptual Commercial Plant, Preliminary Design Criteria," ERDA Contract No. (49-18)-1775. Improvements and revisions developed during the course of the directed process design are to be incorporated into the final design basis document.

DESIGN OBJECTIVES

The objective is a commercial POGO design; this will be a conceptual coal-oil-gas (COG) refinery to produce power, oil, gas, and other products (POGO). The results of preliminary studies indicate that the complex should include SRC II and pyrolysis process units, product-finishing units, and utilities production. The utilities section will include production of 1,000 MW of export power with the objective of a minimum fixed capital investment (FCI) requirement and production costs.

The preliminary design is to be in sufficient detail for a fixed capital estimate with target accuracy of -5 +20% estimate and profitability analysis.

DESIGN PARAMETERS

Five factors are considered in the design parameters.

(1) Design Capacity: 20,000 TPD of coal charged to dissolver.

Pyrolysis unit shall be charged coal of sufficient capacity to provide the char required to generate the required syngas.

(2) Site Location: Preliminary designs will be developed for three separate locations:

- Eastern region of the U.S. interior coal province
- Lower Appalachia
- Rocky Mountain coal province

(3) Coal Feed: Illinois No. 6 seam coal.

Requirements of cleaned coal are to supply feed to dissolver unit, pyrolysis unit, and fuel gas. The pyrolysis unit produces char, which will serve as a gasifier feed for conversion to syngas and hydrogen gas.

The coal properties include cleaned, sized, and dried Illinois No. 6 seam coal with the following typical analysis:

(a) Proximate analysis (wt % of cleaned, dried coal)

Moisture	2.7
Ash	11.8
Volatile matter	39.7
Fixed carbon	45.8
Gross heating value	12,125 Btu/lb

(b) Ultimate analysis (wt % MAF basis)

Carbon	78.6
Hydrogen	5.4
Nitrogen	1.5
Sulfur	4.3
Oxygen	10.2

(4) Coal will be produced in a captive mine.

(5) Products: Liquid products will consist of LPG, gasoline, distillate, and heavy fuel oils.

SNG of pipeline quality with a heating value in the range of 950 to 1,050 Btu/scf.

Byproduct sulfur, ammonia, and electricity will be produced. Product slate expected is:

LPG

Gasoline pool

Diesel fuel

Fuel oil

SNG

Ammonia (if justified)

Sulfur

Power

POGO PROCESS PLANT DESCRIPTION

This section describes current thinking regarding major equipment and process elements of the plant. Changes will be made during the design development as appropriate to achieve the stated objectives.

A block flow diagram, Figure 4-4, depicts the anticipated processing sequence. All effluents are to meet environmental standards.

(A) Dryer

Dryers will be used to remove free water and a small portion of the inherent moisture.

(B) Grinders

Dried 1-1/4 in. x 0 coal will be ground to produce a pyrolyzer feed.

(C) Flash Pyrolysis Unit

Coal will be fed to the system by a dry feeder system. The pyrolysis unit will include its own heat input system. Solids slurry from product separation will be fed to the pyrolysis zone.

Products from the pyrolysis unit will consist of:

- Char as feed to gasifier
- Gas
- Distillate

(D) Pyrolysis Products Separation

This will provide a quench (and heat recovery) section and facilities to separate gas and liquids. Gas will be directed to the purification unit and the gas plant. Liquid treatment will include particulate matter removal and fractionation as required to produce desulfurized unit feed.

Facilities for any required gas recycle for pyrolysis operation are included in this unit.

(E) Gasifier

This design will use the following features:

(1) A steam-oxygen entrainment-type gasifier will be used to produce syngas.

(2) An air or oxygen entrainment-type gasifier will be used to produce fuel gas; final selection will be based on the results of additional studies.

(F) Gas-Solids Removal

The char solids entrained in the gasifier product gas stream are to be removed by such means as high efficiency cyclones, venturi scrubbers, electrostatic precipitators, and wash columns.

