DOE/OR/20717--4-Vol.6

DOE/OR/20717--4 Vol. 6

DE83 000190

The BRECKINRIDGE PROJECT

Initial Effort

REPORT IV

VOLUME 6

MASTER

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

PREPARED FOR
UNITED STATES DEPARTMENT OF ENERGY
UNDER COOPERATIVE AGREEMENT
NO. DE-FC05-800R20717

DISCLAIMER

The following pages are an exact representation of what is in the original document folder.

The information and data contained in this report are the result of an economic evaluation and a preliminary design effort and because of the nature of this work no guarantees or warranties of performance, workmanship, or otherwise are made, either expressed or by implication.

REPORT IV
VOLUME 6

INTRODUCTION

Report IV, Volume 6 provides descriptions, data, and drawings pertaining to Gasification and Purification (Plant 12).

Gasification and Purification (Plant 12) produces makeup hydrogen for H-Coal® Preheating and Reaction (Plant 3), and produces a medium Btu fuel gas for consumption in fired heaters.

The following information is included for the plant described in this volume:

- A description of the plant's process design, including the utility balance, catalysts and chemicals usage, and a process flow diagram.
- An equipment list, including item numbers and descriptions.
- Data sheets and sketches for major plant components.
- Pertinent engineering drawings.

At the end of this volume is an appendix which contains:

- An overall site plan showing the locations of all plants.
- The symbols and legend for the piping and instrument diagrams included in this volume.

Gasification and Purification (Plant 12) utilizes process technology from three licensors: gasification of vacuum bottoms using the Texaco process, shift conversion using the Haldor Topsoe process, and purification of fuel gas and shifted gas using the Allied Chemical Selexol process.

This licensed technology is proprietary in nature. As a result, this volume does not contain full disclosure of these processes although a maximum of information has been presented consistent with the confidentiality requirements. Where data appears incomplete in this volume, it is due to the above described limitations.

Full data concerning this plant are available for DOE review at the Houston offices of Bechtel Petroleum, Inc.

INITIAL EFFORT REPORTS REFERENCE

Report I - Executive Summary

Report II - Breckinridge Project Design Basis

Report III - Specifications
- Volume 1 - Specifications A through J
- Volume 2 - Specifications K through W

Report IV - Process Units
- Volume 1 - Plants 26, 27 and 1
- Volume 2 - Plants 2, 3 and 4
- Volume 3 - Plants 5, 6 and 17
- Volume 4 - Plant 7
- Volume 5 - Plants 8, 9 and 10
- Volume 6 - Plant 12
- Volume 7 - Plants 15 and 18

Report V - Utilities and Offsites Units
- Volume 1 - Plants 19, 20, 21, 22, 23 and 30
- Volume 2 - Plants 31, 32, 33 and 34
- Volume 3 - Plant 35
- Volume 4 - Plants 36, 37, 38, 39, 40, 41, 42 and 44

Report VI - Project Management Plan

Report VII - Environmental, Socioeconomic, Safety and Health
- Volume 1 - Introduction and Background
- Volume 2 - Environmental Baseline
- Volume 3 - Cultural and Socioeconomic
- Volume 4 - Health and Safety

Report VIII - Capital Cost Estimate

Report IX - Operating Cost Estimate

Report X - Economic Analysis and Financial Plan

Report XI - Technical Audit
Volume 1 - Engineering Comparisons
Volume 2 - Engineering Comparisons
Volume 3 - Critical Design Areas
Volume 4 - Critical Review of the Design Basis
Volume 5 - Critical Review of the Design Basis

REPORT IV
VOLUME 6

TABLE OF CONTENTS

PLANT 12 GASIFICATION AND PURIFICATION

1.0 INTRODUCTION

Plant 12 produces makeup hydrogen for the H-Coal® reaction section in Plant 3 and a medium Btu fuel gas for consumption in fired heaters. An overall flow diagram for Plant 12 is presented in Figure 1. Major sections of the plant include:

- Gasification including syngas quenching and scrubbing
- Shift conversion and shifted gas cooling
- Shifted gas purification
- Compression of hydrogen product
- Unshifted gas cooling and purification

All of the vacuum tower bottoms produced in H-Coal® Recycle Slurry Preparation (Plant 5) is charged to Plant 12. The vacuum bottoms stream is gasified and partially oxidized using the Texaco Gasification Process which is licensed from Texaco Development Corporation. The raw syngas produced in the high temperature, moderate pressure reaction zone is cooled in the quench and scrubber sections of the gasification area. Slag and soot, separated from the syngas, are accumulated and sent to solid waste disposal.

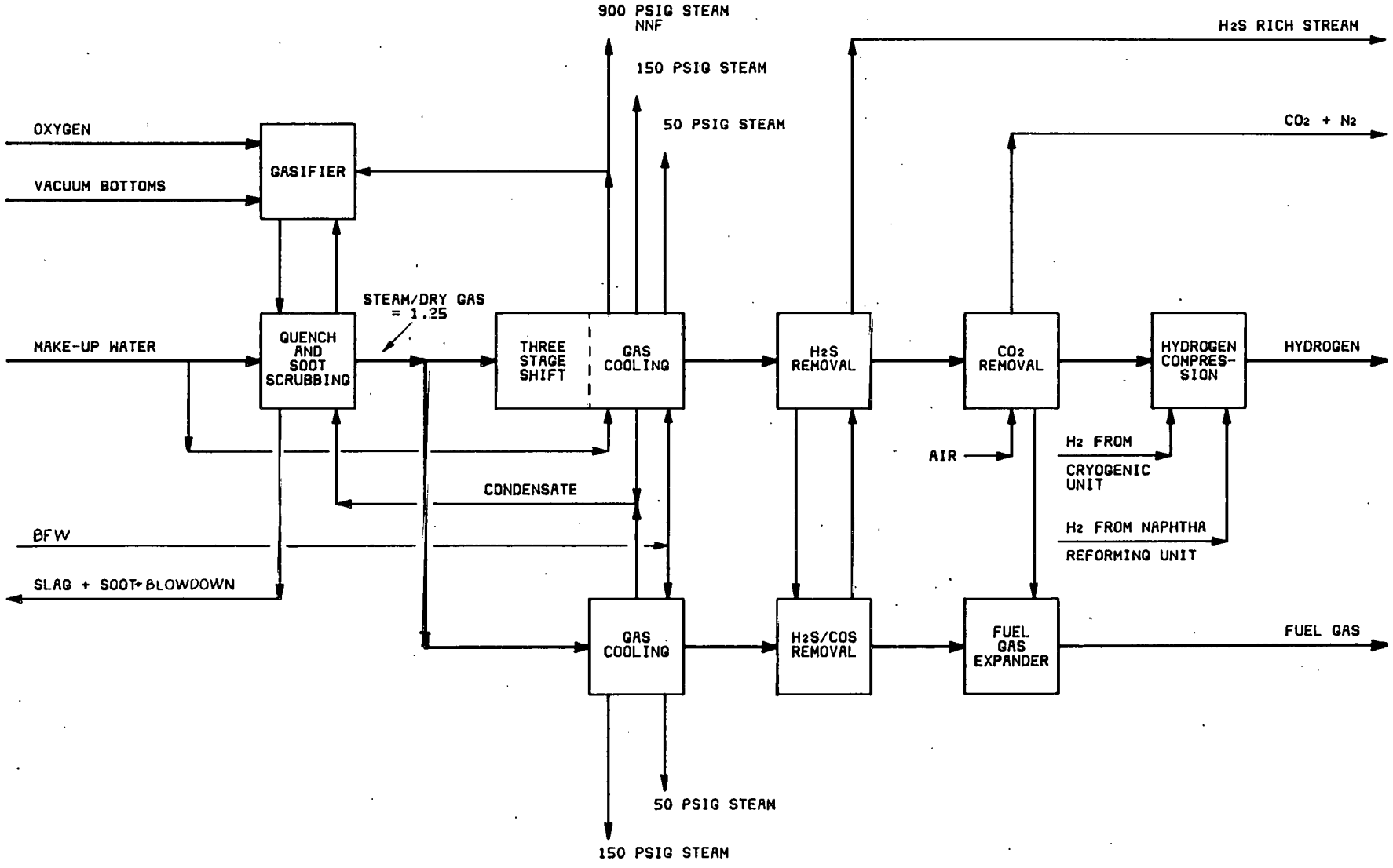
Most of the raw syngas is passed over shift conversion catalyst to generate additional hydrogen via the following water shift reaction:

$$H_2O + CO \rightleftharpoons H_2 + CO_2$$

This is accomplished in a three bed reactor system using Haldor Topsoe SSK-catalyst. The reaction is exothermic, and heat of reaction is recovered by generating steam at different pressure levels between the

Figure 1

PLANT 12 OVERALL BLOCK FLOW DIAGRAM



reactor beds. The 900 psig steam generated is totally consumed in the gasifier section. The 150 psig and 50 psig steam generated is exported into the overall plant steam distribution system.

The shifted gas is purified by removing hydrogen sulfide (H_2S) and carbon dioxide (CO_2) components using Allied Chemical's Selexol Process. The purification is achieved in two stages. The first stage removes H_2S to the 2 ppmw level. The second stage reduces CO_2 in the final hydrogen product to 0.2% by weight. The "lean" Selexol solvent absorbs the contaminant gas components from the shifted gas. The "rich" solvent is stripped to remove contaminants. First stage stripping yields an off-gas rich enough in H_2S to be suitable for feed to the Sulfur Plant (Plant 10). Second-stage stripping produces a carbon dioxide waste gas containing only traces of H_2S that is vented to the atmosphere.

Purified product hydrogen from the Selexol Process is next combined with hydrogen-rich gases from Naphtha Hydrotreating and Reforming (Plant 18) and from Cryogenic Hydrogen Purification (Plant 8). The total hydrogen stream is then compressed to 3,480 psia for transfer to H-Coal® Preheating and Reaction (Plant 3). This stream represents the makeup hydrogen requirement for the coal hydroliquefaction reaction system in Plant 3.

Raw syngas from gasification in excess of that required for hydrogen production is first cooled and then treated to remove H_2S by absorption in Selexol solvent. The treated gas containing less than 10 grains of H_2S per 100 scf is burned as plant fuel in fired heaters.

PLANT 12 GASIFICATION AND PURIFICATION

2.0 PROCESS DESIGN

2.1 Design Basis

Plant 12 is designed to gasify 508,816 lb/hr of H-Coal® vacuum bottoms. Most of the gasified syngas is to be used to produce 312 MM scfd of 97.8 mole percent hydrogen product, which is to be compressed along with supplemental reformer and cryogenic hydrogen streams to 3,480 psia for delivery to H-Coal® Preheating and Reaction (Plant 3). Syngas in excess of that required for hydrogen production is to be used to produce a medium Btu fuel gas.

A summary of design basis feeds and production for Plant 12 is provided in the following list:

Feed Streams

- 508,816 lb/hr vacuum bottoms from H-Coal® Recycle Slurry Preparation (Plant 5)
- 4,528.5 TPD of 99.5 volume percent oxygen from the Oxygen Plant (Plant 15)
- 9.3 MM scfd of 95.1 mole percent hydrogen from Naphtha Hydrotreating and Reforming (Plant 18)
- 225.7 MM scfd of 93.7 mole percent hydrogen from Cryogenic Hydrogen Purification (Plant 8)

Product Streams

- 312 MM scfd of 97.8 mole percent hydrogen as net hydrogen production in addition to reformer and cryogenic hydrogen for delivery to Plant 3
- 86 MM scfd of medium Btu fuel gas
- 17 MM scfd of stripped off-gas containing H_2S as feed to Sulfur Plant (Plant 10)
- 103.5 MM scfd of stripped CO_2 waste gas for discharge to atmosphere

- 1,526 TPD (dry basis) of slag and soot to landfill disposal

Gasifier yields and conversion are as follows:

- 40.6 scf of CO + H_2 per pound of dry and ash-free feed
- 96% carbon conversion to syngas. Unconverted carbon (soot) is rejected with slag

Additional data on design basis feed streams are presented in Tables 1, 2 and 3. Ash analyses are provided in Table 4 for Illinois No. 6, Kentucky No. 9 and Kentucky No. 11 coals. It should be recognized that the Phase Zero design basis for vacuum bottoms composition as shown in Tables 1 and 2 is based on Illinois No. 6 coal.

Product compositions and flow rates are presented in Table 5.

Reliability and operating flexibility have been enhanced by the following provisions:

- Five gasifiers are included when three will provide required stream day rates of hydrogen for hydroliquefaction in Plant 3 and four will provide enough capacity to gasify design rates of vacuum bottoms.
- Intermediate tankage (150,000 Bbl) has been provided for storage of cutback vacuum bottoms. With 50% cutback this represents 10 days holdup for one gasifier.
- Three 33-1/3% trains of shift conversion have been provided. Shifted gas is combined and then redivided into three 33-1/3% for shifted gas purification.
- A spare train of hydrogen compression has been included in the five trains provided.
- The unshifted gas purification section provides a means to handle syngas in excess of that required for hydrogen production.

TABLE 1

GASIFICATION FEED STREAMS

Vacuum Bottoms Plus Flush Oil*
(Base Case Illinois No. 6 Coal)

	wt%
975°F	11.44
975°F+	52.97
Coal	13.77
Inorganic	21.82
Total	100.00
Total lb/hr	519,200
°API 60°F	-35.15
Specific Gravity	1.47
% Solids**	35.6

* Includes 508,816 lb/hr vacuum bottoms from Plant 5 plus 10,384 lb/hr of distillate flush oil from Plant 17. Further discussion regarding the need for flush oil may be found in the following process description section.

**Includes unconverted carbon.

Oxygen	
Component	Mol%
H_2O	--
H_2	--
N_2+Ar	0.5
O_2	99.5
CO	--
CO_2	--
Pound mol/hr	11,800
MM scfd	107.4

TABLE 2

VACUUM BOTTOMS ANALYSIS

Elements	Normal Average wt%	Range wt%
Carbon	68.39	
Hydrogen	4.75	
Sulfur	1.87	1.3 - 2.5
Nitrogen	0.98	1.2 maximum
Oxygen	2.21	--
Ash	21.80	16 - 27.0
High heating value Btu/lb	12,718*	--

Vacuum Residue Analysis (Dry Ash-Free Basis)

Element	Normal Average wt%
Carbon	87.46
Hydrogen	6.07
Sulfur	2.39
Nitrogen	1.25
Oxygen	2.83

* HHV as calculated by Texaco Development Corp.

TABLE 3

COMPOSITIONS
HYDROGEN STREAMS

	Plant 18 Reformer H_2 mol%	Plant 8 Cryogenic H_2 mol%
H_2O	--	--
H_2	95.1	93.73
N_2+Ar	--	2.78
O_2	--	--
CO	--	2.62
CO_2	--	--
H_2S	--	--
NH_3	--	--
C_1	1.6	0.87
C_2	2.2	--
C_3	0.8	--
C_4	0.3	--
Pound-mol/hr	1,025	24,753
MM scfd	9.3	225.4

TABLE 4

SLAG ANALYSIS

	wt%		
	Illinois No. 6	Kentucky No. 9	Kentucky No. 11
P_2O_5	0.10	0.17	
SiO_2	45.1	47.96	40.30
Fe_2O_3	17.6	25.59	28.31
Al_2O_3	19.9	17.51	17.14
TiO_2	1.1	0.89	0.97
CaO	4.0	1.00	1.33
MgO	0.9	0.95	0.60
SO_3	5.6	0.71	0.36
K_2O	1.4	2.19	2.22
Na_2O	1.1	1.60	0.52
Undetermined	3.1	1.50	8.08
Total	100.0	100.00	100.00

TABLE 5

PRODUCT DATA

	Hydrogen from Plant 12 to Plant 3 Mol%	Total Hydrogen[4] to Plant 3 Mol%	Medium Btu[1] [3] Gas Mol% HHV 284 Btu/scf	H_2S-Rich Off-Gas Mol%	Combined CO_2 Off-Gases Mol%	Slag and Soot wt%
Carbon	--	--	--	--	--	3
H_2O	--	--	18 ppm	12.26	0.79	18
H_2	97.85	96.10	40.50	0.94	0.33	--
N_2+Ar	0.54	1.46	0.50	trace	31.78	--
O_2	--	--	--	--	8.45	--
CO	1.10	1.71	51.07	2.60	150 ppm	--
CO_2	0.20	0.12	7.60	68.23	58.62	--
H_2S	--	--	4 ppm	15.82[2]	2 ppm	--
COS	--	--	180 ppm	0.10	6 ppm	--
C_1	0.31	0.56	0.30	0.04	0.02	--
C_2	--	0.04	--	--	--	--
C_3	--	0.01	--	--	--	--
C_4	--	0.01	--	--	--	--
Slag	--	--	--	--	--	79
Total Pound-Mol/hr	34,292	60,071	10,344	1,870	34,092	--
MM scfd	312.3	547.0	102.9	17.0	310.4	--

Notes:

(1) Includes some flashed hydrogen from Selexol unit.
(2) 12% for low sulfur residue.
(3) Total sulfur not to exceed 20 grains/100 scf
(4) Includes hydrogen from Plants 8 and 18.

2.2 Process Description

Plant 12 consists of five trains of gasification, three trains of shift conversion and shifted gas cooling, three trains of shifted gas purification, five trains of hydrogen compression and a single train for unshifted gas cooling and purification. Each of these major sections will be described in more detail in the process description that follows. Unless otherwise denoted, discussion has been facilitated by proceeding through each section as though it contained but one train.

Process flow diagrams are presented on Flowsheets 12-B-B-1 through 12-D-B-6.

2.2.1 Gasification

The Texaco Gasification Process is proprietary and only a simplified flowsheet has been included in this report. Flowsheet 12-B-B-1 presents only battery limit and function information for the gasification step.

Residue from the vacuum towers in H-Coal® Recycle Slurry Preparation (Plant 5) is gasified via partial oxidation gasifiers using steam and oxygen as the gasification agents. Gasifier reactions are many and varied but the predominant ones are as follows:

- $C_xH_y \rightleftharpoons xC + y/2\ H_2$
- $C + H_2O \rightleftharpoons CO + H_2O$
- $C + O_2 \rightleftharpoons CO_2$
- $C + 1/2\ O_2 \rightleftharpoons CO$
- $CO + H_2O \rightleftharpoons CO_2 + H_2$
- $CO + 3H_2 \rightleftharpoons CH_4 + H_2O$
- $S + H_2 \rightleftharpoons H_2S$
- $S + CO \rightleftharpoons COS$

All reactions are reversible and therefore a certain gas composition is established containing all of the gas species. The exact quantities of each species depend on the amounts of reactants, operating conditions and on the approach to equilibrium. At the high temperature prevalent in slagging gasifiers, equilibrium considerations normally dictate a high concentration of CO and H_2, a moderate concentration of CO_2, and very little CH_4.

The synthesis gas produced in the gasifiers at the high temperature is quenched and scrubbed with water to produce a clean saturated synthesis gas. The gas is cooled by direct injection of liquid water to produce a water saturated product. Steam is a reactant in the downstream shift conversion step, and for this design, a nearly optimal steam to dry gas ratio results from the direct water quench.

The size of the gasifier is limited by economic considerations and experience factors. To process the total (508,816 lb/hr) vacuum bottoms yield from H-Coal® Recycle Slurry Preparation (Plant 5) four gasifiers of the largest design are needed. Five gasifier systems are to be installed, including one spare to ensure continuous operation at the design capacity.

Reciprocating pumps are necessary to inject the slurry feed to the gasifiers. A clean flushing oil is injected into the stuffing box of the pumps to minimize plunger wear by the slurry. The oil requirements are 2% of the feed. The flushing oil joins the vacuum bottoms in the pump; therefore, total feed to the gasifiers is 519,200 lb/hr. Further discussion on the source of this flush oil and the details of the flush oil distribution system may be found in the process description for Purge and Flush Oil Systems (Plant 39).

Design carbon conversion for this plant is 96%. The gasifier will produce two distinct solids - a slag (that portion of the solids which melted) and a soot consisting primarily of fine carbon particles. For

greater carbon utilization, the soot can be recovered and recycled, but such was not deemed economical for the Phase Zero design of this project. This is a subject, however, that will merit review and updating prior to Phase 1 design work.

Gasifier operating pressure is determined by balancing economical and practical considerations. For this project, operating pressure was limited by the maximum discharge pressure that could be generated in centrifugal oxygen compressors of proven design. Accordingly, oxygen will be delivered to the Plant 12 battery limits at 935 psia.

2.2.2 Shift

The clean syngas from the gas scrubber is divided into two portions - a large portion which is converted to the hydrogen product and a smaller fraction (the excess) which is used to produce a medium Btu fuel gas. The portion of the gas to be shifted is flow controlled while the smaller (excess) portion is removed at a rate so as to control gasifier pressure.

The process flowsheet for the shift section is presented in 12-D-B-2. The shift reaction represented by $CO + H_2O \rightleftharpoons CO_2 + H_2$ is highly exothermic and reversible. High temperatures favor fast reaction rates but result in unfavorable equilibrium conditions. Since the product specification requires no more than 1.1% (vol) CO, the rest being essentially hydrogen, it is obvious that the reaction must be equilibrated to a point where the H_2 to CO ratio is approximately 98.9 to 1.1 or 89.9, unless a secondary CO removal step is used. Such a step is not necessary since required CO limits can be met at a practical reaction temperature of about 480°F.

A multiple reactor system design has been developed with the number of stages and operating conditions being optimized for minimum cost. The inlet temperature to each reactor stage must be kept above the water dew point. Initial stages will be designed to achieve high reaction rates, and design will be constrained by maximum allowable outlet temperatures. Outlet temperatures must be controlled below the catalyst sintering point and within the limits for practical vessel design. For the design feed gas, in a three reactor system, was found to be optimum.

To accommodate the required capacity, three trains were deemed necessary as limited by maximum reactor vessel diameters.

The catalyst chosen is Haldor Topsoe's type SSK which has a Cobalt-Molybdenum base and operates in the sulfided stage thereby permitting handling of sulfur bearing gases. Also, the SSK catalyst has good activity at low temperature which is necessary to achieve the low CO level required in the shifted gas. The catalyst also has high temperature stability (to about 900°F) which makes it functional over a wide temperature range.

The optimized integrated reactor system is as follows:

	Feed °F	Exit °F	Tr. °F	% CO Conv. (Total)	Recycle to Limit Exit Temp. (% Feed)
First Reactor (12C-111)	516	816	300	86	18
Second Reactor (12C-112)	526	565	39	95	0
Third Reactor (12C-113)	460	471	11	98	0

Inlet temperature to the first and second reactors are as high as practical to take advantage of high reaction rates. A small recycle is used to moderate and control the exit temperature from the first reactor.

The third reactor temperatures are kept low to obtain the necessary low CO level in the product gas. Since the catalyst is quickly deactivated in the presence of liquid water, operation below the gas dew point must be avoided. The design third-stage operating temperature provides a practical margin of safety above the feed gas dew point.

Preheating to the required first-stage inlet temperature is accomplished via a feed/exit gas exchanger. Heat of reaction from the first stage is removed by a waste heat boiler generating 900 psig steam. Lower level heat is used to preheat boiler feedwater. Final gas temperature is controlled at 526°F for feeding to the second-stage reactor.

Second-stage exit gas is cooled to 460°F upstream of the third stage by a waste heat boiler producing 150 psig steam.

In preparation for the purification step, the third-stage exit gas is cooled to ambient temperature in a series of exchangers. The exchangers include in order a process condensate preheater, a waste heat boiler producing 50 psig steam, a boiler feedwater preheater, an air cooler and a final water cooler. Optimum use is made of all heat at the various levels to effect an overall thermally efficient process.

The gas from the three trains of shift is combined prior to resplitting to the subsequent three purification trains to:

- Homogenize the gas composition.
- Segregate the individual shift step from the individual purification step. Thus, if one purification train goes down for any reason it does not force down a specific shift train. This increases the overall plant stream factor.