(G) Acid Gas Cleanup

CO_2 and H_2S are to be removed by scrubbing with a physical solvent in a gas treating unit. A clean CO_2 stream is discharged to the atmosphere. An H_2S/CO_2 mixture is directed to the sulfur recovery unit.

(H) Shift Conversion

This unit will convert most of the CO to H_2. A selective acid gas removal unit will be used to remove CO_2 and H_2S in two streams: One, CO_2 in sufficient purity for discharge to the atmosphere, and the other, a mixture of H_2S in CO_2 sufficiently concentrated in sulfur to make a good sulfur plant feed.

(I) Dissolving Unit

Coal will be slurried with a solvent consisting of 2/3 slurry and 1/3 filtrate solvent. Total solvent-to-coal weight ratio will be 3:1. Coal slurry will be contacted with hydrogen gas at about 2,000 psi total pressure in the dissolver, with a slurry residence time of 15 minutes.

(J) Dissolver Products Recovery

Product slurry will be separated from recycle gases and then flashed in several stages. Wherever economically attractive, power will be recovered from gas expanders and pressure letdown turbines. An atmospheric tower will separate noncondensibles, naphtha, wash oil and distillate oil, and slurry recycle solvent and vacuum tower feed. The vacuum tower will concentrate net-heavy liquid product slurry so that vacuum bottoms containing solids can be fed to the pyrolyzer for liquid recovery or conversion to char.

(K) Gas Treating

Off-gas from the dissolver will be treated in an amine-type acid gas removal unit to remove CO_2 and H_2S, and then it will be sent to a cryogenic separation unit to remove methane and heavier hydrocarbons from H_2 and CO. Purified H_2 and CO will then be recycled to the dissolver preheater. The methane will be separated from the LPG, and purification units will produce the specification SNG, propane-LPG, and butane-LPG.

(L) Sulfur Recovery

Sulfur will be recovered from the process and utility treating units' H_2S gas effluent.

(M) Naphtha Reformer

A naphtha reformer shall be provided as required to produce a pool gasoline whose research octane number is 96.0.

(N) Naphtha Desulfurizer

Recovered naphthas shall be catalytically hydrogenated to convert sulfur values to H_2S and nitrogen values to NH_3 for removal. Severity of operation shall be that required to produce acceptable naphtha-reformer feedstock.

(O) Distillate Desulfurization

Catalytic desulfurization of distillate products shall be accomplished to produce acceptable distillate fuels or diesel products.

(P) Fuel Gas Production

Char or coal will be fed to an entrained gasifier to produce sufficient fuel gas for all plant fuel needs such as steam and power generation, plus heater firing. Additional studies will determine the final gasifier design and configuration. Alternatives to be studied include type of oxidant (air or oxygen), type of carbonaceous feed (char or coal), pressure, temperature profile, slag removal, and mechanical design configurations.

(Q) Water and Waste Gas Treating

All contaminated plant water streams will be collected and treated to remove dissolved gases. The gases, consisting mainly of NH_3 and H_2S, will be separated to produce anhydrous NH_3, a salable product, and H_2S for feed to the sulfur plant. The sulfur plant will, in turn, convert the H_2S to elemental sulfur and a clean stack gas. Stripped water will be sent to process use, where dissolved hydrocarbons will be destroyed.

(R) Oxygen Plant

Oxygen shall be produced in commercial-type oxygen plants using whatever economic head and/or material sources are available in the operating plant or utility section.

(S) Power Generation Unit

A utility-type unit shall produce steam and electric power for use in the processing plant, in addition to 1,000 MW of electric power for sale. This plant will be capable of continuous output in the same manner as public utilities must.