2.2.3 Carbonyl Sulfide Removal

Before proceeding to a review of shifted and unshifted gas purification sections, discussion of sulfur conversion and carbonyl sulfide (COS) removal is appropriate. Most of the sulfur in the feed to the gasifiers forms H_2S in the syngas; however, a small portion is converted to COS. Shift section reaction kinetics favor the formation of H_2S according to $COS + H_2O \rightleftharpoons CO_2 + H_2S$. Therefore, very little COS appears in the feed to the shifted gas purification section. Less than one grain of COS per 100 scf is vented to the atmosphere in the CO_2 waste gas. Although currently there are no Federal EPA regulations limiting emissions of COS, it has been assumed in the Phase Zero design that the low level of COS emission described above will be environmentally acceptable.

The unshifted gas contains a higher concentration of COS than does the shifted gas. During unshifted gas purification, approximately half of the COS that enters with the feed gas is removed with the H_2S in the 12C-127 absorber and sent to the Sulfur Plant (Plant 10). The rest of the COS remains with the treated medium Btu fuel gas that is destined to be burned in fired heaters throughout the plant. This COS in the fuel gas creates an additional 128 lb/hr of SO_2 emissions from the various furnace stacks. The Phase Zero design has assumed that this additional emission will be environmentally acceptable. It is recognized that such emissions may be further limited at some time in the future; therefore, future COS hydrolysis facilities are shown schematically on the Process Flow Diagram 12-D-B-4. The cost for such facilities has not been included in the estimate; however, plot plan area has been provided.

2.2.4 Shifted Gas Purification

The combined shifted gas stream is split into three streams to be processed with three purification trains. Each stream is flow controlled to maintain equal or constant ratio of flow to each purification train. The individual flow controllers are reset in unison by a single pressure

controller on the suction of the hydrogen compressors. Purification feed gas pressure is in turn controlled by regulating the quantity of gas fed to the shift section.

Purification consists of removing H_2S and CO_2 from the shifted gas stream to satisfy hydrogen product purity requirements while at the same time, producing a stripped H_2S off-gas suitable for feed to the Sulfur Plant (Plant 10) and a stripped CO_2 waste gas with less than 10 ppmw H_2S suitable for atmospheric discharge. The hydrogen product is essentially free of H_2S and contains only 0.2% by volume CO_2.

The purification is performed using Allied Chemical's Selexol Process. The Selexol solvent applies the capacity of the dimethyl ether of polyethylene glycol to physically and selectively absorb CO_2 and H_2S.

The Process Flowsheets 12-D-B-5 and 12-D-B-6 present the shifted gas purification section. The purification scheme involves removal of H_2S to the required very low level with a small fraction of CO_2 and then removal of the remainder of the CO_2. These two removal steps are carried out in separate absorbers with separate solutions. Each solution is regenerated separately to give two different off-gases. Essentially all the feed H_2S is contained in the off-gas from the H_2S removal step. The off-gas from the CO_2 removal step contains a maximum of 10 ppm H_2S.

The H_2S Absorber (12C-116) has 70 trays to effect the extremely low H_2S level required in both the product hydrogen and the CO_2 waste gas. To minimize absorber tray requirements and to decrease solution circulation rates, the lean feed solvent is thoroughly presaturated with CO_2 before removing heat of absorption in the Lean Solvent Cooler (12E-121). Presaturation is accomplished by contacting the absorber overhead with lean feed solvent. After cooling, net gas is separated

from presaturated solvent in the 12C-114 drum. The gas then flows to the CO_2 absorber and the presaturated solvent is pumped into the top of the H_2S absorber.

The solution circulation rate is determined by the quantity of the H_2S to be removed and the capacity of the Selexol solvent for H_2S at operating conditions. Full system pressure is used to reduce solvent circulation rate. Ambient temperature operation was also utilized although lower temperature operation would have reduced solution circulation rate due to the greater solvent capacity at lower temperatures. Lower solution temperatures would require refrigeration, the cost of which exceeded the savings accruing to reduced solvent circulation.

The rich solvent from the H_2S absorber at 600 psia is routed through a Hydraulic Recovery Turbine (12GH-132) into the first stage of a flash system. The power output shaft from the turbine is coupled to the solvent circulation Pump (12G-132), which is also provided with an electric motor driver.

A two-stage flash system is required primarily to allow desorption of CO_2 from the rich solution prior to H_2S stripping. Prior partial removal of CO_2 increases the H_2S concentration in the H_2S Stripper (12C-124) off-gas to a level suitable for Sulfur Plant (Plant 10) feed. The flashed gases which contain substantial quantities of H_2S and hydrogen in addition to CO_2 are recycled to the H_2S Absorber (12C-116). Two flash drums (12C-117 and 12C-118) and three stages of compression (12K-104 A, B and C) are included in this flashing and recompression system.

Regeneration of the rich solvent after flashing is performed by stripping with solvent vapors generated by the 12E-133 reboiler at the bottom of 12C-124. Overhead vapors are partially condensed to minimize loss of

solvent and maintain the water balance. The condensate is returned to the tower as reflux. The stripper overhead pressure is set by that required to transfer off-gas to Plant 10.

To conserve energy, cold rich solvent is preheated by the hot stripped solvent in the 12E-135 heat exchanger. The preheated rich solvent is further heated to boiling temperatures with 50 psig steam which minimizes duty of the stripper reboiler.

The overhead gas from the 12C-116 and the Lean Solvent Presaturator (12C-114) in the H_2S removal section still contains about 95% of the CO_2 that was in the shifted gas feed to 12C-116. This overhead stream is next directed to the CO_2 removal section. The CO_2 removal system also includes absorption and stripping with an intermediate flash step.

A single intermediate flash stage is used. The pressure is set on the H Flash Drum (12C-120) to permit most of the absorbed hydrogen to be flashed into the medium Btu fuel gas system.

One of the most important considerations in design of the CO_2 removal section is the solution circulation rate. Due to the large quantity of CO_2 to be removed, circulation rates are quite large. In the Phase Zero design, lean solvent is required at the Shifted Gas CO_2 Absorber (12C-121) in each train. The penalty for high solution circulation rates is large equipment, especially the absorber and stripper towers, and high power requirements of circulating pumps. To reduce circulation requirements below what would otherwise be needed, propane refrigeration has been employed to allow operation of the system at subambient temperatures. An optimum absorber bottoms temperature has been established.

Refrigeration is applied at the two most practical points - on the gas feed to the absorber and immediately after the flash stage where the liquor temperature has dropped only 1°F from the absorber bottom location but is at a much lower pressure.

Regeneration in the stripper system is accomplished with air supplied by the Air Blower (12K-109). The use of air was made possible by the fact that the overhead off-gas is being discharged to the atmosphere. If the CO_2 were to be reused, air stripping would not be possible.

Large solvent circulation rates and the low pressures required for stripping necessitated the use of two Shifted Gas CO_2 Strippers (12C-123 A and B) per train.

The off-gases from stripping at 50°F are used to precool absorber feed gas in the CO_2 Loop Cold Recovery Exchanger (12E-147) and thus further reduce refrigeration requirements. After cold recovery the off-gases are then vented to atmosphere.

As was done in the H_2 removal section, hydraulic recovery turbines are used in the CO_2 removal system to recover energy as the rich solution is depressured from the absorber at 560 psia to the near atmosphere stripping pressure. One turbine (12GH-121A) is located between the absorber and the 250 psia flash stage and the Low-Pressure Flash Drums (12C-132 A and B). These power recovery turbines are coupled to the 12G-121 solution circulating pumps.

A solution purge is necessary to maintain the water balance in the CO_2 removal section. This purge is directed to the H_2S stripper where, because of the high operating temperature, the water is adequately removed. The purged quantity is replenished by a stream of stripped liquor from the H_2S stripper.

2.2.5 Hydrogen Compression

Purified hydrogen product from the CO_2 absorber is combined with hydrogen streams from Naphtha Hydrotreating and Reforming (Plant 18) and from Cryogenic Hydrogen Purification (Plant 8), and then compressed to a final

pressure of 3,480 psia for delivery as the total hydrogen makeup requirement to the H-Coal® Preheating and Reaction plant (Plant 3). Five compressor trains have been specified. Four are to be operating, and one in standby. The hydrogen compression is included on Flowsheet 12-D-B-6.

2.2.6 Unshifted Gas Purification

Raw syngas in excess of that required for hydrogen production is diverted under pressure control to the unshifted gas purification section. This section consists of a single train designed to cool and treat the excess unshifted gas for removal of hydrogen sulfide so that it will be suitable for burning in the plant medium Btu fuel gas system. The technology chosen for this service is a nonselective version of Allied Chemical's Selexol Process which entails treatment of the gas in a single H_2S absorber.

Unshifted gas purification is presented on Flowsheet 12-D-B-4.

The hot saturated syngas at 438°F is first cooled to 385°F with a waste heat boiler producing 150 psig steam and then further cooled to 325°F with another waste heat boiler producing 50 psig steam. All condensed water is removed at the 325°F level. The gas is then further cooled to 100°F in water cooled exchangers. The final cooled gas is then passed through the Fuel Gas H_2S Absorber (12C-127). The treated gas contains less than 10 grains of H_2S per 100 scf.

The absorption is performed at full pressure (660 psia) for greater economy. However, the fuel gas pressure requirement is only 65 psia. Expander turbines are utilized to recover energy from the gas exiting the absorber. Two-stage Fuel Gas Turbo Expanders (12K-111 A and B) have been provided. Due to the expansion cooling, the gas is preheated so as to avoid subambient exit temperatures. Such heating also yields additional energy for power recovery.

Rich solvent from the 12C-127 absorber is routed into the shifted gas purification section for H_2S stripping. Since it is flowing from a single train into a three train system, the rich solvent flow is divided with approximately equal flowrates to each of the three H_2S strippers in the shifted gas purification section. After feed-bottoms exchange at the H_2S stripper, regenerated lean solution from each train is combined and returned to the unshifted gas treating section. The lean solution is further cooled in the Lean Solution Cooler (12E-137) and then pumped to the Fuel Gas H_2S Absorber (12C-127).

2.3 Catalysts, Packings and Chemicals

	Initial Inventory	Consumption Rate or (Estimated Life)
Catalysts		
Haldor Topsoe - SSK	Proprietary	(3 years)
Packing		
2-inch S.S. Pall Rings	21,600 ft^3	
2-inch C.S. Pall Rings	47,600 ft^3	
Chemicals		
Allied Chemical Selexol	Proprietary	400 GPD

2.4 Utility Balance

Electricity, kW

Condition	Consumed	Generated
Operating	60,590	5,128

Steam, lb/hr

Imported Level, psig	Consumed	Generated	Imported (Exported)
900	233,640	233,640	--
150	281,610	211,290	70,320
50	98,940	400,810	(310,870)

Condensate Returned: 453,330 lb/hr

Water, GPM

Boiler feedwater: 1,837

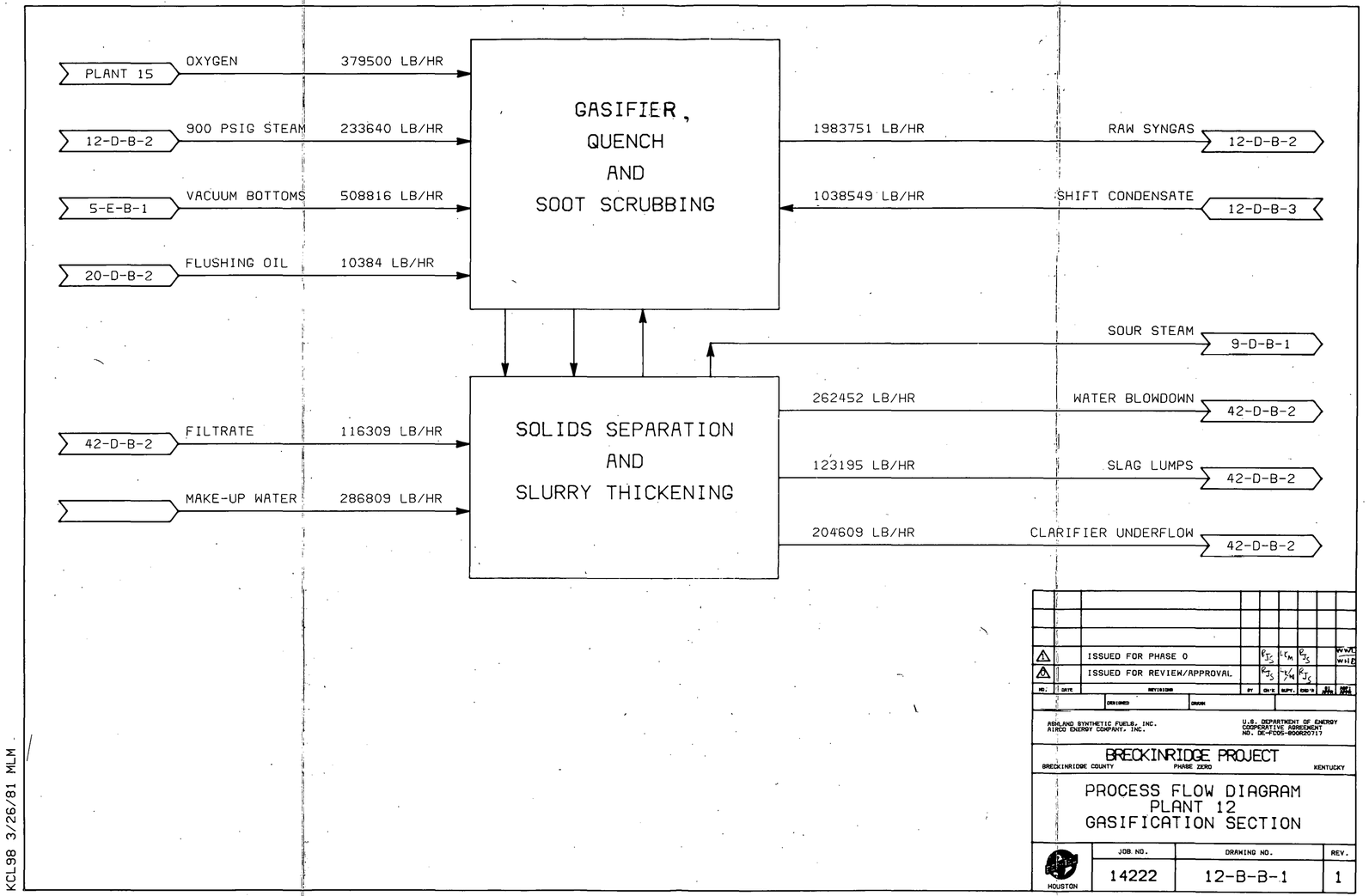
Cooling water circulation: 36,761

Fuel, MM Btu/hr*

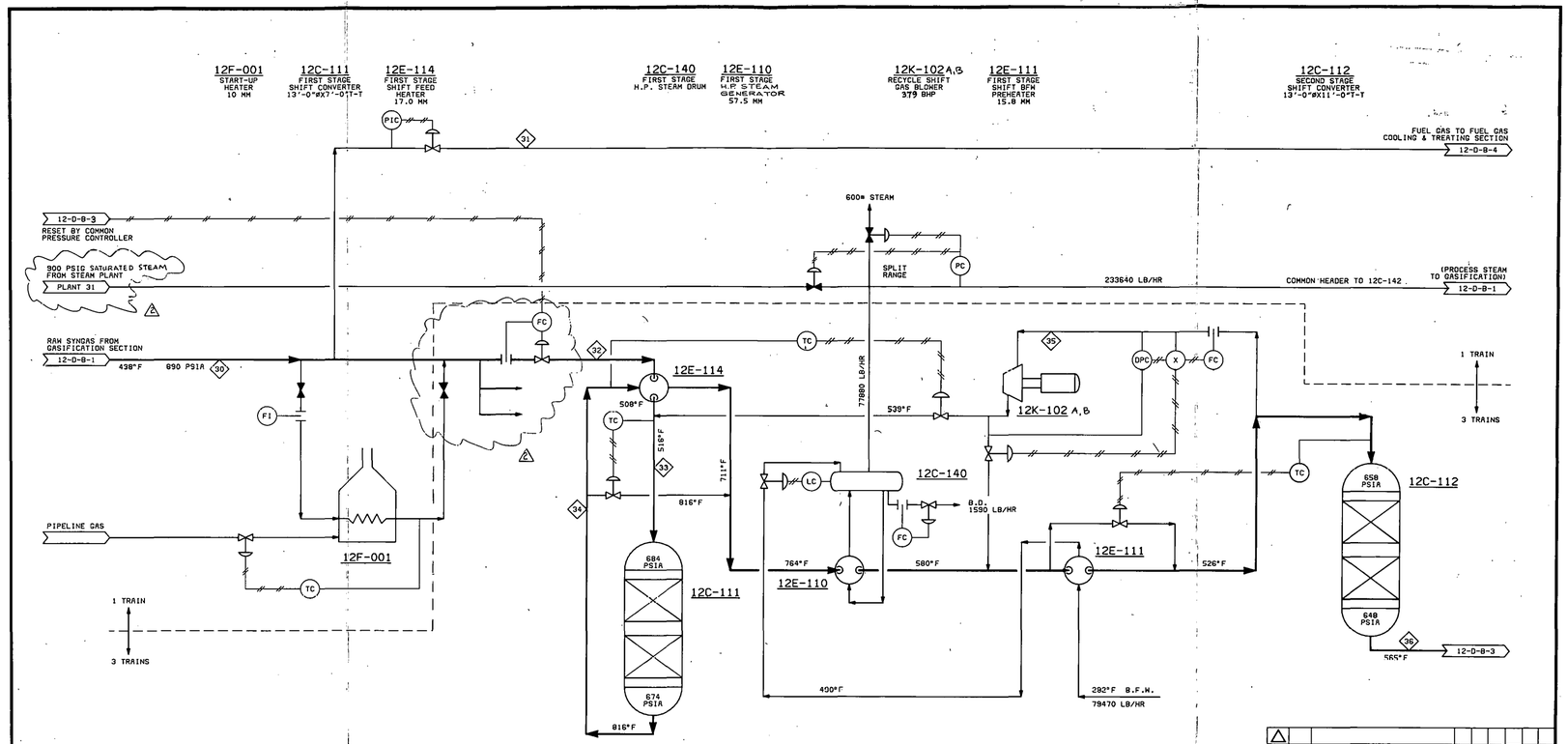
Heat absorbed: 10.0

Total fired duty: 17.0

* For shift section startup furnace.



KCL98 3/26/81 MLM



STREAM NO.	30	31	32	33	34	35	36
DESCRIPTION / COMPONENT	RAW SYNGAS FEED	RAW GAS TO COOLING	SHIFT SECTION FEED	FIRST STAGE CONVERTER FEED	FIRST STAGE CONVERTER EXIT	RECYCLE SHIFT GAS	SECOND STAGE CONVERTER EXIT
MMSCFD	982.3	211.1	257.1	304.0	304.0	46.9	257.1
MW	18.40	18.40	18.40	18.40	18.40	18.40	18.39
LB/HR TOTAL	1384420.	426462.	519317.	614031.	614031.	94714.	519317.
COMPONENT, MOLS/HR							
H2	19029.5	4089.5	4980.0	6908.8	12503.8	1928.9	11173.8
CO	24796.2	5328.8	6489.1	6652.1	1057.1	163.0	295.3
CO2	3432.2	737.6	898.2	2083.3	7682.9	1185.1	7096.5
H2O	59931.0	12879.5	15683.8	17523.1	11923.9	1839.2	9485.8
CH4	144.6	31.1	37.8	44.7	44.7	6.9	37.8
H2S	283.8	61.0	74.3	88.6	92.8	14.3	78.7
COS	17.7	3.8	4.6	4.7	0.50	0.08	0.17
N2	182.0	39.1	47.6	56.3	56.3	8.7	47.6
AR	58.9	12.7	15.4	18.2	18.2	2.8	15.4
MPW, TOTAL	107875.9	23183.1	28230.9	33378.9	33378.9	5149.0	28230.9

NOTES:

1. STREAMS(32)THROUGH(36)1/3 OF THE TOTAL FLOW. (1 TRAIN OUT OF 3)
2. THE CONDENSATE FROM THE SHIFT SECTION AMOUNTS TO 1/3 OF THE FLOW.
3. MM = 1,000,000 BTU/HR.
4. MMSCFD @ 60° AND 14.7 PSIA.
5. GPM ARE AT FLOW CONDITIONS.
6. N.C. = NORMALLY CLOSED.
7. Ø = DIAMETER.
8. T-T = TANGENT TO TANGENT DISTANCE.

NO.	DATE	REVISIONS	BY	CHK'D	SUPV.	ENG'R	BY APPR.	KEPT APPR.
4	9/14/01	REV. 12F-001 OUTLET & STRM.REF.	LCN					WHL
3	9/22/01	ISSUED FOR PHASE 0	LCN					WHP
2	10/22/01	ISSUED FOR REVIEW/APPROVAL	LCN					
1								
0								

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AMOCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-00OR20117

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY | PHASE ZERO | KENTUCKY

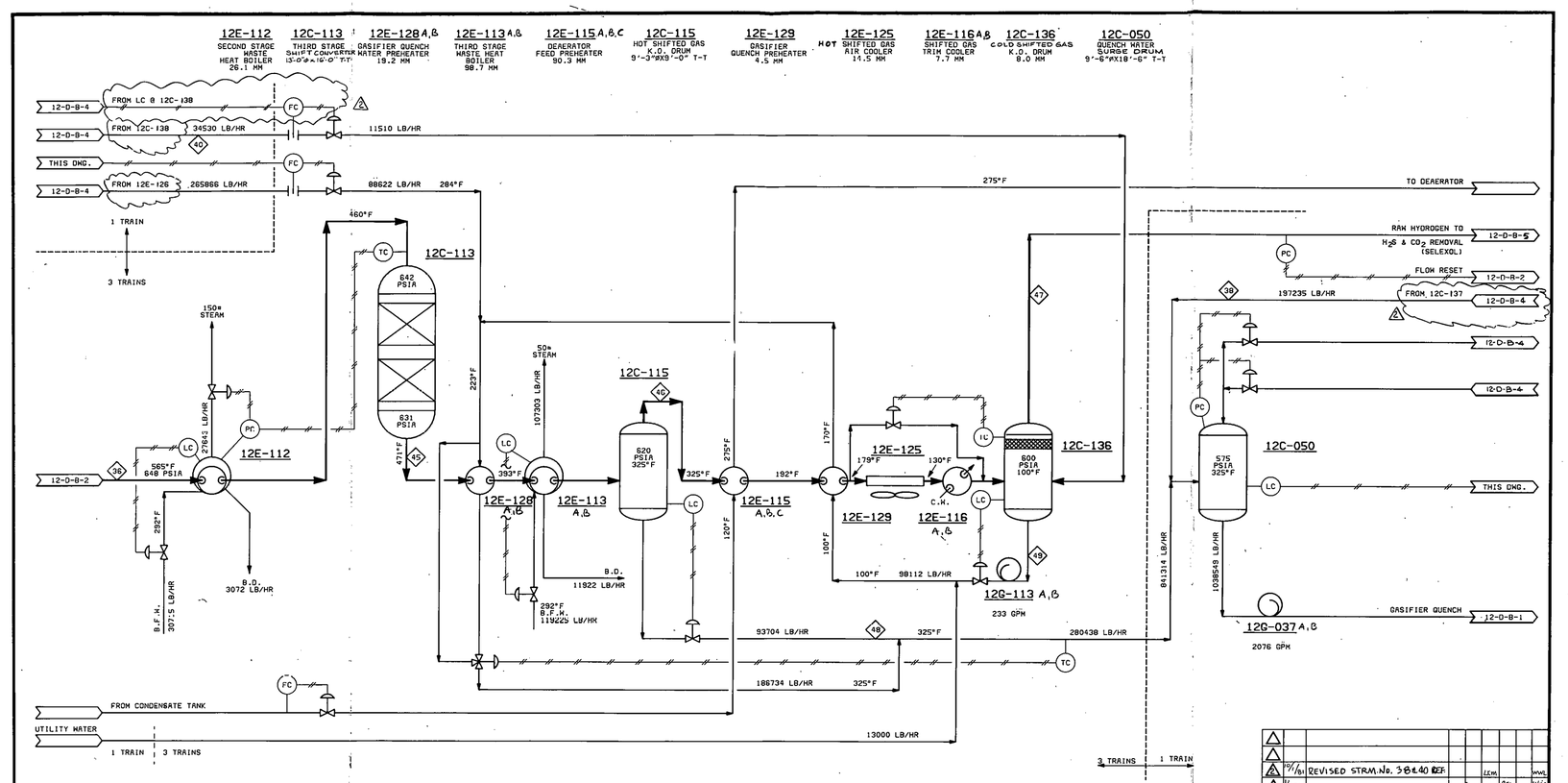
PROCESS FLOW DIAGRAM PLANT 12 GASIFICATION & PURIFICATION PLANT SHIFT SECTION

HOUSTON

JOB NO.	DRAWING NO.	REV.
14222	12-D-B-2	2

22 X 34 "D" SIZE

KCL48C 01/18/01 TM



STREAM NO.	40	45	46	47	48	49
DESCRIPTION / COMPONENT	FUEL GAS COLD SEPARATOR LIQUID	THIRD STAGE EXIT	HOT SEPARATOR GAS	COLD SEPARATOR GAS	HOT SEPARATOR LIQUID	COLD SEPARATOR LIQUID
MMSCFD (GPM @ 60°F)	(68.)	257.1	209.8	172.6	(187.)	(170.)
MM (S.G. @ 60°F)	(1.0006)	18.39	18.48	18.58	(1.0006)	(1.0006)
LB/HR TOTAL	34530.	519317.	425813.	352012.	93704.	85112
COMPONENT, MOLS/HR						
H2		11338.8	11338.8	11338.8		
CO		130.3	130.3	130.3		
CO2		7261.6	7261.6	7261.6		
H2O	1916.2	9320.5	4121.9	37.4	5198.6	4723.2
CH4		37.8	37.8	37.8		
H2S		78.8	78.8	78.8		
COS		0.10	0.10	0.10		
N2		47.6	47.6	47.6		
AR		15.4	15.4	15.4		
MPH, TOTAL	1916.2	28280.9	23032.3	18947.8	5198.6	4723.2

NOTES:

1. STREAM(S) 36 THROUGH 45, 46, 47, 48, 49 1/3 OF THE TOTAL FLOW. (1 TRAIN OUT OF 3)
2. THE CONDENSATE FROM THE SHIFT SECTION AMOUNTS TO 1/3 OF THE FLOW.
3. SOLUBILITY OF H_2S & CO_2 IN CONDENSATE HAS NEGLECTED FOR MATERIAL BALANCE CALCULATIONS.
4. MM = 1,000,000 BTU/HR.
5. MMSCFD @ 60°F AND 14.7 PSIA.
6. PUMP GPM ARE AT FLOW CONDITIONS.
7. NC = NORMALLY CLOSED
   OR EQUIVALENT NOTES FOR THE METRIC SYSTEM.
8. ø = DIAMETER.
9. T-T = TANGENT TO TANGENT DISTANCE.