APPENDIX B

SITE CONDITIONS

Date 3/31/77
Page 1 of 12

Job Name POGO Plant Project Manager A. Bela Job No. 5435-0004

Power Oil, SNG, Gasoline and Coke from Coal (ERDA)

1.0 GENERAL AND METEOROLOGICAL

1.01 Location Eastern Region, U.S. Interior Coal Province

1.02 Elevation 490 ft

1.03 Climatic Conditions % Relative Humidity High: 80 Low: 50

a. Maximum temperature 103 °F; Design for 90 °F

b. Minimum temperature -15 °F; Design for -15 °F

c. Design wet bulb temperature 78 °F

d. Rainfall 38 in. per yr. (average): 0.75 in. per hr. (design)

e. Average wind velocity 12 miles per hour

f. Maximum wind velocity 50 miles per hour (gusts)

g. Direction of wind NW 1Q; NW-SSW 2Q; S 3Q; S-NW

h. Average annual snow fall 20 inches per year

j. Design for 25 PSF snow pack (omit if roof load known)

k. Frost line - Design for 24 inches depth

l. Lightning storms — Number per year 50

m. Dust Storms — Are special provisions required? No Hail & Tornadoes occur March thru June

2.0 STRUCTURAL DATA

2.01 Vertical Live Loads

a. Roofs, tank tops, etc., on horizontal projected area

Area in Sq. Ft.:	0-200	200-600	Over 600	
Rise less than 4 in./ft.	25	25	25	psf
Rise 4 in./ft. and steeper	per UBC	✓	✓	psf

b. Platform, stairs and walks

	Loading	
1. Pedestrian traffic only	75	psf
2. Work area — uniform loading	50	psf
3. Work area — concentrated loading	320	psf

c. Floors on ground

	Uniform Load		Concentrated Load	
1. Control houses	100	psf*	1,000 on 2 1/2" sq.**	
2. Paved areas	100	psf*	15,000	wheel load
3. Other buildings	100	psf		
a. Maintenance Bldg	250	psf		
b. Lab & Admin Bldg	75	psf		
c. Stores/Whse	100	psf	15,000	wheel load

d. Vessels and piping

1. See detailed sheet for weight of normal operating liquid contents.

2.02 Empty Condition

Weight of equipment in place and empty, with removable internal parts all installed and with dead load attachments such as platforms and operating lines in place, plus wind or earthquake.

2.03 Test Condition

Empty weight plus weight of test water, without wind or earthquake.

2.04 Operating Condition

Empty weight plus weight of liquid at maximum level, plus wind or earthquake or expansion forces.

*100 Recommended
**1000 Recommended

2.05 Lateral Loads (Wind)

a. Wind on vertical flat projected areas:

0 to 30 feet above ground	15	psf
30 to 50 feet above ground	20	psf
50 to 100 feet above ground	25	psf
100 to 500 feet above ground	30	psf

b. For circular equipment the wind pressure shall be assumed to act on 0.6 of projected area.

c. For computing wind pressure on exposed open frame structures, use 130 percent of projected areas of all members.

2.06 Lateral Load (Earthquake)

Uniform Building Code Zone #2

Note: Wind and earthquake forces are not additive.

2.07 Allowable Stresses may be increased 1/3 for lateral loadings, and 1/5 during hydrostatic test.

2.08 Stability Ratio

a. Minimum allowable stability ratio = $\frac{\text{Stabilizing Moment}}{\text{Overturning Moment}} = 1.5$

b. Soil bearing foundations to have positive soil pressure over whole footing, except for erection load conditions (provided that toe pressure does not exceed allowable soil bearing pressure).

3.0 FOUNDATIONS AND SOIL DATA

3.01 Soil Data

a. Type of Soil Sand – Rocky

b. Subsoil strata a factor? No

c. Elevations of water table Varies

d. Is piling required? No

e. Special soil analysis reference To be determined

3.01 Soil Data (Continued)

f. Excavation remarks —

3.02 Foundations

a. Allowable Bearing Loads

	Type of Soil	Depth	Vertical Load	Lateral Load
1.	Sand & Rocky	3 ft.	3,000 psf	— psf
2.	—	— ft.	— psf	— psf

b. Ultimate Compressive Strength after 28 days

1. Reinforced concrete 3,000 psf

c. Minimum Coverage of Reinforced Steel

1. Formed sections 2 in. (except 1-1/2 in. for -5 and smaller bars)
2. Unformed sections 3 in.
3. Water contact 3 in.

d. Minimum Depth of Foundations

1. Exterior walls and/or piers 3 ft.
2. Interior building footings 3 ft.
3. Frost line 3 ft.
4. Ground water depth 4 – 20 ft.
5. Are termites and fungi a factor? Yes

e. Elevations

1. Base elevation (Refinery Datum) 100.00 ft.
2. Existing ground elevation 460 – 490 ft.
3. Finished grade To be determined ft.
4. High point of paving To be determined ft.