NO.	DATE	REVISIONS	BY	CHK.	SUPV.	ENG'R	BI APPR.	ASST APPR.
3	10/1/81	REVISED STRM. No. 36 & 40 REF.			LEM			WWL
2	9/23/81	ISSUED FOR PHASE 0		JSL	LEM	RJC		WHD
1	7/22/81	ISSUED FOR REVIEW/APPROVAL		JSL	LEM	RJC		

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80DP20117

BRECKINRIDGE PROJECT

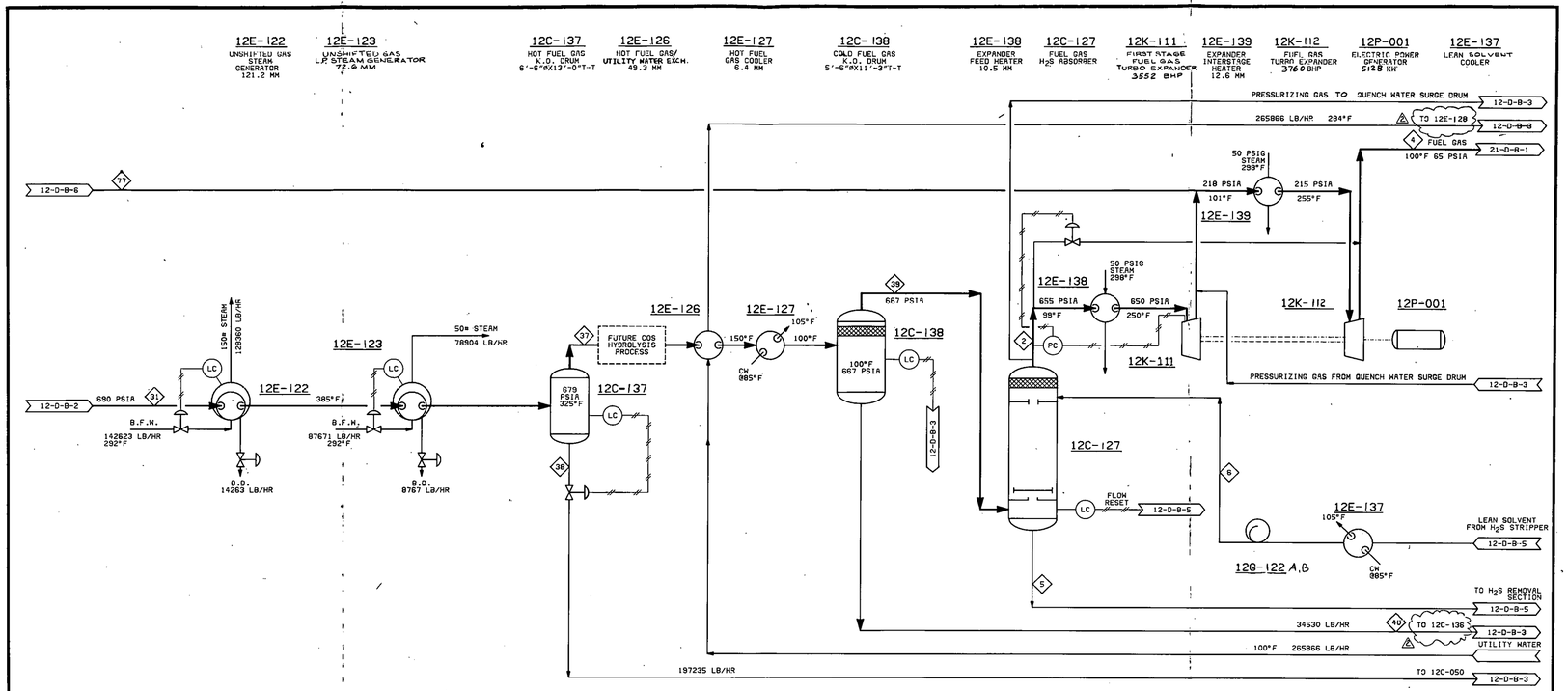
BRECKINRIDGE COUNTY | PHASE ZERO | KENTUCKY

PROCESS FLOW DIAGRAM PLANT 12 GASIFICATION & PURIFICATION PLANT SHIFT SECTION

HOUSTON	JOB NO.	DRAWING NO.	REV.
	14222	12-D-B-3	2

22 X 34 "D" SIZE

KCL32E 01/18/81 MJ



STREAM NO.	31	37	38	39	40	2	5	6	17	4
DESCRIPTION / COMPONENT	RAW GAS TO COOLING	HOT SEPARATOR FUEL GAS	HOT FUEL GAS SEP. LIQUID	COLD SEPARATOR FUEL GAS	COLD FUEL GAS SEP. LIQUID	DESUL-FURIZED FUEL GAS	ABSORBER RICH SOLVENT	ABSORBER LEAN SOLVENT	H2 RICH GAS FROM SELEXOL	FUEL GAS TO PLNT DISTRIB.
MMSCFD (GPM @ 60°F)	211.1	111.5	(394.)	94.0	(69.)	91.2	P	P	3.0	94.2
MW (S.G. @ 60°F)	18.40	18.73	(1.0006)	18.86	(1.0006)	18.35	(1.0244)	(1.0298)	28.79	18.68
LB/HR TOTAL	426462.	229227.	197235.	194697.	34530.	183858.	P	P	9382.	193250.
COMPONENT, MOLS/HR										
H2	4089.5	4089.5		4089.5		4072.8	17.0		116.4	4189.0
CO	5328.8	5328.8		5328.8		5280.3	48.5		2.33	5282.6
CO2	737.6	737.6		737.6		580.4	157.2		205.7	786.1
H2O	12879.5	1934.2	10945.3	18.0	1916.2		1149.2	1131.2	0.19	0.19
CH4	31.1	31.1		31.1		30.4	0.66		0.99	31.4
H2S	61.0	61.0		61.0		0.05	61.0	0.04		0.01
COS	3.8	3.8		3.8		2.0	1.8			2.0
N2	39.1	39.1		39.1		38.9	0.23		0.53	39.4
AR	12.7	12.7		12.7		12.6	0.07		0.18	12.8
SELEXOL							P	P		
MPH, TOAL	29189.1	12237.8	10945.3	10321.6	1916.2	10017.2	P	P	326.3	10313.5

KCL34C 01/16/81 KJ

NOTES:
1. MM = 1,000,000 BTU/HR
2. MMSCFD AT 60°F AND 14.7 PSIA
3. GPM ARE AT FLOW CONDITIONS
4. NC = NORMALLY CLOSED
5. ø = DIAMETER
6. T-T = TANGENT TO TANGENT DISTANCE
7. P = PROPRIETARY

NO.	DATE	REVISIONS	BY	CHK'D	APP'D	BY APPR.	APPT. APPR.
4	5/16/81	REVISED STRM NO. 40 REF.		LKH			WWC
3	2/23/81	ISSUED FOR PHASE 0		LKH	REC		WWC
2	2/2/81	ISSUED FOR REVIEW/APPROVAL		LKH	REC		

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AMOCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80ER20717

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY — PHASE ZERO — KENTUCKY

PROCESS FLOW DIAGRAM PLANT 12 - GASIFICATION & PURIFICATION FUEL GAS COOLING AND TREATING SECTION

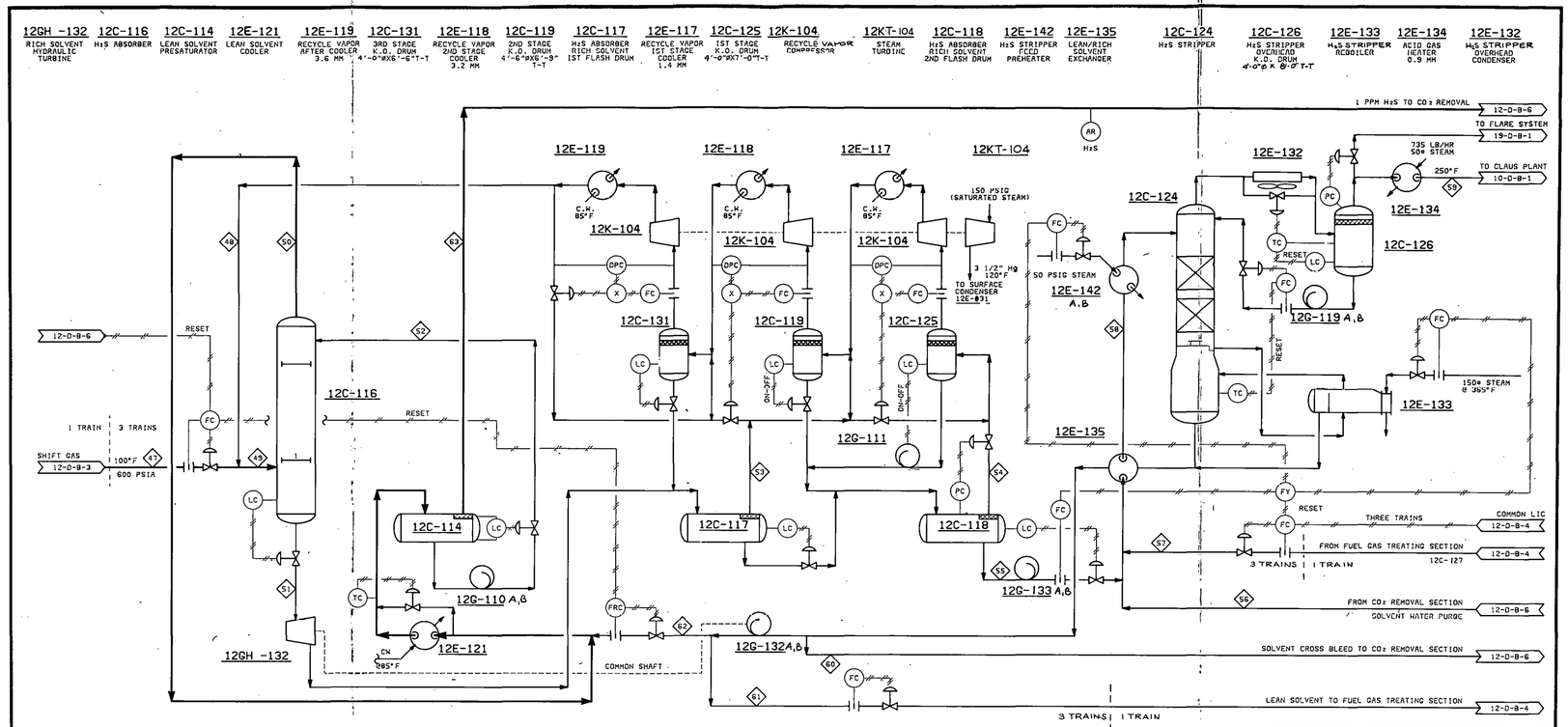
HOUSTON

JOB NO. 14222

DRAWING NO. 12-D-B-4

REV. 2

22 X 34 "D" SIZE



STREAM NO.	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
DESCRIPTION / COMPONENT	SHIFT GAS TO H2S ABSORBER	RECYCLE ABSORBER GAS	TOTAL FEED GAS TO ABSBR	OVHD GAS FROM H2S ABSORBER	H2S ABSBR RICH SOLVENT	LEAN SOLV TO H2S ABSORBER	FLASH GAS FROM 1ST STAGE	FLASH GAS FROM 2ND STAGE	RICH SOLV FROM 2ND STAGE	LEAN SOLV H2O PURGE FROM CO2 REMOVAL	RICH SOLV FROM FUEL GAS ABSBR	TOTAL RICH SOLV TO H2S STRPPR	H2S RICH GAS FROM GAS HTR	LEAN SOLV H2O PURGE TO CO2 REMOVAL	LEAN SOLV TO FUEL GAS ABSBR	LEAN SOLV TO CO2 PRESAT'R	PRESAT R FLASH OVHD TO CO2 REMOVAL
MMSCFD (GPM @ 60°F)	172.6	18.0	190.6	185.9	P	P	11.5	6.6	P	P	P	P	P	P	P	P	168.1
MW (S.G. @ 60°F)	18.59	42.45	20.84	20.36	(1.0108)	(1.0141)	41.85	43.51	(1.0262)	(1.0292)	(1.0244)	(1.0260)	38.45	(1.029)	(1.0298)	(1.0298)	18.00
LBS/HR TOTAL	3212012	84189.	436189.	415769.	P	P	52845.	31413.	P	P	P	P	23965.	P	P	P	332240.
COMPONENT, MOLS/HR	2%																
H2	11398.8	58.1	11396.9	11389.4	58.3	60.8	57.4	0.78	0.15		5.7	5.85	5.85				11398.7
CO	130.3	1.5	131.0	121.0	1.5	1.6	1.5	0.03	0.01		16.2	16.2	16.2				130.3
CO2	7261.6	1863.6	9125.2	8702.4	2237.5	1894.7	1174.9	688.7	372.6	0.27	52.4	425.3	425.3				6888.9
H2O	37.4	0.4	37.8		2582.9	2545.1	0.14	0.25	2582.5	99.4	383.1	3065.0	76.4	66.4	377.1	2545.1	
CH4	37.8	1.0	38.8	38.8	1.0	1.0	0.93	0.07	0.01		0.21	0.22	0.22				37.8
H2S	78.8	57.8	136.6	0.03	136.6	0.03	25.7	32.1	78.3		20.3	98.6	98.6		0.01	0.02	0.02
COS	0.10	0.05	0.15	0.11	0.07	0.04	0.03	0.02	0.02		0.61	0.63	0.63				0.07
N2	47.6	0.3	47.9	47.9	0.28	0.28	0.26	0.01	0.01		0.06	0.07	0.07				47.6
AR	15.4	0.2	15.6	15.6	0.09	0.09	0.09	0.00	0.00		0.04	0.04	0.04				15.5
SELEXOL					P	P			P	P	P	P		P	P	P	
MPH, TOTAL	18947.8	1983.0	20930.7	20416.0	P	P	1261.0	722.0	P	P	P	P	623.3	P	P	P	18458.9

NCL:BB1 01/16/81 MJ

NOTES:

1. MATERIAL FLOW FOR A SINGLE TRAIN.
2. A TOTAL OF 3 TRAINS REQUIRED.
3. MM = 1,000,000 BTU/HR.
4. MMSCFD @ 60°F AND 14.7 PSIA.
5. GPM ARE AT FLOW CONDITIONS.
6. N.C. = NORMALLY CLOSED.
7. ø = DIAMETER.
8. T-T = TANGENT TO TANGENT DISTANCE.
9. P= PROPRIETARY.

NO.	DATE	REVISIONS	BY	CHK'D	SUPV.	ENG'G	M. APPR.	ASST. SUPR.
4	10/1/81	REVISED STR.M. NO. 47 M.W.			LBM		MVL	
3	9/23/81	ISSUED FOR PHASE 0		KSS	LKM	RBK		WJH
2	10/24/80	ISSUED FOR REVIEW/APPROVAL		KSS	LKM	RBK		

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80DR20177

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY — PHASE ZERO — KENTUCKY

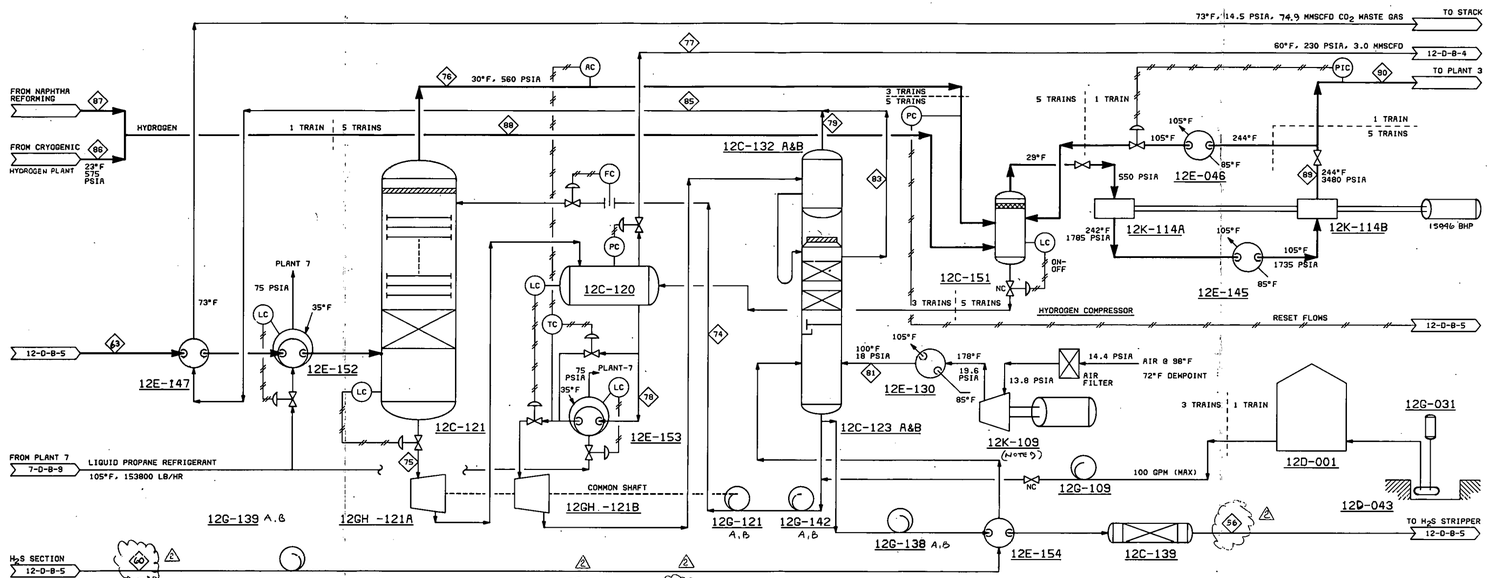
PROCESS FLOW DIAGRAM PLANT 12 GASIFICATION & PURIFICATION SELEXOL H2S REMOVAL SECTION

HOUSTON	JOB NO.	DRAWING NO.	REV.
	14222	12-D-B-5	2

22 X 34 "D" SIZE

12E-152	12E-147	12GH -121A	12C-121	12C-120	12E-153	12GH -121B	12C-132 A&B	12E-130	12C-123 A&B	12C-151	12K-109	12K-114	12E-145
CO_2 ABSORBER PRECOOLER	CO_2 LOOP COLD RECOVERY EXCHANGER	HYDRAULIC TURBINE	CO_2 ABSORBER	H_2 FLASH DRUM	RICH SOLUTION CHILLER	HYDRAULIC TURBINE	LOW PRESSURE FLASH DRUM	STRIPPER AIR-COOLER	CO_2 STRIPPER	H_2 COMPRESSOR 4.0 DRUM 4'-6"ØX9'-9"T-T	AIR BLOWER	HYDROGEN COMPRESSOR 15946 BHP	H_2 COMPRESSOR INTERSTAGE COOLER 14.4 MM

12E-046	12E-154	12C-139	12D-001	12D-043
SPILL-BACK COOLER 3.0 MM (MAX)	SOLVENT EXCHANGER	SOLVENT FILTER	SOLVENT MAKE-UP TANK	SOLVENT SUMP



STREAM NO.	63	74	75	76	77	78	79	80	81	60	83	56	85	86	87	88	89	90
DESCRIPTION / COMPONENT	FEED GAS FROM H2S ABSORBER	LEAN SOLV TO CO2 ABSORBER	RICH SOLV FROM CO2 ABSORBER	H2 GAS PRODUCT TO COMP	H2 FLASH GAS TO FUEL GAS	RICH SOLV FROM H2 FLASH	LP FLASH CO2 WASTE GAS	LP FLASH SOLV TO CO2 STPR	AIR TO CO2 STRIPPER	LEAN-SOLV H2O PURGE FROM H2S REMOVAL	CO2 STRIPPER OFF GAS	LEAN-SOLV H2O PURGE TO H2S REMOVAL	TOTAL CO2 WASTE GAS TO ATM	H2 FROM CRYOGENIC PURIF.	H2 FROM NAPHTHA REFORMING	ONE TRAIN CRYO/REFR H2 TOTAL	COMPR H2 PRODUCT	TOTAL H2 TO PLANT 3
MMSCFD (GPM @60DEGF)	188.1	P	P	104.1	3.0	P	53.8	P	14.3	P	21.1	P	74.9	225.7	9.3	58.8	136.8	547.6
MM (S.G. @ 60DEGF)	18.00 (1.0292)	(1.0092)	2.59	28.78 (1.0106)	43.63 (1.0268)	28.68 (1.029)	33.76 (1.0292)	P	40.61	3.65	3.36	3.64	3.04	3.06				
LBS/HR TOTAL	332240.	P	P	28568.	9392.	P	257941.	P	44694.	P	79439.	P	331580.	90530.	3445.	23493.	45670.	182680.
COMPONENT,MOLS/HR																		
H2	11338.7		154.2	11184.6	116.4	37.8	37.7	0.04			0.04		37.7	23201.0	974.9	6044.0	14432.4	57729.6
CO	130.3		4.08	126.2	2.33	1.75	1.75						1.75	648.5		162.1	256.8	1027.2
CO2	6888.9	26.8	6892.9	22.9	205.7	6687.2	5847.8	839.4	0.46		812.8	0.27	6660.6				17.2	68.8
H2O		10136.1	10136.1		0.19	10135.9	22.9	10113.0	41.1	66.4	22.4	99.4	45.3					
C1	37.8		2.92	34.9	0.99	1.93	1.92	0.01			0.01		1.93	215.4	18.4	58.0	84.2	336.8
C2=															1.07	0.27	0.27	1.08
C2															21.5	5.38	5.38	21.52
C3=															0.17	0.04	0.04	0.16
C3															8.03	2.01	2.01	8.04
C4=															0.28	0.07	0.07	0.28
NC4															2.31	0.58	0.58	2.32
IC4															0.50	0.13	0.13	0.52
H2S	0.02		0.02			0.02	0.01	0.01			0.01		0.02					
COS	0.07		0.07			0.07	0.05	0.02			0.02		0.07					
N2	47.6		0.73	46.9	0.53	0.20	0.20		2189.3		1189.3		1189.5	519.1		129.8	165.0	660.0
AR	15.5		0.24	15.2	0.18	0.06	0.06		10.3		10.3		10.4	169.0		42.2	53.7	214.8
O2									319.9		319.9		319.9					
SELEXOL		P	P			P		P		P		P						
MPH, TOTAL	18458.9	P	P	11430.7	326.3	P	5912.4	P	4565.2	P	2356.8	P	82712.	24753.0	1025.2	6444.6	15017.8	60071.2

NOTES:

1. MATERIAL BALANCE FOR A SINGLE SELEXOL TRAIN OUT OF THREE TRAINS.
2. MATERIAL BALANCE FOR A SINGLE GAS COMPRESSION OUT OF FOUR TRAINS, WITH 5TH SPARE TRAIN.
3. MM = 1,000,000 BTU/HR.
4. MMSCFD @ 60°F AND 14.7 PSIA.
5. GPM ARE AT FLOW CONDITIONS.
6. NC = NORMALLY CLOSED.
7. Ø = DIAMETER.
8. T-T = TANGENT TO TANGENT DISTANCE.
9. 12K-003 COMMON SPARE TO 12K-100 TO 303
10. P= PROPRIETARY

NO.	DATE	REVISIONS	BY	CHK'D	SUPV.	ENG'G	BI APPR.	ASHT APPR.
3	9/21/01	REVISED STRM. No. 56 & 60			TSM			WWL
2	11/22/00	ISSUED FOR PHASE 0		KSS	LKM	KKL		WWL
1	10/27/00	ISSUED FOR REVIEW/APPROVAL		KSS	LKM	KKL		

DESIGNED DRAWN

ASHLAND SYNTHETIC FUELS INC.
AIRCO ENERGY COMPANY, INC

U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-92OR20117

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

PROCESS FLOW DIAGRAM PLANT 12 SELEXOL GAS PURIFICATION CO_2 REMOVAL AND H_2 COMPRESSION

HOUSTON	JOB NO. 14222	DRAWING NO. 12-D-B-6	REV. 2

CCL17E 01/19/01 MDB

22 X 34 "D" SIZE

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12	GASIFICATION & PURIFICATION PLANT	000000
12C-001	GASIFIER FEED TANK	000000
12C-002	GASIFIER FEED TANK	000000
12C-102	LOCK HOPPER	000000
12C-202	LOCK HOPPER	000000 NA
12C-302	LOCK HOPPER	000000 NA
12C-402	LOCK HOPPER	000000 NA
12C-502	LOCK HOPPER	000000 NA
12C-103	SOOT SCRUBBER	000000
12C-203	SOOT SCRUBBER	000000 NA
12C-303	SOOT SCRUBBER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-403	SOOT SCRUBBER	000000
12C-503	SOOT SCRUBBER	000000 NA
12C-004	FLASH DRUM	000000 NA
12C-111	FIRST STAGE SHIFT CONVERTER	000000
12C-211	FIRST STAGE SHIFT CONVERTER	000000
12C-311	FIRST STAGE SHIFT CONVERTER	000000
12C-112	SECOND STAGE SHIFT CONVERTER	000000
12C-212	SECOND STAGE SHIFT CONVERTER	000000
12C-312	SECOND STAGE SHIFT CONVERTER	000000
12C-113	THIRD STAGE SHIFT CONVERTER	000000
12C-213	THIRD STAGE SHIFT CONVERTER	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-313	THIRD STAGE SHIFT CONVERTER	000000
12C-114	LEAN SOLVENT PRESATURATOR	000000
12C-214	LEAN SOLVENT PRESATURATOR	000000
12C-314	LEAN SOLVENT PRESATURATOR	000000
12C-115	HOT SHIFTED GAS K.O. DRUM	000000
12C-215	HOT SHIFTED GAS K.O. DRUM	000000
12C-315	HOT SHIFTED GAS K.O. DRUM	000000
12C-116	H2S ABSORBER	000000
12C-216	H2S ABSORBER	000000
12C-316	H2S ABSORBER	000000
12C-117	H2S ABSORBER RICH SOLVENT 1ST FLASH DRUM	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-217	H2S ABSORBER RICH SOLVENT 1ST FLASH DRUM -	000000
12C-317	H2S ABSORBER RICH SOLVENT 1ST FLASH DRUM -	000000
12C-118	H2S ABSORBER RICH SOLVENT 2ND FLASH DRUM -	000000
12C-218	H2S ABSORBER RICH SOLVENT 2ND FLASH DRUM -	000000
12C-318	H2S ABSORBER RICH SOLVENT 2ND FLASH DRUM -	000000
12C-119	2ND STAGE K.O. DRUM -	000000
12C-219	2ND STAGE K.O. DRUM -	000000
12C-319	2ND STAGE K.O. DRUM -	000000
12C-120	H2 FLASH DRUM -	000000
12C-220	H2 FLASH DRUM -	000000
12C-320	H2 FLASH DRUM -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-121	CO2 ABSORBER	000000
12C-221	CO2 ABSORBER	000000
12C-321	CO2 ABSORBER	000000
12C-123A	CO2 STRIPPER	000000
12C-123B	CO2 STRIPPER	000000
12C-223A	CO2 STRIPPER	000000
12C-223B	CO2 STRIPPER	000000
12C-323A	CO2 STRIPPER	000000
12C-323B	CO2 STRIPPER	000000
12C-124	H2S STRIPPER	000000
12C-224	H2S STRIPPER	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-324	H2S STRIPPER	000000
12C-125	1ST STAGE K.O. DRUM	000000
12C-225	1ST STAGE K.O. DRUM	000000
12C-325	1ST STAGE K.O. DRUM	000000
12C-126	H2S STRIPPER OVERHEAD K.O. DRUM	000000
12C-226	H2S STRIPPER OVERHEAD K.O. DRUM	000000
12C-326	H2S STRIPPER OVERHEAD K.O. DRUM	000000
12C-127	FUEL GAS H2S ABSORBER	000000
12C-131	3RD STAGE K.O. DRUM	000000
12C-231	3RD STAGE K.O. DRUM	000000
12C-331	3RD STAGE K.O. DRUM	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-132A	LOW PRESSURE FLASH DRUM	000000
12C-132B	LOW PRESSURE FLASH DRUM	000000
12C-232A	LOW PRESSURE FLASH DRUM	000000
12C-232B	LOW PRESSURE FLASH DRUM	000000
12C-332A	LOW PRESSURE FLASH DRUM	000000
12C-332B	LOW PRESSURE FLASH DRUM	000000
12C-136	COLD SHIFTED GAS K.O. DRUM	000000
12C-236	COLD SHIFTED GAS K.O. DRUM	000000
12C-336	COLD SHIFTED GAS K.O. DRUM	000000
12C-137	HOT FUEL GAS K.O. DRUM	000000
12C-138	COLD FUEL GAS K.O. DRUM	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-139	SOLVENT FILTER	000000
12C-239	SOLVENT FILTER	000000
12C-339	SOLVENT FILTER	000000
12C-140	FIRST STAGE H.P. STEAM DRUM	000000
12C-240	FIRST STAGE H.P. STEAM DRUM	000000
12C-340	FIRST STAGE H.P. STEAM DRUM	000000
12C-142	GASIFIER	000000
12C-242	GASIFIER	000000
12C-342	GASIFIER	000000
12C-442	GASIFIER	000000
12C-542	GASIFIER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-050	QUENCH WATER SURGE DRUM	000000
12C-151	H2 COMPRESSOR K.O. DRUM	000000
12C-251	H2 COMPRESSOR K.O. DRUM	000000
12C-351	H2 COMPRESSOR K.O. DRUM	000000
12C-451	H2 COMPRESSOR K.O. DRUM	000000 NA
12C-551	H2 COMPRESSOR K.O. DRUM	000000 NA
12C-052	50 PSIG CONDENSATE POT	000000 NA
12C-053	CONDENSATE K.O. DRUM	000000 NA
12C-154	LOCK HOPPER SURGE DRUM	000000 NA
12C-254	LOCK HOPPER SURGE DRUM	000000 NA
12C-354	LOCK HOPPER SURGE DRUM	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12C-454	LOCK HOPPER SURGE DRUM	000000 NA
12C-554	LOCK HOPPER SURGE DRUM	000000 NA
12C-055	FLUSHING OIL TANK	000000 NA
12C-056	CLARIFIED WATER TANK	000000 NA
12C-057A	FLUSHING OIL FILTER	000000 NA
12C-057B	FLUSHING OIL FILTER	000000 NA
12C-158	ASPIRATOR K.O. DRUM	000000 NA
12C-258	ASPIRATOR K.O. DRUM	000000 NA
12C-358	ASPIRATOR K.O. DRUM	000000 NA
12C-458	ASPIRATOR K.O. DRUM	000000 NA
12C-558	ASPIRATOR K.O. DRUM	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12D-001	SOLVENT MAKE UP TANK	000000
12D-002	BURNER TIP WATER TANK	000000
12D-102	GASIFIER QUENCH EFFLUENT WATER SUMP	000000 NA
12D-202	GASIFIER QUENCH EFFLUENT WATER SUMP	000000 NA
12D-302	GASIFIER QUENCH EFFLUENT WATER SUMP	000000 NA
12D-402	GASIFIER QUENCH EFFLUENT WATER SUMP	000000 NA
12D-502	GASIFIER QUENCH EFFLUENT WATER SUMP	000000 NA
12D-043	SELEXOL SUMP	000000
12E-110	FIRST STAGE H.P. STEAM GENERATOR	000000
12E-210	FIRST STAGE H.P. STEAM GENERATOR	000000
12E-310	FIRST STAGE H.P. STEAM GENERATOR	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-111	FIRST STAGE SHIFT BFW PREHEATER	000000
12E-211	FIRST STAGE SHIFT BFW PREHEATER	000000
12E-311	FIRST STAGE SHIFT BFW PREHEATER	000000
12E-112	SECOND STAGE WASTE HEAT BOILER	000000
12E-212	SECOND STAGE WASTE HEAT BOILER	000000 NA
12E-312	SECOND STAGE WASTE HEAT BOILER	000000
12E-113A	THIRD STAGE WASTE HEAT BOILER	000000
12E-113B	THIRD STAGE WASTE HEAT BOILER	000000
12E-213A	THIRD STAGE WASTE HEAT BOILER	000000
12E-213B	THIRD STAGE WASTE HEAT BOILER	000000
12E-313A	THIRD STAGE WASTE HEAT BOILER	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-313B	THIRD STAGE WASTE HEAT BOILER	000000
12E-114	FIRST STAGE SHIFT FEED HEATER	000000
12E-214	FIRST STAGE SHIFT FEED HEATER	000000
12E-314	FIRST STAGE SHIFT FEED HEATER	000000
12E-115A	DEAEREATOR FEED PREHEATER	000000
12E-115B	DEAEREATOR FEED PREHEATER	000000 NA
12E-115C	DEAEREATOR FEED PREHEATER	000000 NA
12E-215A	DEAEREATOR FEED PREHEATER	000000
12E-215B	DEAEREATOR FEED PREHEATER	000000 NA
12E-215C	DEAEREATOR FEED PREHEATER	000000 NA
12E-315A	DEAEREATOR FEED PREHEATER	000000

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-315B	DEAEREATOR FEED PREHEATER -	000000 NA
12E-315C	DEAEREATOR FEED PREHEATER -	000000 NA
12E-116A	SHIFTED GAS COOLER -	000000
12E-116B	SHIFTED GAS COOLER -	000000
12E-216A	SHIFTED GAS COOLER -	000000
12E-216B	SHIFTED GAS COOLER -	000000
12E-316A	SHIFTED GAS COOLER -	000000
12E-316B	SHIFTED GAS COOLER -	000000
12E-117	RECYCLE VAPOR 1ST STAGE COOLER -	000000
12E-217	RECYCLE VAPOR 1ST STAGE COOLER -	000000
12E-317	RECYCLE VAPOR 1ST STAGE COOLER -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-118A	RECYCLE VAPOR 2ND STAGE COOLER -	000000
12E-118B	RECYCLE VAPOR 2ND STAGE COOLER -	000000
12E-218A	RECYCLE VAPOR 2ND STAGE COOLER -	000000
12E-218B	RECYCLE VAPOR 2ND STAGE COOLER -	000000
12E-318A	RECYCLE VAPOR 2ND STAGE COOLER -	000000
12E-318B	RECYCLE VAPOR 2ND STAGE COOLER -	000000
12E-119A	RECYCLE VAPOR AFTER COOLER -	000000
12E-119B	RECYCLE VAPOR AFTER COOLER -	000000
12E-219A	RECYCLE VAPOR AFTER COOLER -	000000
12E-219B	RECYCLE VAPOR AFTER COOLER -	000000
12E-319A	RECYCLE VAPOR AFTER COOLER -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-319B	RECYCLE VAPOR AFTER COOLER	000000
12E-121A	LEAN SOLVENT COOLER	000000
12E-121B	LEAN SOLVENT COOLER	000000
12E-121C	LEAN SOLVENT COOLER	000000
12E-221A	LEAN SOLVENT COOLER	000000
12E-221B	LEAN SOLVENT COOLER	000000
12E-221C	LEAN SOLVENT COOLER	000000
12E-321A	LEAN SOLVENT COOLER	000000
12E-321B	LEAN SOLVENT COOLER	000000
12E-321C	LEAN SOLVENT COOLER	
12E-122A	UNSHIFTED GAS STEAM GENERATOR	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-122B	UNSHIFTED GAS STEAM GENERATOR	000000
12E-122C	UNSHIFTED GAS STEAM GENERATOR	000000
12E-123A	UNSHIFTED GAS L.P. STEAM BOILER	000000
12E-123B	UNSHIFTED GAS L.P. STEAM BOILER	000000
12E-125	HOT SHIFTED GAS AIR COOLER	000000
12E-225	HOT SHIFTED GAS AIR COOLER	000000
12E-325	HOT SHIFTED GAS AIR COOLER	000000
12E-126A	STRIPPED WATER PREHEATER	000000
12E-126B	STRIPPED WATER PREHEATER	000000
12E-126C	STRIPPED WATER PREHEATER	000000 NA
12E-127	HOT FUEL GAS COOLER	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-128A	GASIFIER QUENCH WATER PREHEATER -	000000
12E-128B	GASIFIER QUENCH WATER PREHEATER -	000000 NA
12E-228A	GASIFIER QUENCH WATER PREHEATER -	000000 NA
12E-228B	GASIFIER QUENCH WATER PREHEATER -	000000 NA
12E-328A	GASIFIER QUENCH WATER PREHEATER -	000000 NA
12E-328B	GASIFIER QUENCH WATER PREHEATER -	000000 NA
12E-129	GASIFIER QUENCH WATER PREHEATER -	000000
12E-229	GASIFIER QUENCH WATER PREHEATER -	000000
12E-329	GASIFIER QUENCH WATER PREHEATER -	000000
12E-130A	CO2 STRIPPING AIR COOLER -	000000 NA
12E-130B	CO2 STRIPPING AIR COOLER -	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-230A	CO2 STRIPPING AIR COOLER	000000 NA
12E-230B	CO2 STRIPPING AIR COOLER	000000 NA
12E-330A	CO2 STRIPPING AIR COOLER	000000 NA
12E-330B	CO2 STRIPPING AIR COOLER	000000 NA
12E-131	SURFACE CONDENSER	000000
12E-231	SURFACE CONDENSER	000000
12E-331	SURFACE CONDENSER	000000
12E-132	H2S STRIPPER OVERHEAD CONDENSER	000000
12E-232	H2S STRIPPER OVERHEAD CONDENSER	000000
12E-332	H2S STRIPPER OVERHEAD CONDENSER	000000
12E-133	H2S STRIPPER REBOILER	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-233	H2S STRIPPER REBOILER	000000
12E-333	H2S STRIPPER REBOILER	000000
12E-134	ACID GAS HEATER	000000
12E-234	ACID GAS HEATER	000000
12E-934	ACID GAS HEATER	000000
12E-135A	LEAN/RICH SOLVENT EXCHANGER	000000
12E-135B	LEAN/RICH SOLVENT EXCHANGER	000000
12E-135C	LEAN/RICH SOLVENT EXCHANGER	000000
12E-135D	LEAN/RICH SOLVENT EXCHANGER	000000
12E-135E	LEAN/RICH SOLVENT EXCHANGER	000000 NA
12E-135F	LEAN/RICH SOLVENT EXCHANGER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-135G	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135H	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135I	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135J	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135K	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135L	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135M	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-135N	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235A	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-235B	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-235C	LEAN/RICH SOLVENT EXCHANGER -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-235D	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-235E	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235F	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235G	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235H	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235I	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235J	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235K	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235L	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235M	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-235N	LEAN/RICH SOLVENT EXCHANGER -	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-335A	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-335B	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-335C	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-335D	LEAN/RICH SOLVENT EXCHANGER -	000000
12E-335E	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-335F	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-335G	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-335H	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-335I	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-335J	LEAN/RICH SOLVENT EXCHANGER -	000000 NA
12E-335K	LEAN/RICH SOLVENT EXCHANGER -	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-335L	LEAN/RICH SOLVENT EXCHANGER	000000 NA
12E-335M	LEAN/RICH SOLVENT EXCHANGER	
12E-335N	LEAN/RICH SOLVENT EXCHANGER	000000 NA
12E-137A	LEAN SOLVENT COOLER	000000
12E-137B	LEAN SOLVENT COOLER	000000
12E-137C	LEAN SOLVENT COOLER	000000 NA
12E-138	EXPANDER FEED HEATER	000000
12E-139	EXPANDER INTERSTAGE HEATER	000000
12E-142A	H2S STRIPPER FEED PREHEATER	000000
12E-142B	H2S STRIPPER FEED PREHEATER	000000
12E-242A	H2S STRIPPER FEED PREHEATER	000000 NA

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-242B	H2S STRIPPER FEED PREHEATER	000000 NA
12E-342A	H2S STRIPPER FEED PREHEATER	000000 NA
12E-342B	H2S STRIPPER FEED PREHEATER	000000 NA
12E-043A	BURNER TIP WATER COOLER	000000 NA
12E-043B	BURNER TIP WATER COOLER	000000 NA
12E-044	BLACK WATER AIR COOLER	000000 NA
12E-145	H2 COMPRESSOR INTERSTAGE COOLER	000000
12E-245	H2 COMPRESSOR INTERSTAGE COOLER	000000
12E-345	H2 COMPRESSOR INTERSTAGE COOLER	000000
12E-445	H2 COMPRESSOR INTERSTAGE COOLER	000000 NA
12E-545	H2 COMPRESSOR INTERSTAGE COOLER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-046	H2 COMPRESSOR SPILL BACK COOLER	000000
12E-147A	CO2 LOOP COLD RECOVERY EXCHANGER	000000
12E-147B	CO2 LOOP COLD RECOVERY EXCHANGER	000000 NA
12E-247A	CO2 LOOP COLD RECOVERY EXCHANGER	000000
12E-247B	CO2 LOOP COLD RECOVERY EXCHANGER	000000 NA
12E-347A	CO2 LOOP COLD RECOVERY EXCHANGER	000000
12E-347B	CO2 LOOP COLD RECOVERY EXCHANGER	000000 NA
12E-152	CO2 ABSORBER PRECOOLER	000000 NA
12E-252	CO2 ABSORBER PRECOOLER	000000 NA
12E-352	CO2 ABSORBER PRECOOLER	000000 NA
12E-153A	RICH SOLUTION CHILLER	000000

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-153B	RICH SOLUTION CHILLER	000000
12E-153C	RICH SOLUTION CHILLER	000000 NA
12E-253A	RICH SOLUTION CHILLER	000000
12E-253B	RICH SOLUTION CHILLER	000000
12E-253C	RICH SOLUTION CHILLER	000000 NA
12E-353A	RICH SOLUTION CHILLER	000000
12E-353B	RICH SOLUTION CHILLER	000000
12E-353C	RICH SOLUTION CHILLER	000000 NA
12E-154A	SOLVENT EXCHANGER	000000
12E-154B	SOLVENT EXCHANGER	000000 NA
12E-154C	SOLVENT EXCHANGER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-254A	SOLVENT EXCHANGER	000000
12E-254B	SOLVENT EXCHANGER	000000 NA
12E-254C	SOLVENT EXCHANGER	000000 NA
12E-354A	SOLVENT EXCHANGER	000000
12E-354B	SOLVENT EXCHANGER	000000 NA
12E-354C	SOLVENT EXCHANGER	000000 NA
12E-055	FLASHED GAS AIR COOLER	000000 NA
12E-156	CLARIFIED WATER PREHEAT EXCHANGER	000000 NA
12E-256	CLARIFIED WATER PREHEAT EXCHANGER	000000 NA
12E-356	CLARIFIED WATER PREHEAT EXCHANGER	000000 NA
12E-456	CLARIFIED WATER PREHEAT EXCHANGER	000000 NA

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12E-556	CLARIFIED WATER PREHEAT EXCHANGER	000000 NA
12E-157	STEAM JET CONDENSER	000000 NA
12E-257	STEAM JET CONDENSER	000000 NA
12E-357	STEAM JET CONDENSER	000000 NA
12F-001	START-UP HEATER	000000
12F-102	STARTUP BURNER	000000 NA
12F-202	STARTUP BURNER	000000 NA
12F-302	STARTUP BURNER	000000 NA
12F-402	STARTUP BURNER	000000 NA
12F-502	STARTUP BURNER	000000 NA
12F-103A	PROCESS BURNER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12F-103B	PROCESS BURNER	000000 NA
12F-103C	PROCESS BURNER	000000 NA
12F-203A	PROCESS BURNER	000000 NA
12F-203B	PROCESS BURNER	000000 NA
12F-203C	PROCESS BURNER	000000 NA
12F-303A	PROCESS BURNER	000000 NA
12F-303B	PROCESS BURNER	000000 NA
12F-303C	PROCESS BURNER	000000 NA
12F-403A	PROCESS BURNER	000000 NA
12F-403B	PROCESS BURNER	000000 NA
12F-403C	PROCESS BURNER	000000 NA