4.0 UTILITIES

4.01 Air

a. Instrument air at 60 psi and maximum dew point -20 °F at 100 psi

b. Utility air at 90 psi

c. Starting air for compressors at Atm psi

4.02 Cooling Water

a. Type Tower — °F

b. Maximum cold water temperature — °F

c. Design cold water temperature 80 °F

d. Maximum hot water temperature 120 °F

e. Design hot water temperature 120 °F

f. Design water supply pressure at grade 50 PSIG

g. Design water return pressure at grade 35 PSIG

4.03 Cooling Tower

a. Water inlet temperature 120 °F

b. Water outlet temperature 86 °F

c. Design wet bulb 78 °F

d. Type of tower Natural Draft (Parabolic)

e. Structural design-lateral load: See Section 2.0

4.04 Steam and Condensate

a. High pressure steam at 1250 psi and 300 °F superheat

b. Low pressure steam at 150 & 50 psi and — °F superheat

c. Intermediate pressure steam at 625 psi and 200 °F superheat

d. Condensate system at 50 psi

4.05 Boiler Feedwater

a. Supply pressure at plot limit 60 psi

b. Supply temperature at plot limit 60 °F

4.06 Fuel Gas

		Natural Gas	Refinery Gas
a.	Pressure at plot limit	X psi	60 psig
b.	Heating value at 1 atm	X Btu/cu. ft	X Btu/cu. ft.
c.	Composition	—	

4.07 Air Coolers 30 °F Approach 120 °F min

4.08 Liquid Fuel

a. Type —

b. SP Gravity —

c. Viscosity (poises at 210 °F) —

d. Heating value — Btu/lb.

e. Supply pressure at plot limit — psi

f. Return pressure at plot limit — psi

g. Temperature at plot limit — °F

4.09 Water Systems

		Supply Pressure	Supply Temperature	Required Treatment
a.	Drinking	50-70 psi	Ambient °F	Settled, Demineralized, and Chlorinated
b.	Sanitary	50-70 psi	Ambient °F	Settled, Demineralized, and Chlorinated
c.	Fire System	90 psi	Ambient °F	Raw River Water

4.10 Sewers

a. Types

1. Sanitary Yes
2. Oily Water Yes
3. Surface Runoff Ditches
4. Chemical Yes
5. Combine 2 and 3? No

b. Materials and Installations

Location	Sewer Systems			
	Sanitary	Oily Water	Runoff	Other
1. Inside Buildings	CI	CI	—	—
2. Under concrete	CI	CI	CI	—
3. Under unpaved areas	VC to 12" RC > 12"	VC to 12" RC > 12"	Ditch	—
4. Design Velocity*	3-5 ft/ sec	3-5 ft/ sec	Under pavement 3-5 ft/ sec	—
5. Slope (%)	As Below**	2%	1%	—
6. Minimum Coverage	3 ft	3 ft	3 ft	—
7. Manholes Precast Concrete	At junctions and changes of direction Sealed @ 300' min distance			—
8. Manhole Covers CI	Plain	Bolted & Gasketed	Bolted & Gasketed	—
9. Junction Boxes	None	Sealed	Sealed	—

*3-5 recommended.
**Minimum 2% to septic tank, 1% beyond.