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12F-503A	PROCESS BURNER	000000
	-	NA
12F-503B	PROCESS BURNER	000000
	-	NA
12F-503C	PROCESS BURNER	000000
	-	NA
12GH-132	RICH SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH121A	LEAN SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH121B	LEAN SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH221A	LEAN SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH221B	LEAN SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH321A	LEAN SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH321B	LEAN SOLVENT HYDRAULIC TURBINE	000000
	-	NA
12GH-232	RICH SOLVENT HYDRAULIC TURBINE	000000
	-	NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12GH-332	RICH SOLVENT HYDRAULIC TURBINE	000000 NA
12G-001A	GASIFIER FEED PUMP	000000 NA
12G-001B	GASIFIER FEED PUMP	000000 NA
12G-001C	GASIFIER FEED PUMP	000000
12G-101	GASIFIER FEED PUMP	000000 NA
12G-201	GASIFIER FEED PUMP	000000
12G-301	GASIFIER FEED PUMP	000000
12G-401	GASIFIER FEED PUMP	000000
12G-501	GASIFIER FEED PUMP	000000 NA
12G-003A	QUENCH MAKE UP WATER PUMP	000000 NA
12G-003B	QUENCH MAKE UP WATER PUMP	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-003C	QUENCH MAKE UP WATER PUMP -	000000 NA
12G-006A	CLARIFIER SLURRY PUMP -	000000
12G-006B	CLARIFIER SLURRY PUMP -	000000 NA
12G-006C	CLARIFIER SLURRY PUMP -	000000
12G-006D	CLARIFIER SLURRY PUMP -	000000 NA
12G-009	SELEXOL SOLVENT MAKEUP PUMP -	000000
12G-110A	H2S ABSORBER PRESAT. SOLVENT CHARGE PUMP -	000000
12G-110B	H2S ABSORBER PRESAT. SOLVENT CHARGE PUMP -	000000 NA
12G-210A	H2S ABSORBER PRESAT. SOLVENT CHARGE PUMP -	000000 NA
12G-210B	H2S ABSORBER PRESAT. SOLVENT CHARGE PUMP -	000000 NA
12G-310A	H2S ABSORBER PRESAT. SOLVENT CHARGE PUMP -	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-310B	H2S ABSORBER PRESAT. SOLVENT CHARGE PUMP -	000000 NA
12G-111	FLASH GAS K.O. PUMP -	000000
12G-211	FLASH GAS K.O. PUMP -	000000
12G-311	FLASH GAS K.O. PUMP -	000000
12G-113A	COLD CONDENSATE PUMP -	000000
12G-113B	COLD CONDENSATE PUMP -	000000
12G-213A	COLD CONDENSATE PUMP -	000000
12G-213B	COLD CONDENSATE PUMP -	000000
12G-313A	COLD CONDENSATE PUMP -	000000
12G-313B	COLD CONDENSATE PUMP -	000000
12G-119A	H2S STRIPPER REFLUX PUMP -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-119B	H2S STRIPPER REFLUX PUMP -	000000
12G-219A	H2S STRIPPER REFLUX PUMP -	000000
12G-219B	H2S STRIPPER REFLUX PUMP -	000000
12G-319A	H2S STRIPPER REFLUX PUMP -	000000
12G-319B	H2S STRIPPER REFLUX PUMP -	000000
12G-121A	CO2 ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-121B	CO2 ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-221A	CO2 ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-221B	CO2 ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-321A	CO2 ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-321B	CO2 ABSORBER LEAN SOLVENT CHARGE PUMP -	000000

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-122A	F.G. H2S ABSORBER LEAN SOLUTION CHARGE PUMP -	000000
12G-122B	F.G. H2S ABSORBER LEAN SOLUTION CHARGE PUMP -	000000
12G-123A	VENTURI SCRUBBER CIRCULATION PUMP -	000000
12G-123B	VENTURI SCRUBBER CIRCULATION PUMP -	000000
12G-223A	VENTURI SCRUBBER CIRCULATION PUMP -	000000
12G-223B	VENTURI SCRUBBER CIRCULATION PUMP -	000000
12G-323A	VENTURI SCRUBBER CIRCULATION PUMP -	000000
12G-323B	VENTURI SCRUBBER CIRCULATION PUMP -	000000
12G-423A	VENTURI SCRUBBER CIRCULATION PUMP -	000000 NA
12G-423B	VENTURI SCRUBBER CIRCLATION PUMP -	000000 NA
12G-523A	VENTURI SCRUBBER CIRCULATION PUMP -	000000 NA

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-523B	VENTURI SCRUBBER CIRCULATION PUMP -	000000 NA
12G-025A	GASIFIER FEED BOOSTER PUMP -	000000 NA
12G-025B	GASIFIER FEED BOOSTER PUMP -	000000 NA
12G-025C	GASIFIER FEED BOOSTER PUMP -	000000 NA
12G-025D	GASIFIER FEED BOOSTER PUMP -	000000 NA
12G-126A	QUENCH WATER SUMP PUMP -	000000
12G-126B	QUENCH WATER SUMP PUMP -	000000 NA
12G-226A	QUENCH WATER SUMP PUMP -	000000 NA
12G-226B	QUENCH WATER SUMP PUMP -	000000 NA
12G-326A	QUENCH WATER SUMP PUMP -	000000 NA
12G-326B	QUENCH WATER SUMP PUMP -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-426A	QUENCH WATER SUMP PUMP	000000
	-	NA
12G-426B	QUENCH WATER SUMP PUMP	000000
	-	NA
12G-526A	QUENCH WATER SUMP PUMP	000000
	-	NA
12G-526B	QUENCH WATER SUMP PUMP	000000
	-	NA
12G-027A	BURNER TIP WATER PUMP	000000
	-	
12G-027B	BURNER TIP WATER PUMP	000000
	-	
12G-029A	SOOT SLURRY PUMP	000000
	-	
12G-029B	SOOT SLURRY PUMP	000000
	-	NA
12G-030A	CLARIFIER WATER PUMP	000000
	-	
12G-030B	CLARIFIER WATER PUMP	000000
	-	
12G-031	SELEXOL SUMP PUMP	000000
	-	NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-132A	H2S ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-132B	H2S ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-232A	H2S ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-232B	H2S ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-332A	H2S ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-332B	H2S ABSORBER LEAN SOLVENT CHARGE PUMP -	000000
12G-133A	RICH SOLVENT TRANSFER PUMP -	000000
12G-133B	RICH SOLVENT TRANSFER PUMP -	000000
12G-233A	RICH SOLVENT TRANSFER PUMP -	000000
12G-233B	RICH SOLVENT TRANSFER PUMP -	000000
12G-333A	RICH SOLVENT TRANSFER PUMP -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-333B	RICH SOLVENT TRANSFER PUMP -	000000
12G-037A	GASIFIER QUENCH WATER PUMP -	000000
12G-037B	GASIFIER QUENCH WATER PUMP -	000000
12G-138A	CO2 STRIPPER SOLVENT WATER PURGE PUMP -	000000
12G-138B	CO2 STRIPPER SOLVENT WATER PURGE PUMP -	000000
12G-238A	CO2 STRIPPER SOLVENT WATER PURGE PUMP -	000000
12G-238B	CO2 STRIPPER SOLVENT WATER PURGE PUMP -	000000
12G-338A	CO2 STRIPPER SOLVENT WATER PURGE PUMP -	000000
12G-338B	CO2 STRIPPER SOLVENT WATER PURGE PUMP -	000000
12G-139A	LEAN SOLVENT CROSS BLEED PUMP -	000000
12G-139B	LEAN SOLVENT CROSS BLEED PUMP -	000000

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-239A	LEAN SOLVENT CROSS BLEED PUMP -	000000
12G-239B	LEAN SOLVENT CROSS BLEED PUMP -	000000
12G-339A	LEAN SOLVENT CROSS BLEED PUMP -	000000
12G-339B	LEAN SOLVENT CROSS BLEED PUMP -	000000
12G-142A	LEAN SOLVENT BOOSTER PUMP -	000000 NA
12G-142B	LEAN SOLVENT BOOSTER PUMP -	000000 NA
12G-242A	LEAN SOLVENT BOOSTER PUMP -	000000
12G-242B	LEAN SOLVENT BOOSTER PUMP -	000000 NA
12G-342A	LEAN SOLVENT BOOSTER PUMP -	000000
12G-342B	LEAN SOLVENT BOOSTER PUMP -	000000 NA
12G-143A	QUENCH WATER RETURN PUMP -	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-143B	QUENCH WATERRETURN PUMP	000000 NA
12G-243A	QUENCH WATER RETURN PUMP	000000 NA
12G-243B	QUENCH WATER RETURN PUMP	000000 NA
12G-343A	QUENCH WATER RETURN PUMP	000000 NA
12G-343B	QUENCH WATER RETURN PUMP	000000 NA
12G-443A	QUENCH WATER RETURN PUMP	000000 NA
12G-443B	QUENCH WATER RETURN PUMP	000000 NA
12G-543A	QUENCH WATER RETURN PUMP	000000 NA
12G-543B	QUENCH WATER RETURN PUMP	000000 NA
12G-044A	FLUSHING OIL PUMP	000000 NA
12G-044B	FLUSHING OIL PUMP	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12G-145A	CONDENSATE PUMP -	000000 NA
12G-145B	CONDENSATE PUMP -	000000 NA
12G-245A	CONDENSATE PUMP -	000000 NA
12G-245B	CONDENSATE PUMP -	000000 NA
12G-345A	CONDENSATE PUMP -	000000 NA
12G-345B	CONDENSATE PUMP -	000000 NA
12G-046A	GREY WATER PUMP -	000000 NA
12G-046B	GREY WATER PUMP -	000000 NA
12G-047A	50 PSIG CONDENSATE PUMP -	
12G-047B	50 PSIG CONDENSATE PUMP -	000000 NA
12H-101	START-UP VENTURI SCRUBBER -	000000

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12H-201	START-UP VENTURI SCRUBBER -	000000
12H-301	START-UP VENTURI SCRUBBER -	000000
12H-401	START-UP VENTURI SCRUBBER -	000000
12H-501	START-UP VENTURI SCRUBBER -	000000 NA
12H-102A	GASIFIER VAPOR VENTURI SCRUBBER -	000000
12H-102B	GASIFIER VAPOR VENTURI SCRUBBER -	000000 NA
12H-202A	GASIFIER VAPOR VENTURI SCRUBBER -	000000
12H-202B	GASIFIER VAPOR VENTURI SCRUBBER -	00000
12H-302A	GASIFIER VAPOR VENTURI SCRUBBER -	000000
12H-302B	GASIFIER VAPOR VENTURI SCRUBBER -	000000 NA
12H-402A	GASIFIER VAPOR VENTURI SCRUBBER -	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12H-402B	GASIFIER VAPOR VENTURI SCRUBBER	000000 NA
12H-502A	GASIFIER VAPOR VENTURI SCRUBBER	000000 NA
12H-502B	GASIFIER VAPOR VENTURI SCRUBBER	000000 NA
12H-104	EXHAUST STEAM JET	000000 NA
12H-204	EXHAUST STEAM JET	000000 NA
12H-304	EXHAUST STEAM JET	000000 NA
12K-102A	RECYCLE SHIFT GAS BLOWER	000000
12K-102B	RECYCLE SHIFT GAS BLOWER	000000
12K-202A	RECYCLE SHIFT GAS BLOWER	000000
12K-202B	RECYCLE SHIFT GAS BLOWER	000000
12K-302A	RECYCLE SHIFT GAS BLOWER	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12K-302B	RECYCLE SHIFT GAS BLOWER	000000
12K-104	RECYCLE VAPOR COMPRESSOR TURBINE	000000
12K-204	RECYCLE VAPOR COMPRESSOR TURBINE	000000
12K-304	RECYCLE VAPOR COMPRESSOR TURBINE	000000
12K-009	CO2 STRIPPER AIR COMPRESSOR	000000 NA
12K-109	CO2 STRIPPER AIR COMPRESSOR	000000 NA
12K-209	CO2 STRIPPER AIR COMPRESSOR	000000 NA
12K-309	CO2 STRIPPER AIR COMPRESSOR	000000 NA
12K-111	FIRST STAGE FUEL GAS TURBO EXPANDER	000000
12K-112	SECOND STAGE FUEL GAS TURBO EXPANDER	000000
12K-114	HYDROGEN COMPRESSOR	000000

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12T-101H	SCREENED SLAG BELT CONVEYOR	000000 NA
12Y-002A	GASIFIER FEED TANK MIXER	000000
12Y-002B	GASIFIER FEED TANK MIXER	000000 NA
12Y-103	QUENCH EFFLUENT SCREENS	000000
12Y-203	QUENCH EFFLUENT SCREENS	000000
12Y-303	QUENCH EFFLUENT SCREENS	000000
12Y-403	QUENCH EFFLUENT SCREENS	000000 NA
12Y-503	QUENCH EFFLUENT SCREENS	000000 NA
12Y-105	SLAG CRUSHER	000000 NA
12Y-205	SLAG CRUSHER	000000 NA
12Y-305	SLAG CRUSHER	000000 NA

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

THE BRECKINRIDGE PROJECT

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12K-214	HYDROGEN COMPRESSOR	000000
12K-314	HYDROGEN COMPRESSOR	000000
12K-414	HYDROGEN COMPRESSOR	000000 NA
12K-514	HYDROGEN COMPRESSOR	000000 NA
12T-101A	SCREENED SLAG BELT CONVEYOR	000000 NA
12T-101B	SCREENED SLAG BELT CONVEYOR	000000 NA
12T-101C	SCREENED SLAG BELT CONVEYOR	000000 NA
12T-101D	SCREENED SLAG BELT CONVEYOR	000000 NA
12T-101E	SCREENED SLAG BELT CONVEYOR	000000 NA
12T-101F	SCREENED SLAG BELT CONVEYOR	000000 NA
12T-101G	SCREENED SLAG BELT CONVEYOR	000000 NA

THE BRECKINRIDGE PROJECT

MAJOR EQUIPMENT LIST SORTED BY SEQUENCE NUMBER

PHASE ZERO
MAJOR EQUIPMENT LIST-14222

ITEM NUMBER	ITEM DESCRIPTION	
12Y-405	SLAG CRUSHER	000000
	-	NA
12Y-505	SLAG CRUSHER	000000
	-	NA
12Z-001	SOOT SLURRY CLARIFIER	000000
	-	
12Z-002	SOOT SLURRY CLARIFIER	000000
	-	NA

4.1 Data Sheets for Columns and Pressure Vessels

12-DS-C-15: Hot Shifted Gas K.O. Drum (12C-115, 215, 315)

12-DS-C-19: 2nd Stage Flash Gas K.O. Drum (12C-119, 219, 319)

12-DS-C-25: First Stage K.O. Drum (12C-125, 225, 325)

12-DS-C-31: 3rd Stage Flash Gas K.O. Drum (12C-131, 231, 331)

12-DS-C-36: Cold Shifted Gas K.O. Drum (12C-136, 236, 336)

12-DS-C-37: Hot Fuel Gas K.O. Drum (12C-137)

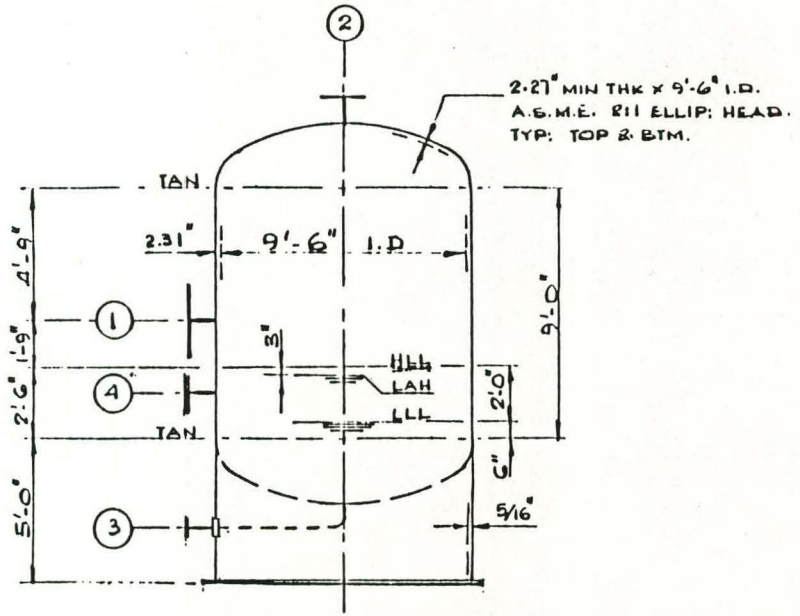
12-DS-C-38: Cold Fuel Gas K.O. Drum (12C-138)

12-DS-C-40: First Stage H.P. Steam Drum (12C-140, 240, 340)

12-DS-C-50: Quench Water Surge Drum (12C-050)

12-DS-C-51: H_2 Compressor K.O. Drum (12C-151, 251, 351, 451, 551)

12-DS-C-52: 50 psig Condensate Pot (12C-052)



DESIGN REQUIREMENTS

1. ASME SECTION VIII, DIV 1 1980 EDITION, LATEST ADDENDA
2. SPECIFICATION 14222-C4
3. MATERIALS ASME
   SHELL AND HEADS A-516-70 w/304 SS CL PIPING: A-106 B
   SUPPORTS: A-36 STRUCTURAL:
   FORGINGS A-105 BOLTS:
4. INTERNAL DESIGN PRESSURE 625 psig @ 350 °F (OPERATING 525 psig @ 325 °F)
5. EXTERNAL DESIGN PRESSURE psi @ °F
6. CORROSION ALLOWANCE 1/8" = CLAD THICK
7. RADIOGRAPHY FULL JOINT EFFICIENCY 100%
8. PWHT YES REQUIRED BY (CODE) ( )
9. CODE HYDROSTATIC TEST PER UG 99 (c) = 1.3 B2 psig @ top (bottom) (HORIZ)

OTHER REQUIREMENTS

EXAM/TEST UT , MT , PT , CHARPY V NOTCH @ °F
WELD SAMPLING PER SPEC C-103 , HARDNESS MAX BHN
CLIPS PER C-628 : A 4 B 4 C 4 D E L F G H J
INSULATION: THICKNESS 1 1/2"
PAINTING:
VESSEL CAPACITY 862 CU FT, EMPTY WT 58 KIPS, TEST WT 112 KIPS
OPERATING WT = 80 K.

NOZZLE DATA

4	20"	1	300#	RTJ	MANWAY	WITH DAVIT
3	3"	1	300#	RTJ	OUTLET (LIQUID)	
2	14"	1	"	"	OUTLET (VAPOR)	
1	24"	1	"	"	INLET	

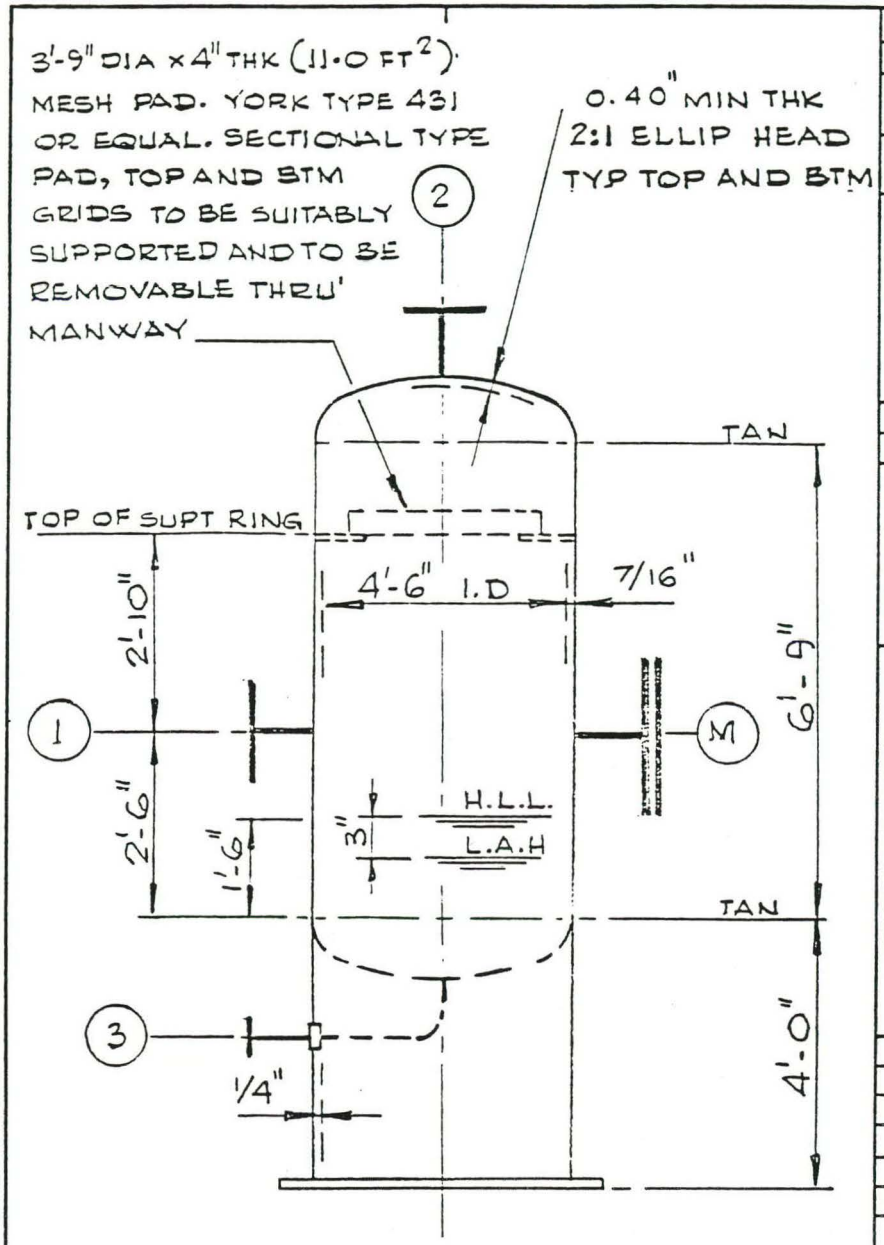
REFERENCE DRAWINGS

C-509, C-515, C-525, C-610, C-529, C-611, C-549

NO	DATE	REVISION	DWN BY	CHK	APP	APP
0	4/10/80	ISSUED FOR PHASE I ERO				

THE BRECKINRIDGE PROJECT
HOT SHIFTED GAS K.O DRUM
12C-115,215,315

JOB NO. 14222
DRAWING NO. 12-DS-C-13
REV 0



CODE	ASME SECT VIII DIV 1 '80	
SPEC.	14222 - C1	
OPER. COND.	PRESS.	
	TEMP.	
DES. COND.	PRESS.	
	TEMP.	

MATERIALS		
	SHELL & HDS	A-516-70 ⚠
	SKIRT	A-36
	FORGING	A-181
	PIPING	A-106 B
	STRUCTURAL	
	BOLTS	
	INTERNALS	316 SS MESH

C.A.				1/8"	
PWHT	NO				
TESTS/EXAM.	X-RAY	SPOT	JOINT EFF.	85%	
	UT	MT	PT	CV @	°F.
	HARDNESS MAX. BHN				
	WELD SAMPLING				
	CODE	POSITION HORIZ			
	HYDRO	PRESS @ TOP 180			PSIG

NOZZLES & MANWAYS	MK	NO.	SIZE	RATING	SERVICE
	1	1	10"	150#	VAPOR INLET
	2	1	8"	150#	VAPOR OUT
	3	1	2"	300#	LIQUID OUT
	M	1	20"	150#	MANWAY
				WITH	COVER
				AND	DAVIT

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS			IN.
PAINTING			
VESSEL CAPACITY		131	CU. FT.
VESSEL WEIGHT EMPTY		55	KIPS
VESSEL WEIGHT TEST			KIPS

REF. DWGS.	C-509, 510, 511, 515
	C-525, 529

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
1	1/20/81	REVISED MATERIAL	HKN				HNH
B	10-23-80	CHANGED DWG & EQUIPMENT NUMBER		WJW			
A	10-8-80	ISSUED FOR ESTIMATE	NN	RWN		See	

BECHTEL

THE BRECKINRIDGE PROJECT

2ND STAGE FLASH GAS K.O. DRUM

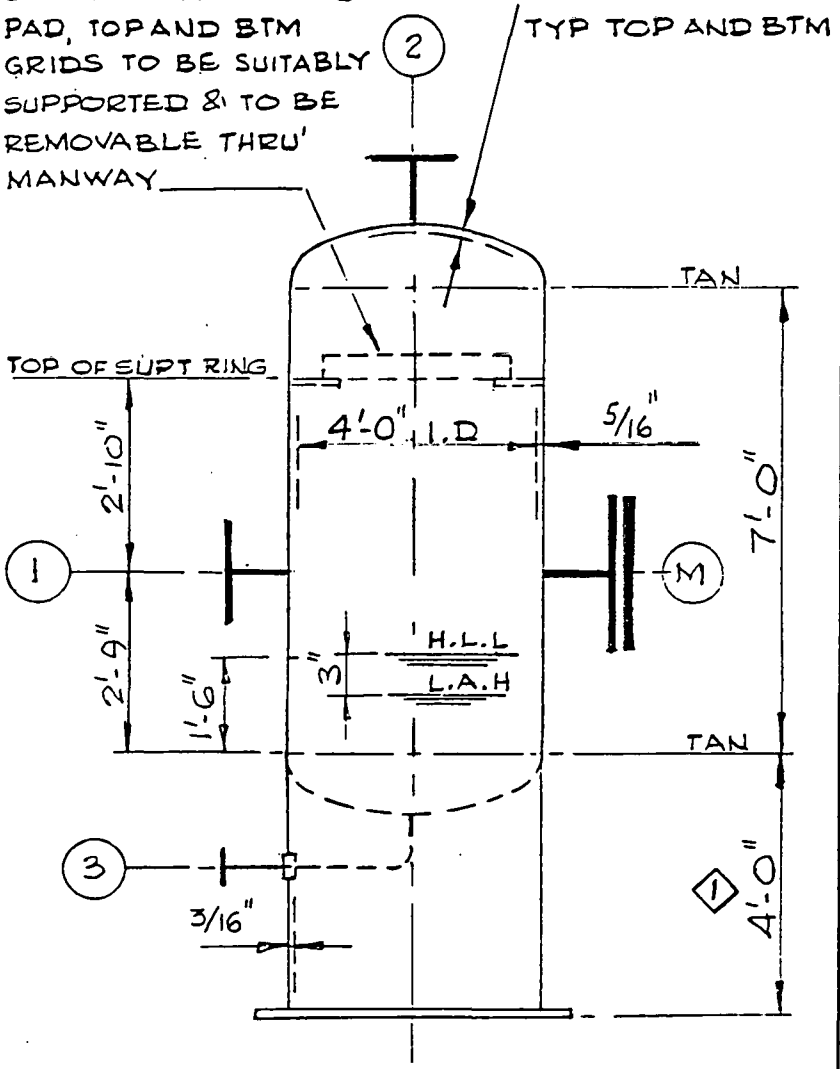
12C-119, 219, 319

JOB NO. 14222

DRAWING NO. 12-DS-C—19

REV. 1

FORM 875, 4/79



1 MAKE 15' FOR SUCTION HEAD REQUIREMENT.

WJW 10/7/80

CODE	ASME SECT VIII DIV 1 '80
SPEC.	14222 - C1
OPER. COND.	PRESS. / TEMP.
DES. COND.	PRESS. / TEMP.

MATERIALS	
SHELL & HDS	A-516-70 (1)
SKIRT	A-36
FORGING	A-181
PIPING	A-106 B
STRUCTURAL	
BOLTS	
INTERNALS	316 SS MESH
C.A. ~~OR CLAD~~	1/8"
PWHT	NO

TESTS/EXAM.					
X-RAY	SPOT	JOINT EFF.	85%		
UT	MT	PT	CV @	°F.	
HARDNESS MAX. BHN					
WELD SAMPLING					
CODE	POSITION	HORIZ			
HYDRO	PRESS @ TOP	75	PSIG		

NOZZLES & MANWAYS				
MK	NO.	SIZE	RATING	SERVICE
1	1	12"	150 #	VAPOR INLET
2	1	10"	150 #	VAPOR OUT
3	1	2"	300#	LIQUID OUT
M	1	20"	150 #	MANWAY WITH COVER AND DAVIT

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS			IN.
PAINTING			
VESSEL CAPACITY			CU. FT.
VESSEL WEIGHT	EMPTY	3	KIPS
	TEST		KIPS

REF. DWGS.	C-509, 510, 511, 515
	C-525, 529

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
1	1/20/81	REVISED MATERIAL	NKN				HNH
B	10-23-80	CHANGED DWG & EQUIPMENT NUMBER		WJW			
A	10-8-80	ISSUED FOR ESTIMATE	NN	RWN			

BECHTEL

THE BRECKINRIDGE PROJECT

FIRST STAGE K-Φ. DRUM 12C-125, 225, 325

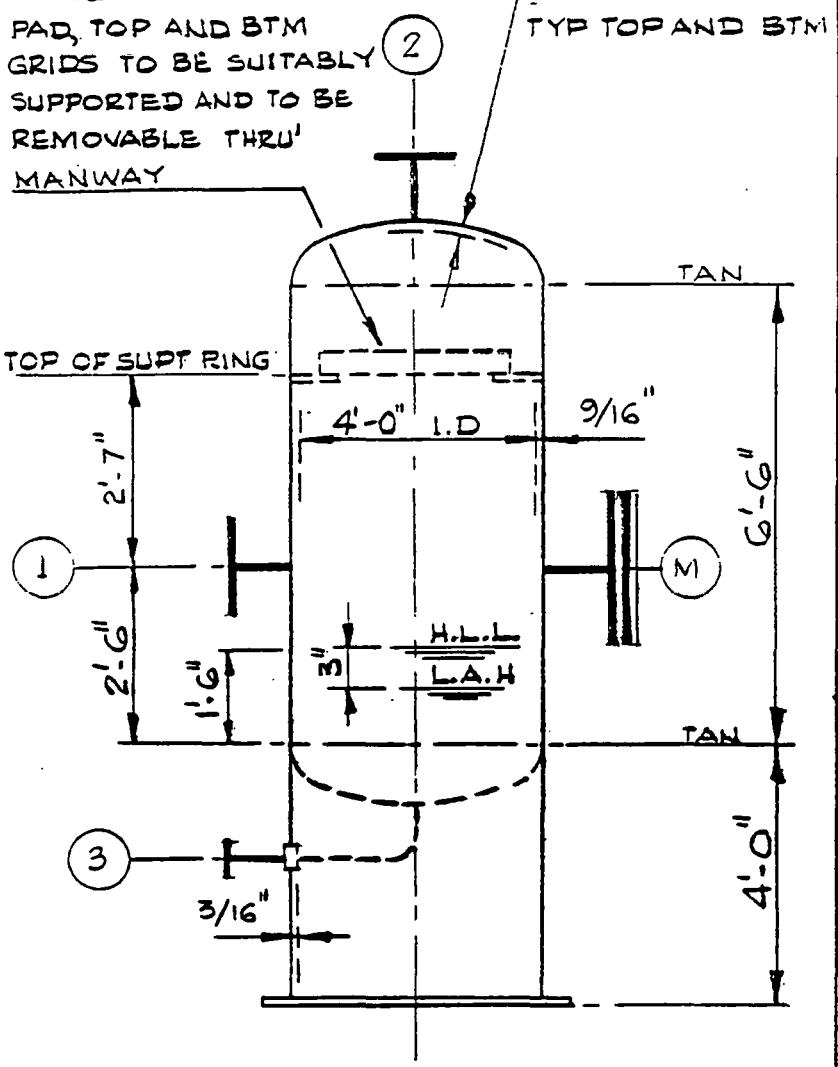
JOB NO. 14222

DRAWING NO. 12-DS-C-25

REV. 1

FORM 875, 4/79

3'-0" DIA x 4" THK (7.1 FT^2) MESH PAD. YORK TYPE 431 OR EQUAL. SECTIONAL TYPE PAD, TOP AND BTM GRIDS TO BE SUITABLY SUPPORTED AND TO BE REMOVABLE THRU' MANWAY



CODE	ASME SECT VIII DIV 1 '80				
SPEC.	14222 - C1				
OPER. COND.	PRESS.	241 PSIG			
	TEMP.	105 °F			
DES. COND.	PRESS.	266 PSIG			
	TEMP.	300 °F			
MATERIALS	SHELL & HDS	A-516-70			
	SKIRT	A-36			
	FORGING	A-181			
	PIPING	A-106 B			
	STRUCTURAL				
	BOLTS				
	INTERNALS	316 SS MESH			
C.A.		1/8"			
PWHT	NO				
TESTS/EXAM.	X-RAY	SPOT	JOINT EFF.	85 %	
	UT	MT	PT	CV @	°F.
	HARDNESS MAX. BHN				
	WELD SAMPLING				
	CODE	POSITION HORIZ			
	HYDRO	PRESS @ TOP 400 PSIG			

NOZZLES & MANWAYS	MK	NO.	SIZE	RATING	SERVICE
	1	1	8"	150 #	VAPOR INLET
	2	1	6"	150 #	VAPOR OUT
	3	1	2"	300 #	LIQUID OUT
	M	1	20"	150 #	MANWAY
				WITH	COVER
				AND	DAVIT

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS			IN.
PAINTING			
VESSEL CAPACITY			CU. FT.
VESSEL WEIGHT EMPTY		5	KIPS
VESSEL WEIGHT TEST			KIPS

REF. DWGS.	
	C-509, 510, 511, 515
	C-525, 529

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
0	10-23-80	ISSUED FOR PHASE ZERO		WJW			HNH
A	10-8-80	ISSUED FOR ESTIMATE	NN	RWN			

THE BRECKINRIDGE PROJECT

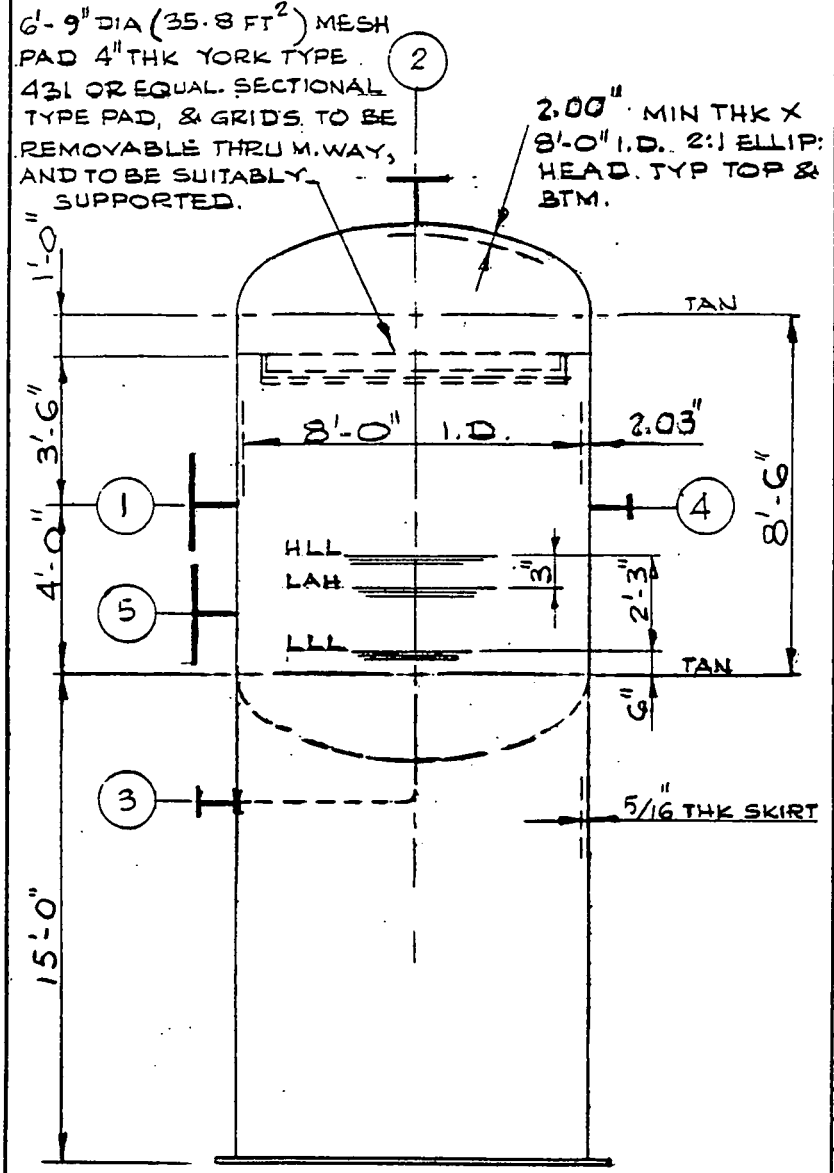
3rd STAGE FLASH GAS K.O DRUM 12C-131, 231, 331

JOB NO. 14222

DRAWING NO. 12-DS-C-31

REV. 0

FORM 876, 4/79



CODE	ASME SECTION VIII DIV 1, 80		
SPEC.	14222 - C-1		
OPER. COND.	PRESS.	575 PSIG	
	TEMP.	100 °F	
DES. COND.	PRESS.	632 PSIG	
	TEMP.	300 °F	
MATERIALS	SHELL & HDS	A-516-70	
	SKIRT	A-36	
	FORGING	A-105	
	PIPING	A-106 B	
	STRUCTURAL		
	BOLTS		
C.A.	1/4"		
PWHT	YES		
TESTS/EXAM.	X-RAY	FULL	JOINT EFF. 100%
	UT / MT / PT / CV @ °F.		
	HARDNESS MAX. BHN		
	WELD SAMPLING		
	CODE	POSITION HORIZ	
	HYDRO	PRESS @ TOP 948 PSIG	

NOZZLES & MANWAYS	MK	NO.	SIZE	RATING	SERVICE
	5	1	20"	300#	MANWAY W/DAVIT
	4	1	2"	"	INLET (LIQUID)
	3	1	3"	"	OUTLET (LIQUID)
	2	1	10"	"	OUTLET (VAPOR)
	1	1	20"	"	INLET (MIXED)

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS		IN.	
PAINTING			
VESSEL CAPACITY	562	CU. FT.	
VESSEL WEIGHT EMPTY	40	KIPS	
VESSEL WEIGHT TEST	77	KIPS	

OPERATING WT - 53 K.

REF. DWGS. C-509, 510, 511; C-515, 525, 529

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
0	10-23-80	ISSUED FOR PHASE ZERO		RWN	N N	[illegible]	HNH

BECHTEL

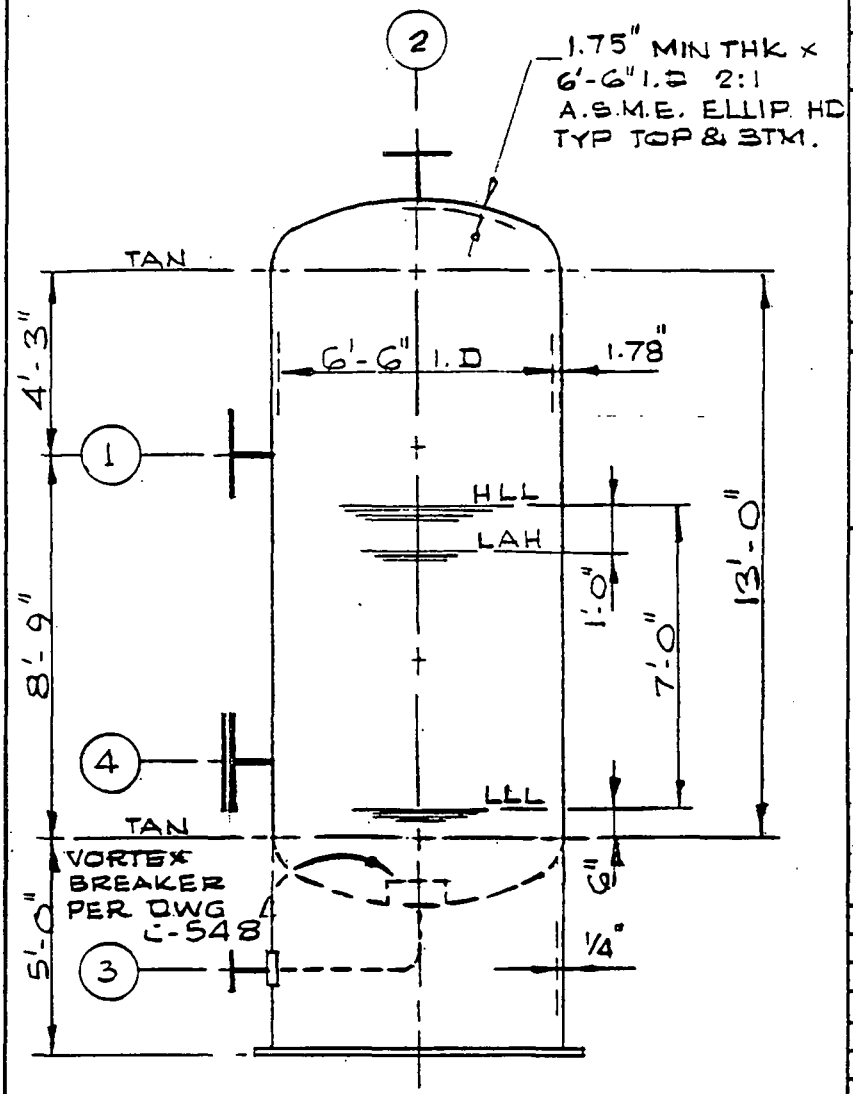
THE BRECKINRIDGE PROJECT

COLD SHIFTED GAS K.O. DRUM 12C-136, 236, 336

JOB NO. 14222

DRAWING NO. 12-DS-C-36 REV. 0

FORM 876, 4/79



CODE	ASME SECTION VIII DIV 1, 80	
SPEC.	14222-C1	
OPER. COND.	PRESS.	655 PSIG
	TEMP.	325 °F
DES. COND.	PRESS.	720 PSIG
	TEMP.	350 °F
MATERIALS	SHELL & HDS	SA-516-70*
	SKIRT	SA-36
	FORGING	SA-105
	PIPING	SA-106B
	STRUCTURAL	
	BOLTS	
	*	CLAD W/TP 304 SS
CLAD		1/8"
PWHT	YES	

TESTS/EXAM.						
X-RAY	FULL	JOINT EFF.	100%			
UT	MT	PT	CV @ °F.			
HARDNESS MAX. BHN						
WELD SAMPLING						
CODE	POSITION HORIZ					
HYDRO	PRESS @ TOP 1090 PSIG					

NOZZLES & MANWAYS					
MK	NO.	SIZE	RATING	SERVICE	
4	1	20"	600*	M/WAY & DAVIT	
3	1	6"	"	OUTLET (LIQUID)	
2	1	12"	"	OUTLET (VAPOR)	
1	1	16"	"	INLET	

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS	1 1/2 IN.		
PAINTING			
VESSEL CAPACITY	504 CU. FT.		
VESSEL WEIGHT EMPTY	31 KIPS		
VESSEL WEIGHT TEST	63 KIPS		
OPERATING WT. 89 K.			

REF. DWGS.	C-548, 509, 510, 511
	C-515, 525, 529, 549

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
0	10/22/80	ISSUED FOR PHASE ZERO		RWN	NN	[illegible]	HWH

BECHTEL

THE BRECKINRIDGE PROJECT

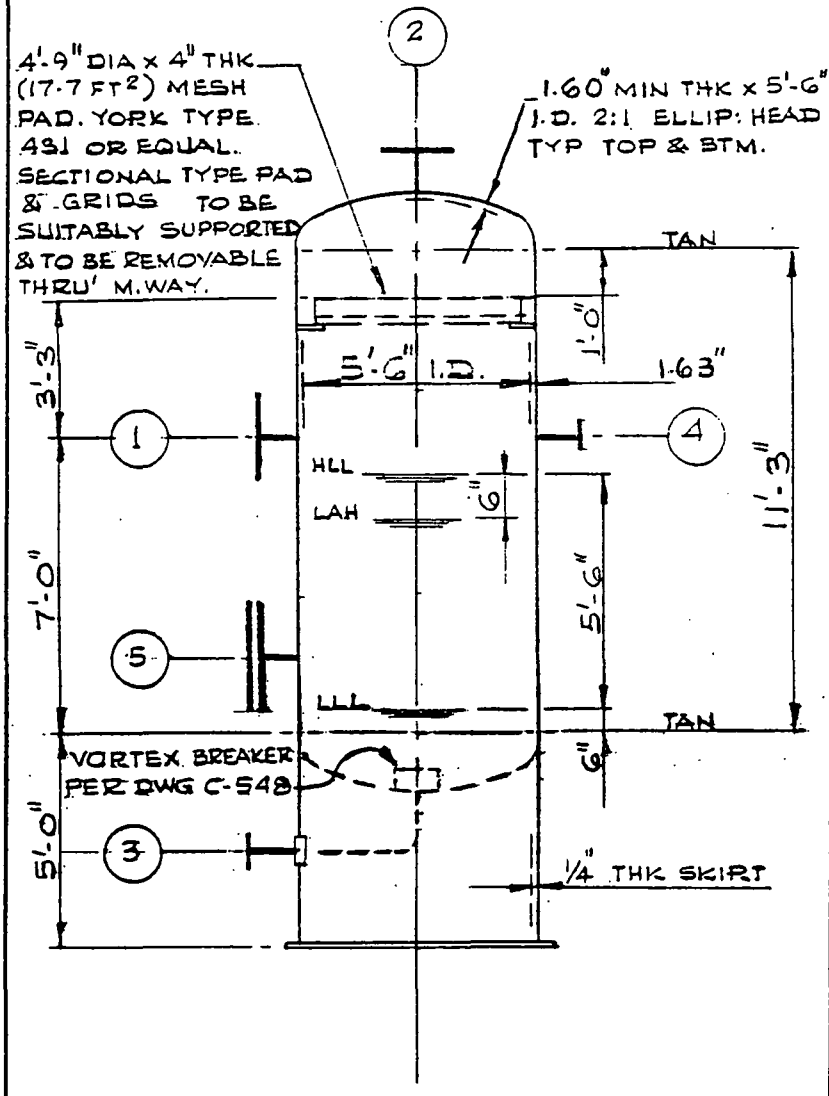
HOT FUEL GAS K.O. DRUM 12C-L37

JOB NO. 14222

DRAWING NO. 12-DS-C-37

REV.

FORM 876. 4/79



CODE	ASME SECT: VIII DIV 1, 80		
SPEC.	14222 - C1		
OPER. COND.	PRESS.	645 PSIG	
	TEMP.	100 °F	
DES. COND.	PRESS.	709 PSIG	
	TEMP.	300 F	
MATERIALS	SHELL & HDS	A-516-70	
	SKIRT	A-36	
	FORGING	A-105	
	PIPING	A-106 B	
	STRUCTURAL		
	BOLTS		
C.A.	1/4"		
PWHT	YES		
TESTS/EXAM.	X-RAY FULL	JOINT EFF. 100%	
	UT MT PT CV @ °F.		
	HARDNESS MAX. BHN		
	WELD SAMPLING		
	CODE	POSITION HORIZ	
	HYDRO	PRESS @ TOP 1063 PSIG	

NOZZLES & MANWAYS

MK	NO.	SIZE	RATING	SERVICE
5	1	20"	600#	MANWAY W/DAVIT
4	1	3"	??	INLET (LIQUID)
3	1	4"	??	OUTLET (LIQUID)
2	1	10"	??	OUTLET (VAPOR)
1	1	14"	??	INLET (MIXED)

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS		IN.	
PAINTING			
VESSEL CAPACITY	311	CU. FT.	
VESSEL WEIGHT EMPTY	24.5	KIPS	
VESSEL WEIGHT TEST	44.5	KIPS	

OPERATING WT - 43 K.