5.0 ELECTRICAL EQUIPMENT

5.01 Power Supply and Characteristics

a. Source In Plant Generation – Emergency Firm Power from local Utility Company

b. Routing Overhead, Trays

c. Service	Volts	Phase	Cycle
1. Main supply	138K	3	60
2. Primary distribution	138K	3	60
3. Secondary distribution	2300/480	3	60
4. Lighting	480/240/120	3	60
5. Emergency heating	–	–	–
6. Electrical Instrumentation	24	–	DC

5.02 Switchgear and Design Details

a. Refer to "Electrical Design Criteria Project No. – "

5.03 Material Classification – See Drawing –

a. Hazardous areas	Class 1, Group D, Division 1
b. Semi-hazardous	Class 1, Group D, Division 2
c. Non-hazardous	NEMA

5.04 Motors

a. Size 150 hp and up	2200 volts	3 phase
b. Size 3/4 hp to 125 up	480 volts	3 phase
c. Size 1/2 hp and smaller	120 volts	3 phase

5.05 Metering

a. Main Supply By plant powerhouse

b. Others To be determined

6.0 INSTRUMENTS

6.01 Accounting Meters Required	Yes		No
a. Plant feed streams	X		
b. Plant product streams	X		
c. — stream system	X		
d. — stream system	X		
e. Fresh water	X		
f. Sanitary Water			X
g. Cooling water	X	As process requires	
h. Air			X
i. Fuel gas	X		
j. Fuel oil	X		

k. Others Chlorine, Sulfuric Acid, NaOH, KOH (liquid)

6.02 Panelboard

a. Type Local Panels and Main Control Center

b. Instruments Pneumatic and Electronic; Computer Controlled

c. Arrangement of instruments —

d. Chart drives Electrical

6.03 Emergency supply of instrument air Yes

6.04 Instrument air cooler and dryer Yes

6.05 Master instrument air filters Yes

7.0 PROCESS DATA

7.01 Product to Storage Temperatures

a.	LPG	100 °F	Gas Oil	120	°F
b.	Pen-hex	- °F	Diesel Oil	-	°F
c.	Gasoline	- °F	Fuel Oil	180	°F
d.	Light naphtha	100 °F	Asphalt		°F
e.	Heavy naphtha	100 °F	Two		°F
f.	Kerosene	°F	Pitch		°F
g.	Others		Others		
	Liquid Sulfur:	250 + °F	Solid Sulfur:	Ambient	

7.02 Equipment Data

		Normal Contingency	Process Control Contingency	
a.	Pumps			
	Feed	%	10 %	
	Reflux, Furnace, Recirc	%	20 %	
	Product	%	10 %	
b.	Compressors	%	10 %	
c.	Heat exchangers	%	0 %	
d.	Furnaces	%	10 %	IMM Btu Mininum
e.	Cooling tower	%	10 %	
f.	Others	%	%	
		%	%	

*Contingency for large pumps and compressors to be revicwed on a case by case basis (500 HP and over)

7.03 Codes - latest editions

a. API-ASME unfired Pressure Vessel
API 650 - Storage Tanks
ASME, Section VIII, Div. 2

b. ASA Piping Code
USAS B 31.3 — 1966 — Piping
USAS B 16.5 — Flanges and Fittings
USAS B 31.1 — Power Piping

c. ASME Code Power Boilers — Section I

d. National Electric Code NEMA

e. Uniform Building Code (by International Conference of Bldg. Officials.)

f. National Plumbing Code IBC

g. Petroleum Safety Orders Apply

h. Exceptions to codes None

8.0 MISCELLANEOUS

8.01 Safety

a. Maximum temperature for safety to personnel 140 °F

b. Hazardous chemicals Chlorine, Caustic, Sulfuric Acid

8.02 Winterization

a. Design considerations Yes, -5° for water, steam condensate and various process lines and instrumentation

b. Degree required As dictated by process requirements

8.03 Noise abatement a factor Yes, all fans, compressors, generators and pipelines

8.04 Air pollution requirements Yes, per Federal and State of Illinois Requirements

8.05 Water pollution requirements Yes, per above

8.06 Aircraft warning regulations Yes, per above

8.07 Shipping problems None — Truck and Railway both available

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