REF. DWGS. C-548, 509, 510, 511
C-515, 525, 529, 549

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
0	10-24-80	ISSUED FOR PHASE ZERO		RWN	NN	[illegible]	HNH

BECHTEL

THE BRECKINRIDGE PROJECT

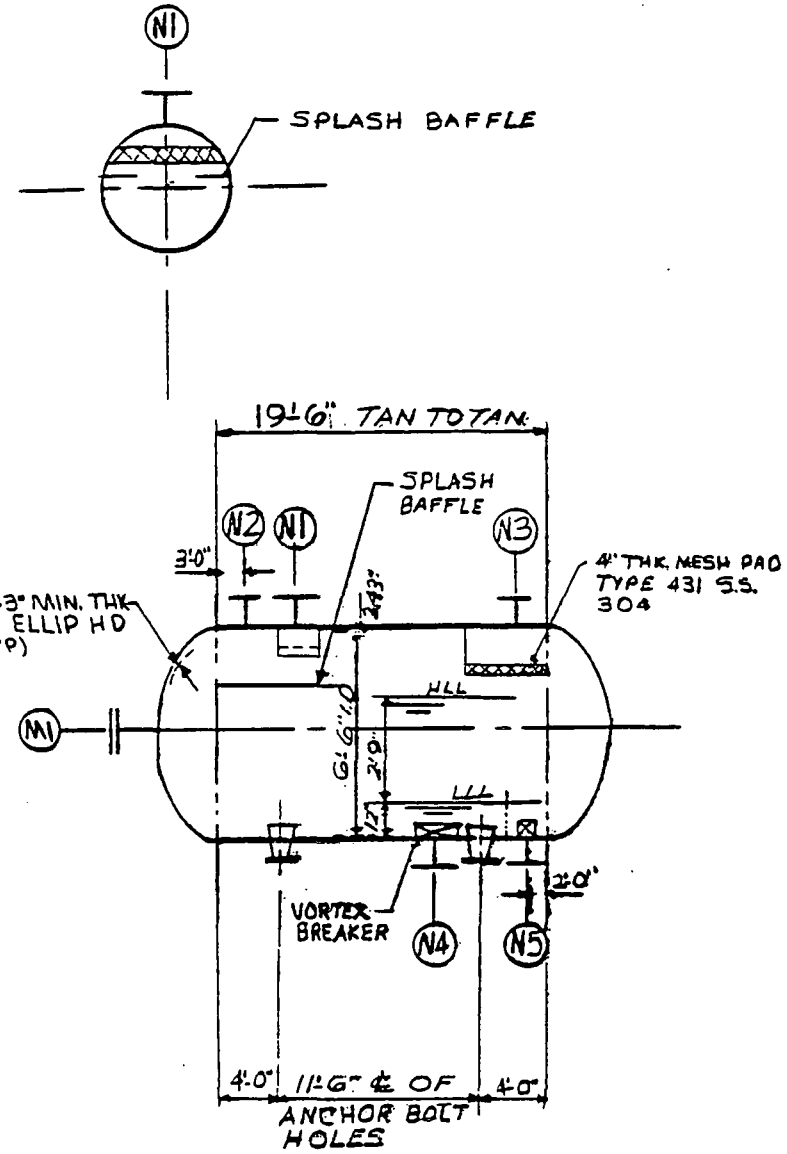
COLD FUEL GAS K.O. DRUM. 12C-138

JOB NO. 14222

DRAWING NO. 12-DS-C-38

REV.

FORM 875, 4/79



CODE	ASME SEC VIII DIV 1	
SPEC.	14222-C1	
OPER. COND.	PRESS.	903 PSIG
	TEMP.	534 °F
DES. COND.	PRESS.	993 PSIG
	TEMP.	650 °F
MATERIALS: SHELL & HDS		SA-516-70
SKIRT		SA-36
FORGING		SA-105
PIPING		SA-106-B
STRUCTURAL		
BOLTS		
C.A.		1/8"
PWHT	REQ'D	
TESTS/EXAM. X-RAY	FULL	JOINT EFF. 1
UT / MT / PT / CV @ °F		
HARDNESS MAX. BHN		
WELD SAMPLING		
CODE	POSITION	HORIZONTAL
HYDRO	PRESS @ TOP	1490 PSIG

NOZZLES & MANWAYS

MK	NO.	SIZE	RATING	SERVICE
N5	1	2"	600#	LIQUID OUT
N4	1	8"	600#	LIQUID OUT
N3	1	6"	600#	VAPOR OUT
N2	1	4"	600#	FEED
N1	1	10"	600#	MIXED FEED
M1	1	20"	600#	MANWAY

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS	3	IN.	
PAINTING			
VESSEL CAPACITY	720	CU. FT.	
VESSEL WEIGHT EMPTY	58	KIPS	
VESSEL WEIGHT TEST		KIPS	

REF. DWGS.

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
0	11/17/80	ISSUE FOR PHASE ZERO	—	JK	YMT	[illegible]	HNH

BECHTEL

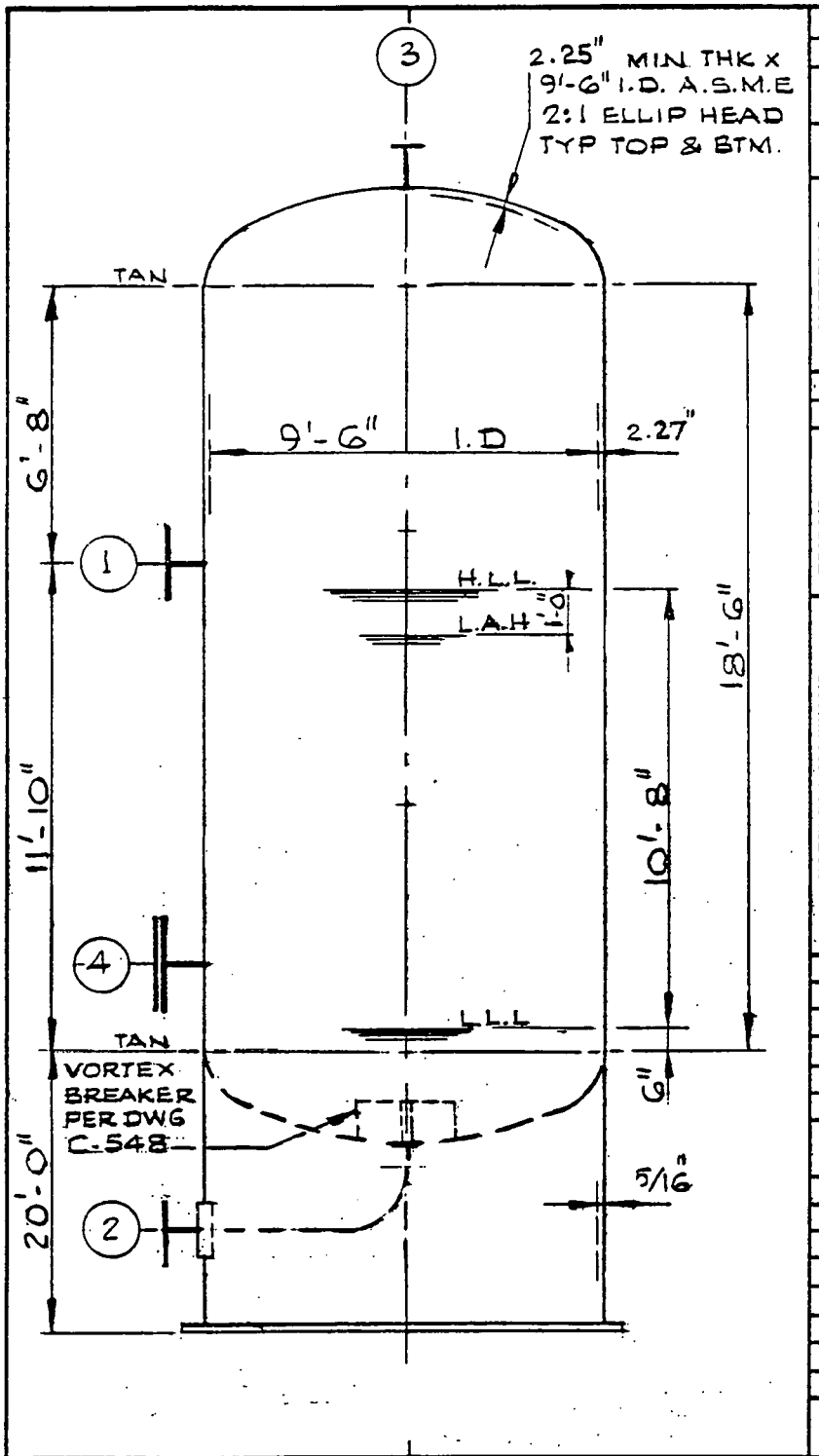
THE BRECKINRIDGE PROJECT

FIRST STAGE H.P. STEAM DRUM 12C-140, 12C-240, 12C-340

JOB NO. 14222

DRAWING NO.	REV.
12-DS-C-40	0

FORM 876, 4/79



CODE	ASME SECT VIII DIV 1, 80		
SPEC.	14222-C4		
OPER. COND.	PRESS.	585 PSIG	
	TEMP.	325 °F	
DES. COND.	PRESS.	643 PSIG	
	TEMP.	350 °F	
MATERIALS	SHELL & HDS	SA-516-70 *	
	SKIRT	SA-36	
	FORGING	SA-105	
	PIPING	SA-106 B	
	STRUCTURAL		
	BOLTS		
	*	CLAD W/TP 304 SS	
CLAD		1/8"	
PWHT	YES		

TESTS/EXAM.						
X-RAY	FULL	JOINT EFF.	100%			
UT	MT	PT	CV @ °F.			
HARDNESS MAX. 8HN						
WELD SAMPLING						
CODE	POSITION	HORIZ				
HYDRO	PRESS @ TOP	965	PSIG			

NOZZLES & MANWAYS				
MK	NO.	SIZE	RATING	SERVICE
1	1	12"	300#	INLET (LIQUID)
2	1	12"	??	OUTLET (LIQUID)
3	1	3"	??	VAPOR
4	1	20"	??	M/WAY WITH DAVIT

LADDER & PTFM CLIPS	REQD.		NO
PIPE SUPPORT CLIPS	REQD.		NO
INSUL. SUPPORT CLIPS	REQD.		NO
INSUL. THICKNESS	1 1/2		IN.
PAINTING			
VESSEL CAPACITY	1536		CU. FT.
VESSEL WEIGHT EMPTY	88		KIPS
VESSEL WEIGHT TEST	187		KIPS
OPERATING WT - 139 K			

REF. DWGS.	C-548, 509, 510, 511
	C-515, 525, 529, 549

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
0	12/20/80	ISSUED FOR PHASE ZERO		RWN	NN	[illegible]	HNH

BECHTEL

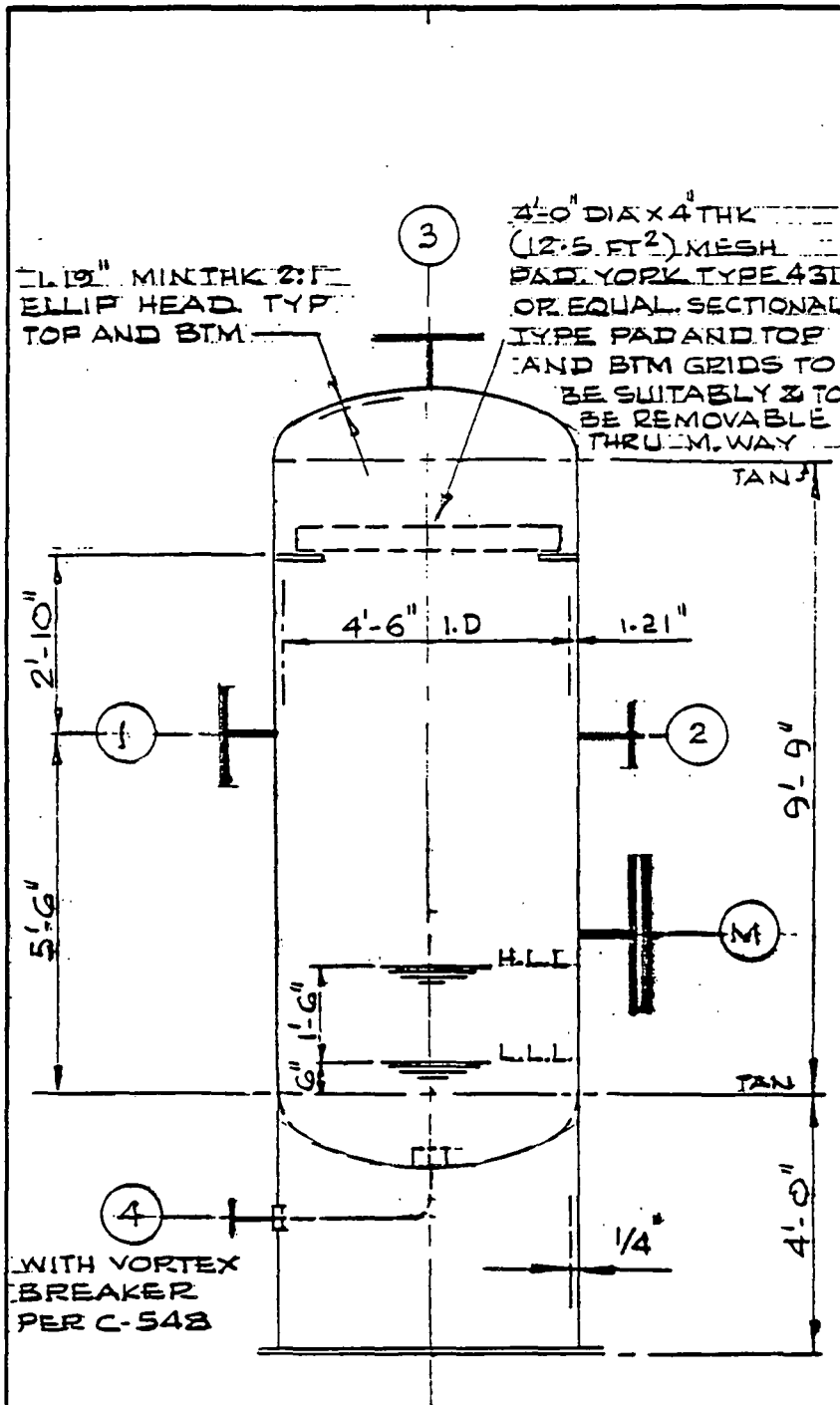
THE BRECKINRIDGE PROJECT

QUENCH WATER SURGE DRUM 12C-050

JOB NO. 14222

DRAWING NO.	REV.
12-DS-C-50	0

FORM 876. 4/79



CODE	A.S.M.E. SECT VIII DIV 1 '80
SPEC.	14222 - C1
OPER. COND.	PRESS. 530 PSIG; TEMP. 30 °F
DES. COND.	PRESS. 583 PSIG; TEMP. 300 °F

MATERIALS	
SHELL & HDS	A-516-70
SKIRT	A-36
FORGING	A-181
PIPING	A-106 B
STRUCTURAL	
BOLTS	

C.A.	1/8"
PWHT	NO

TESTS/EXAM.					
X-RAY	SPOT		JOINT EFF.	85%	
UT	MT	PT	CV @	°F.	
HARDNESS MAX. 8HN					
WELD SAMPLING					
CODE	POSITION HORIZ				
HYDRO	PRESS @ TOP 974 PSIG				

NOZZLES & MANWAYS				
MK	NO.	SIZE	RATING	SERVICE
1	1	10"	300#	VAPOR IN
2	1	6"	??	VAPOR IN
3	1	12"	??	VAPOR OUT
4	1	2"	??	LIQUID OUT
M	1	20"	??	MANWAY WITH COVER AND DAVIT

LADDER & PTFM CLIPS	REQD.	NO	
PIPE SUPPORT CLIPS	REQD.	NO	
INSUL. SUPPORT CLIPS	REQD.	NO	
INSUL. THICKNESS			IN.
PAINTING			
VESSEL CAPACITY			CU. FT.
VESSEL WEIGHT EMPTY		15	KIPS
VESSEL WEIGHT TEST			KIPS

REF. DWGS.

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
1	1-15-81	REVISED ITEM NUMBERS		DWP			HNH
B	10-23-80	CHANGED DWG & EQUIPMENT NUMBERS		DJW			
A	10-8-80	ISSUED FOR ESTIMATE	NN	RWN			

BECHTEL

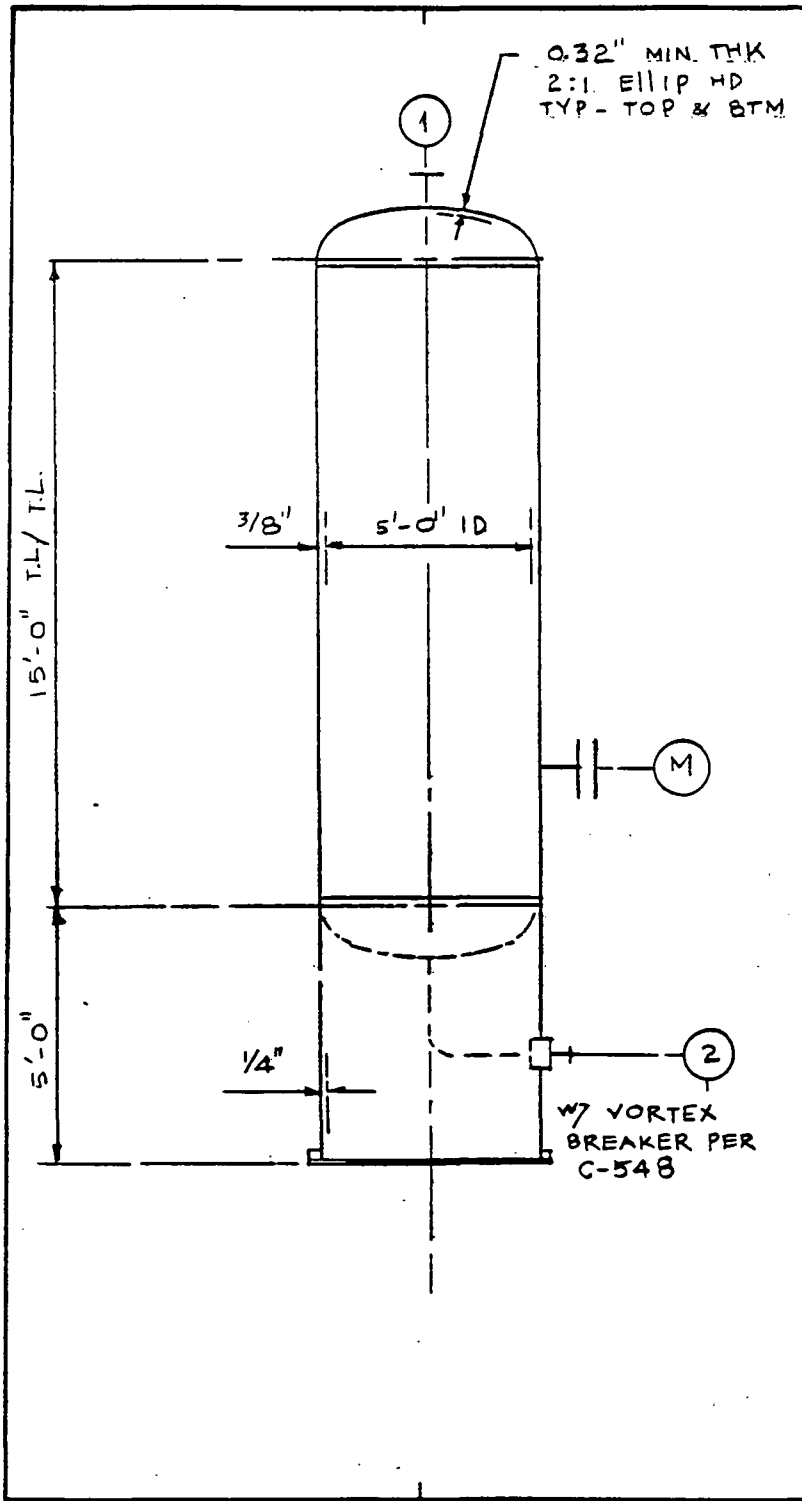
THE BRECKINRIDGE PROJECT

H2 COMPRESSOR K.O. DRUM
12C-151, 251, 351, 451, 551 △1

JOB NO. 14222

DRAWING NO.	REV.
12-DS-C-51	1

FORM 875. 4/79



CODE	ASME SECT VIII DIV 1, 80	
SPEC.	14222 -C1	
OPER. COND.	PRESS.	50 PSIG
	TEMP.	281 °F
DES. COND.	PRESS.	75 PSIG
	TEMP.	350 °F

MATERIALS	
SHELL & HDS	A-516-70 ⚠
SKIRT	A-36
FORGING	A-181 II
PIPING	A-106 B
STRUCTURAL	
BOLTS	

C.A.	1/8"
PWHT	NOT REQ'D

TESTS/EXAM.				
X-RAY	SPOT	JOINT EFF.	85%	
UT	MT	PT	CV @	°F.
HARDNESS MAX. BHN				
WELD SAMPLING				
CODE	POSITION	HORIZ		
HYDRO	PRESS @ TOP	112	PSIG	

NOZZLES & MANWAYS				
MK	NO.	SIZE	RATING	SERVICE

LADDER & PTFM CLIPS	REQD.	✓	NO	
PIPE SUPPORT CLIPS	REQD.		NO	
INSUL. SUPPORT CLIPS	REQD.	✓	NO	
INSUL. THICKNESS	2			IN.
PAINTING				
VESSEL CAPACITY	327			CU. FT.
VESSEL WEIGHT EMPTY	6-8			KIPS
VESSEL WEIGHT TEST	27.2			KIPS

OPER. WT = 28.5 K

REF. DWGS.

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
1	1/20/81	REVISED MATERIAL	HRN			[illegible]	HNH
0	12/30/80	ISSUED FOR PHASE ZERO	NN	NN		[illegible]	

BECHTEL

THE BRECKINRIDGE PROJECT

50 PSIG CONDENSATE POT
12C-052

JOB NO. 14222

DRAWING NO. 12-DS-C-52

REV. 1

FORM 876, 4/79

4.2 Data Sheets for Tanks

12-DS-D-01: Solvent Makeup Tank (12D-001)

TANK DATA

SELEXOL	
TANK NO.	12D-001
SIZE, DIA. X HEIGHT (FT)	42.5X40
CAPACITY (42 GAL. BBLS)	10110
ROOF TYPE	CONE
BOTTOM TYPE	FLAT
FILLING RATE-BPH	✓
EMPTYING RATE-BPH	✓
BEARING PLATES	YES
DRAW-OFF SUMP	
WATER DRAW CONN.	
STORAGE TEMP. °F	AMB.
CORROSION ALLOWANCE	1/8
DESIGN METAL TEMP. – °F MIN./MAX.	125
DESIGN SPECIFIC GRAVITY @ 60°F	1.031
TOTAL NET WORKING CAP. – MBBLS	10.0
MINIMUM NO. OF TANKS	
GAS BLANKET – MIN./MAX. IN. WATER	NTM
MATERIALS OF CONSTRUCTION	CS
VISCOSITY CP @ 60°F	7.9

SHELL APPURTENANCES

SUCTION NOZZLE	✓
SUCTION NOZZLE W/1" COUPLING	
FILL NOZZLE	✓
FILL NOZZLE W/1" COUPLING	
STEAM NOZZLE – DOUBLE FLANGED	
CONDENSATE NOZZLE – DOUBLE FLGD.	
ROOF DRAIN NOZZLE – DOUBLE FLGD.	
FOAM CHAMBER	
FOAM TROUGHS	
MANHOLES – 20" OR 24" DIA.	24"
MIXER NOZZLE	
MIXER NOZZLE – W/BLIND FLG. (MH)	
FLUSH TYPE CLEANOUT, 3' X 4'	
SAMPLE CONNECTION – 1" COUPLING	
TEMP. GAUGE CONN. – 1" COUPLING	
PRESSURE GAUGE CONN.	
TEMP. CONTROLLER CONN. – 1" CPLG.	
SUCTION NOZZLE – DBL. FLG. W/1" CPLG.	
SPECIAL CONNECTIONS	
HIGH & LOW LEVEL ALARMS	
LEVEL GAUGE CONNS.	
HIGH & LOW PRESS. ALARMS	

GENERAL

PAINTING BECHTEL STD.	X-502
BOTTOM PLATE COATING	YES
WINDGIRDERS	
TANK STRAPPING	NO
SPECIFICATIONS D-501 +	API 650
FOUNDATION CONCRETE RINGWALL	

ROOF APPURTENANCES

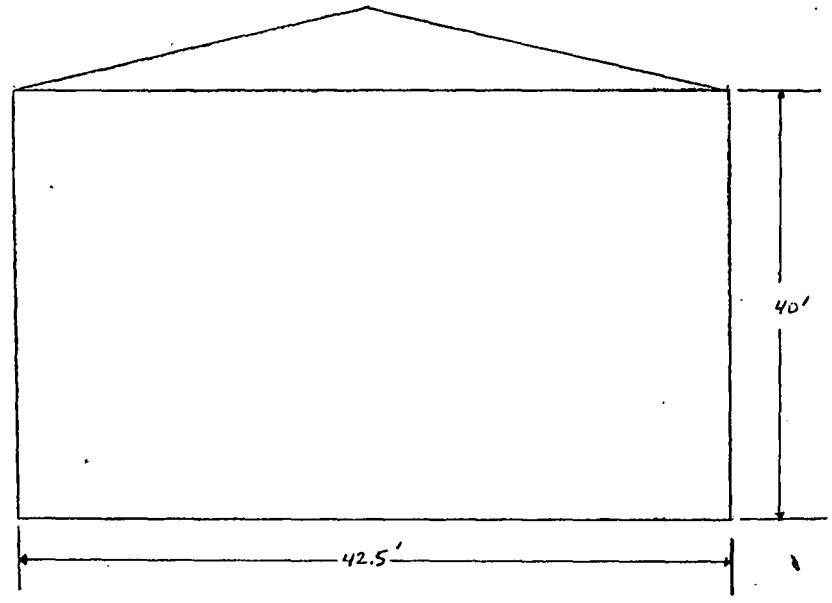
VENT NOZZLE	✓
RIM VENTS	
MANHOLE – 20"	20"
MANHOLE – COMB. EMER. RELIEF	
PONTOON MANHOLE – 20"	
GAUGE HATCH NOZZLE	✓
ROOF DRAIN, FLEX. PIPE	
BLANKET GAS INLET – 2" FLG.	
GAS BLANKET PC 2" FLG. NOZZLE	
AUTOMATIC BLEEDER VENT	
AUTO. GAUGE FLOAT WELL & COVER	
AUTO. GAUGE INSPECT. OPEN. & COVER	
LEVEL GAUGE CONNS.	✓
AVERAGING TEMP. BULB CONN.	
AUTO. GAUGE FLOAT STILLING WELL	

MISCELLANEOUS APPURTENANCES

LADDER W/CAGE	
CIRCUMFERENTIAL STAIRS	YES
PLATFORM (ROOF ACCESS)	YES
ROLLING LADDER W/SELF-LEVEL TRDS.	
GROUNDING LUGS	
MIXER SUPPORT LUGS	
LEVEL GAUGE SUPPORTS	YES
FOAM LINE SUPPORTS	
INSULATION SUPPORTS	NO
CATHODIC PROTECTION	
AUTO. LEVEL GAUGE	
AUTO. LEVEL GAUGE, REMOTE	
AUTO. LEVEL GAUGE, REMOTE PRESS.	
TARGET LEVEL GAUGE	✓
TARGET LEVEL GAUGE, W/ALARM	
TARGET LEV. GA., W/LIQ. SEAL, ALARM	
TEMPERATURE GAUGE	
FOAM GENERATOR	
TANK HEATER (INSTALL BY	
HEATER MANIFOLDS (INSTALL BY	
PRESSURE VACUUM RELIEF VALVE	
OPEN VENT (WITH RETURN BEND)	✓
OPEN VENT (MUSHROOM)	
INSULATION	NONE
SAMPLE COOLER	
CENTER PIN FOR PAINTER'S TROLLEY	YES

GENERAL NOTES

1. CONSTRUCTION IS TO BE PER API 650 + BECHTEL SPEC 14222-D-1
2. CORROSION ALLOWANCE SHALL BE ADDED TO ROOF, BOTTOM, + SHELL CALCULATED THICKNESSES.



△											
△											
△											
△											
△											
6	14/11/80	ISSUE FOR PHASE ZERO	QD				DWJ				HWH
No.	DATE	REVISIONS	BY	CHKD	PROJ. ENGR. APPD.	CONST. APPD.	PROJ. MGR. APPD.	OPER. APPD.	SAFETY APPD.	ENVIR. APPD.	

SCALE | DESIGNED | DRAWN | CHKD | PROJ. ENGR. | CONST. | PROJ. MGR. | OPER. | SAFETY | ENVIR.

BECHTEL

SOLVENT MAKE-UP TANK

TANK DATA & LIST OF APPURTENANCES

JOB No.	DRAWING No.	REV.
14222	12-DS-D-01	0

R&C S.F. Form 173 (4/77)

4.3 Data Sheets for Exchangers

12-DS-E-00: First Stage H.P. Steam Generator (12E-110, 210, 310)

12-DS-E-01: First Stage Shift BFW Preheater (12E-111, 211, 311)

12-DS-E-02: 2nd Stage Waste Heat Boiler (12E-112, 212, 312)

12-DS-E-03: 3rd Stage Waste Heat Boiler (12E-113 A, B, 213 A, B, 313 A, B)

12-DS-E-04: First Stage Shift Feed Heater (12E-114, 214, 314)

12-DS-E-05: Deaerator Feed Preheater (12E-115 A, B, C, 215 A, B, C, 315 A, B, C)

12-DS-E-06: Shifted Gas Trim Cooler (116 A, B, 216 A, B, 316 A, B)

12-DS-E-12: Unshifted Gas H.P. Steam Generator (12E-122 A, B, C)

12-DS-E-13: Unshifted Gas L.P. Steam Boiler (12E-123 A, B)

12-DS-E-15: Hot Shifted Gas Air Cooler (12E-125, 225, 325)

12-DS-E-16: Stripped Water Preheater (12E-126 A, B)

12-DS-E-17: Hot Fuel Gas Cooler (12E-127)

12-DS-E-18: Gasifier Quench Water Preheater (12E-128 A, B, 228 A, B, 328 A, B)

12-DS-E-19: Gasifier Quench Preheater (12E-129, 229, 329)

12-DS-E-21: Surface Condenser (12E-131, 231, 331)

12-DS-E-24: Acid Gas Heater (12E-134, 234, 334)

12-DS-E-28: Expander Feed Heater (12E-138)

12-DS-E-29: Expander Interstage Heater (12E-139)

12-DS-E-35: Hydrogen Compressor Interstage Cooler (12E-145, 245, 345, 445, 545)

12-DS-E-36: Hydrogen Compressor Spillback Cooler (12E-046)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS. INC. BRECKINRIDGE CO, KY				EXCHANGER MANUFACTURER				
2	PLANT	GASIFICATION & PURIFICATION	EXCH. NO.	12E110,210,310		REQ. NO.				
3	SERVICE OF UNIT	1ST STG H.P. STEAM GENERATOR				ITEM NO.				
4	SIZE	52-96	TYPE	BEM	HORIZ	CONNECTED IN	1	SERIES	1	PARALLEL
5	SURF./UNIT (EFF/GROSS)	2767	SHELLS/UNIT	1		SURF/SHELL (EFF/GROSS)	2767			
6	PERFORMANCE OF ONE UNIT									
7	FLUID ALLOCATION		SHELLSIDE			TUBESIDE				
8	FLUID CIRCULATED		BFW			SYNGAS (H_2, CO, CO_2)				
9	TOTAL FLUID ENTERING	LB/HR	DET'D. BY CIRC.			630605.				
10			IN		OUT	IN		OUT		
11	LIQUID									
12	VAPOR	LB/HR, MW								
13	NONCOND	LB/HR, MW				415662	18.6	415662	18.6	
14	STEAM				77,880.	214943.		214943		
15	WATER				1570 GO.					
16	FLUID VAPORIZED/CONDENSED									
17	GRAVITY, LIQ.									
18	VISCOSITY, LIQ. (VAP.)	cP				(0.024)		(0.022)		
19	THERM. COND., LIQ. (VAP.)	BTU/HR FT°F				(0.0626)		(0.0597)		
20	SPECIFIC HEAT, LIQ. (VAP.)	BTU/#°F				(0.489)				
21		IG, 32F BASE								
22	TEMPERATURE	°F	~530		534	773		501		
23	OPERATING PRESS.	PSIA	918		915	660		655		
24	NO. PASSES/SHELL									
25	VELOCITY	FT/SEC								
26	PRESS. DROP, ALLOW/CALC.	PSI	3 /			5 /				
27	FOULING RESISTANCE		0.001			0.001				
28	HEAT EXCHANGED	MM BTU/HR; MTD (CORR) (WTD)	57.5			178.27				°F
29	TRANSFER RATE, SERVICE		CLEAN							BTU/HR. SQ. FT. °F
30	CONSTRUCTION									
31			SHELLSIDE		TUBESIDE					
32	DESIGN/TEST PRESS.	PSIG	1000 / CODE		725 / CODE					
33	DESIGN TEMPERATURE	°F	600		850					
34	CORROSION ALLOWANCE	IN	1/8"		—					
35	CONNECTIONS	INLET								
36	SIZE	OUTLET								
37	RATING									
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH	PITCH	FLOW ◁ △ ◇ □			
39	TUBE MATERIAL	INCOLOY 800			TUBE-TUBESHEET JOINT					
40	SHELL	C.S.	ID	OD	SHELL COVER				(INTEG.) (REMOV.)	
41	CHANNEL/BONNET				CHANNEL COVER					
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING					
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)					
44	BAFFLES-CROSS	TYPE			% CUT (DIA/AREA)	SPACING				
45	BAFFLES-LONG	SEAL TYPE			TUBE SUPPORTS					
46	INSUL. THK.: SHELL	CHAN.			EXPANSION JOINT					
47	GASKETS									
48	CODE REQUIREMENTS	STAMP (YES) (NO)			TEMA CLASS	SPECS				
49	WEIGHT: EACH SHELL	BUNDLE			FULL OF WATER					
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED									
51	Heat exchanger fed to a steam drum via									
52	natural circulation thermosyphon									
53	Gas composition Vol % tubeside									
54	H_2O 35, H_2 38, CO 3.5, CO_2 23, H_2S 0.3									

REV.	DATE				JOB NO.	DRWG. NO.	REV.
2	9/23/80	REVISED STM. FLOW & Q	ARJ	WWL	14222	12-DS-E-00	1
1	11/13/80	ISSUED FOR PHASE ZERO	[illegible]	HNH			

BECHTEL

R&C SPE FORM 150 (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS INC. BRECKINRIDGE CO., KY.						EXCHANGER MANUFACTURER					
2	PLANT	GASIFICATION & PURIFICATION		EXCH. NO.	12E-111,211,311			REQ. NO.					
3	SERVICE OF UNIT	1ST STG SHIFT BFW PREHEATER						ITEM NO.					
4	SIZE	27-96	TYPE	BEM	HORIZ	CONNECTED IN	1	SERIES	1	PARALLEL			
5	SURF./UNIT (EFF/GROSS)	1002		SHELLS/UNIT	1			SURF/SHELL (EFF/GROSS)	1002				
6	PERFORMANCE OF ONE UNIT												
7	FLUID ALLOCATION			SHELLSIDE				TUBESIDE					
8	FLUID CIRCULATED			BFW				SYNGAS					
9	TOTAL FLUID ENTERING		LB/HR	79,470				630605					
10				IN		OUT		IN		OUT			
11	LIQUID												
12	VAPOR		LB/HR, MW										
13	NONCOND		LB/HR, MW					415662	18.6	415662	18.6		
14	STEAM							214943		214943			
15	WATER			2 79,470		79,470							
16	FLUID VAPORIZED/CONDENSED												
17	GRAVITY, LIQ.												
18	VISCOSITY, LIQ. (VAP.)		CP					(0.022)		(0.020)			
19	THERM. COND., LIQ. (VAP.)		BTU/HR-FT-°F					(0.0597)		(0.0522)			
20	SPECIFIC HEAT, LIQ. (VAP.)		BTU/LB-°C					(0.450)					
21			IG .32°F BASE										
22	TEMPERATURE		°F	2 292		490		591		536			
23	OPERATING PRESS.		(PSIA) (PSIG)	913		918		655		650			
24	NO. PASSES/SHELL												
25	VELOCITY		FT/SEC										
26	PRESS. DROP, ALLOW/CALC.		PSI	≤ 1				5 1					
27	FOULING RESISTANCE			0.001				0.001					
28	HEAT EXCHANGED			2 15.8 MM	BTU/HR; MTD (CORR) (WTD)			162.2 2		°F			
29	TRANSFER RATE, SERVICE			2 97.3	CLEAN					BTU/HR, SQ. FT. °F			
30	CONSTRUCTION												
31				SHELLSIDE		TUBESIDE							
32	DESIGN/TEST PRESS.		PSIG	1000 / CODE		725 / CODE							
33	DESIGN TEMPERATURE		°F	550		650							
34	CORROSION ALLOWANCE		IN	1/8"									
35	CONNECTIONS	INLET	IN	3		24							
36	SIZE	OUTLET	IN	3		24							
37	RATING		PSIG	600 RF		300 RF							
38	TUBES NO.	OD		THK (MIN/AVG)		LENGTH		PITCH		FLOW			
39	TUBE MATERIAL	304 LSS				TUBE-TUBESHEET JOINT							
40	SHELL	C.S.	ID	OD		SHELL COVER				(INTEG.) (REMOV)			
41	CHANNEL/BONNET					CHANNEL COVER							
42	TUBESHEET-STATIONARY					TUBESHEET FLOATING							
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)							
44	BAFFLES-CROSS		TYPE			% CUT (DIA/AREA)		SPACING					
45	BAFFLES-LONG		SEAL TYPE			TUBE SUPPORTS							
46	INSUL. THK.: SHELL		CHAN.			EXPANSION JOINT							
47	GASKETS												
48	CODE REQUIREMENTS		STAMP (YES) (NO)			TEMA CLASS		SPECS					
49	WEIGHT: EACH SHELL		BUNDLE			FULL OF WATER							
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED.												
51													
52													
53													
54													

REV.	DATE			WWL	JOB NO.	DRWG. NO.	REV.
2	9/28/81	REV. 2S FLOW & Q, &t,	MP				
1	12/18/80	REISSUED FOR PHASE ZERO	JHN OWP	HWH	14222	12-05-E-01	2
0	11/13/80	ISSUED FOR PHASE ZERO					

BECHTEL

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS INC. BRECKINRIDGE CO., KY.				EXCHANGER MANUFACTURER				
2	PLANT	GASIFICATION & PURIFICATION	EXCH. NO.	12E-112, 212, 312		REQ. NO.				
3	SERVICE OF UNIT	2ND STG.	WASTE HEAT BOILER			ITEM NO.				
4	SIZE	56/43 - 162	TYPE	CKU	(HORIZ/VERT)	CONNECTED IN	1	SERIES	1	PARALLEL
5	SURF./UNIT (EFF/GROSS)	3054	SHELLS/UNIT	1		SURF/SHELL (EFF/GROSS)	3054			
6	PERFORMANCE OF ONE UNIT									
7	FLUID ALLOCATION	SHELLSIDE				TUBESIDE				
8	FLUID CIRCULATED	BFW				SYNGAS				
9	TOTAL FLUID ENTERING LB/HR	35060				533336.				
10		IN		OUT		IN		OUT		
11	LIQUID									
12	VAPOR LB/HR, MW									
13	NONCOND LB/HR, MW					364009	18.6	364009	18.6	
14	STEAM			31550		169327		169327		
15	WATER	35060		3510						
16	FLUID VAPORIZED/CONDENSED									
17	GRAVITY, LIQ.									
18	VISCOSITY, LIQ. (VAP.) CP					(0.022)		(0.019)		
19	THERM. COND., LIQ. (VAP.) BTU/HR FT°F					(0.0536)		(0.0491)		
20	SPECIFIC HEAT, LIQ. (VAP.) BTU/#°F					(0.519)				
21	IG. 32°F BASE									
22	TEMPERATURE °F	275		406		575		464		
23	OPERATING PRESS. (PSIA)	266		265		640		635		
24	NO. PASSES/SHELL									
25	VELOCITY FT/SEC									
26	PRESS. DROP, ALLOW/CALC. PSI	5 /				5 /				
27	FOULING RESISTANCE	0.001				0.001				
28	HEAT EXCHANGED	30.7 MM BTU/HR; MTD (CORR) (MTD)				107.66				°F
29	TRANSFER RATE, SERVICE	93-37 CLEAN								BTU/HR. SQ. FT. °F
30	CONSTRUCTION									
31		SHELLSIDE		TUBESIDE						
32	DESIGN/TEST PRESS. PSIG	300 /		700 /						
33	DESIGN TEMPERATURE °F	450		625						
34	CORROSION ALLOWANCE IN	1/8"								
35	CONNECTIONS INLET IN	3		24						
36	SIZE OUTLET IN	3		24						
37	RATING PSIG	300 RF		450 RF						
38	TUBES NO. OD	THK (MIN/AVG)		LENGTH		PITCH		FLOW → ◁ △ ◇ □		
39	TUBE MATERIAL INCOLOY 800			TUBE-TUBESHEET JOINT						
40	SHELL C.S. ID OD			SHELL COVER				(INTEG.) (REMOV)		
41	CHANNEL/BONNET			CHANNEL COVER						
42	TUBESHEET-STATIONARY			TUBESHEET FLOATING						
43	FLOATING HEAD COVER			IMPINGEMENT PLATE (YES) (NO)						
44	BAFFLES-CROSS	TYPE		% CUT (DIA/AREA)		SPACING				
45	BAFFLES-LONG	SEAL TYPE		TUBE SUPPORTS						
46	INSUL. THK.: SHELL	CHAN.		EXPANSION JOINT						
47	GASKETS									
48	CODE REQUIREMENTS	STAMP (YES) (NO)		TEMA CLASS		SPECS				
49	WEIGHT: EACH SHELL	BUNDLE		FULL OF WATER						
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED									
51	GAS COMPOSITION VOL % H_2O 32.5% H_2 40% CO 26%									
52	CO_2 1.4% N_2 0.3% DEW POINT 395 F°									
53										
54										

REV.	DATE			JOB NO.	DRWG. NO.	REV.
	11/13/80	ISSUED FOR PHASE ZERO	MWH	18222	12-05-E-02	0

BECHTEL

RGC SPE FORM 150 (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS INC BRECKINRIDGE CO., KY.					EXCHANGER MANUFACTURER	12E-113 A&B		
2	PLANT	GASIFICATION & PURIFICATION	EXCH. NO.	12E-213 A&B 313 A&B			REQ. NO.			
3	SERVICE OF UNIT	THIRD STAGE WASTE HEAT BOILER					ITEM NO.			
4	SIZE	77/54-120	TYPE	CKU	(HORIZ/VERT)	CONNECTED IN 1	SERIES 2	PARALLEL		
5	SURF./UNIT (EFF/GROSS)	9053	SHELLS/UNIT	2			SURF/SHELL (EFF/GROSS)	4526		
6	PERFORMANCE OF ONE UNIT									
7	FLUID ALLOCATION		SHELLSIDE				TUBESIDE			
8	FLUID CIRCULATED		Boiling WATER				SYNGAS			
9	TOTAL FLUID ENTERING	LB/HR	117292				533336.			
10			IN		OUT		IN		OUT	
11	LIQUID									
12	VAPOR	LB/HR, MW								
13	NONCOND	LB/HR, MW					367264	18.6	367264	13.6
14	STEAM				105562		166072		28885	
15	WATER		117292		11730				87187	
16	FLUID VAPORIZED/CONDENSED				105562				87187	
17	GRAVITY, LIQ.									
18	VISCOSITY, LIQ. (VAP.)	CP					(0.019)		(0.019)	
19	THERM. COND., LIQ. (VAP.)	BTU/HR FT °F					(0.046)		(0.0596)	
20	SPECIFIC HEAT, LIQ. (VAP.)	BTU/LB °F					(0.408)		(0.405)	
21		IG 32°F BASE								
22	TEMPERATURE	°F	275		298		393		325	
23	OPERATING PRESS.	(PSIA)	66		65		620		615	
24	NO. PASSES/SHELL									
25	VELOCITY	FT/SEC								
26	PRESS. DROP, ALLOW/CALC.	PSI	1		1		5		1	
27	FOULING RESISTANCE		0.005				0.001			
28	HEAT EXCHANGED	93 MM	BTU/HR; MTD (CORR) (WTD)				58.55		°F	
29	TRANSFER RATE, SERVICE	176.02	CLEAN						BTU/HR. SQ. FT. °F	
30	CONSTRUCTION									
31			SHELLSIDE		TUBESIDE					
32	DESIGN/TEST PRESS.	PSIG	475 / CODE		700 / CODE					
33	DESIGN TEMPERATURE	°F	350		440					
34	CORROSION ALLOWANCE	IN	1/8"		—					
35	CONNECTIONS	INLET IN	4		18					
36	SIZE	OUTLET IN	13		16					
37	RATING	PSIG	150 RF		400 RF					
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH	PITCH	FLOW → ◁ △ ◇ □			
39	TUBE MATERIAL	TZCR.			TUBE-TUBESHEET JOINT					
40	SHELL	C.S.	ID	OD	SHELL COVER				(INTEG.) (REMOV.)	
41	CHANNEL/BONNET				CHANNEL COVER					
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING					
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)					
44	BAFFLES-CROSS		TYPE		% CUT (DIA/AREA)	SPACING				
45	BAFFLES-LONG		SEAL TYPE		TUBE SUPPORTS					
46	INSUL. THK.: SHELL		CHAN.		EXPANSION JOINT					
47	GASKETS									
48	CODE REQUIREMENTS		STAMP (YES) (NO)		TEMA CLASS	SPECS				
49	WEIGHT: EACH SHELL		BUNDLE		FULL OF WATER					
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED									
51	Gas composition Dry volume CO_2 39% H_2 60%									
52	CO 0.7% N_2 0.3%									
53	Inlet gas is dry outlet gas is wet.									
54	SEE SHEET 2 OF 2 FOR COOLING CURVE									

REV.	DATE		JOB NO.	DRWG. NO.	REV.
△			14232	A2-05-E-03	0
△					
△	11/13/80	ISSUED FOR PHASE ZERO			

BECHTEL

R&C SPE FORM 156 (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS INC Breckinridge Co., Ky.						EXCHANGER MANUFACTURER			
2	PLANT	GASIFICATION & PURIFICATION	EXCH. NO.	12E-114, 214, 314				REQ. NO.			
3	SERVICE OF UNIT	1 ST STG SHIFT FEED HEATER						ITEM NO.			
4	SIZE	27/120	TYPE	CJN △	(HORIZ/VERT)	CONNECTED IN	1	SERIES		PARALLEL	
5	SURF./UNIT (EFF/GROSS)	589		SHELLS/UNIT	1			SURF/SHELL (EFF/GROSS)	589		
6	PERFORMANCE OF ONE UNIT										
7	FLUID ALLOCATION			SHELLSIDE				TUBESIDE			
8	FLUID CIRCULATED			SYNGAS				SYNGAS			
9	TOTAL FLUID ENTERING	LB/HR		315303				533336			
10				IN		OUT		IN		OUT	
11	LIQUID										
12	VAPOR	LB/HR, MW		207831	18.4	207831	18.4	364009	18.4	364009	18.4
13	NONCOND	LB/HR, MW		107472		107472		169327		169327	
14	STEAM										
15	WATER										
16	FLUID VAPORIZED/CONDENSED										
17	GRAVITY, LIQ.										
18	VISCOSITY, (VAP.)	CP		(0.025)		(0.024)		(0.017)		(0.018)	
19	THERM. COND., (VAP.)	BTU/HR FT °F		(0.0654)		(0.0598)		(0.0478)		(0.051)	
20	SPECIFIC HEAT, (VAP.)	BTU/# OF		(0.453)		(0.450)		(0.450)		(0.447)	
21		IG 32°F BASE									
22	TEMPERATURE	°F		830		711		438		508	
23	OPERATING PRESS.	(PSIA)		665		660		680		675	
24	NO. PASSES/SHELL										
25	VELOCITY	FT/SEC									
26	PRESS. DROP, ALLOW/CALC.	PSI		5 /				5 /			
27	FOULING RESISTANCE			0.001				0.001			
28	HEAT EXCHANGED	17.0 MM BTU/HR; MTD (CORR) (WTD)						293		°F	
29	TRANSFER RATE, SERVICE	CLEAN								BTU/HR. SQ. FT. °F	
30	CONSTRUCTION										
31				SHELLSIDE		TUBESIDE					
32	DESIGN/TEST PRESS.	PSIG		715 /		730 /					
33	DESIGN TEMPERATURE	°F		915		560					
34	CORROSION ALLOWANCE	IN		—		—					
35	CONNECTIONS	INLET									
36	SIZE	OUTLET									
37	RATING										
38	TUBES NO.	OD		THK (MIN/AVG)		LENGTH		PITCH		FLOW ◁ △ ◇ □	
39	TUBE MATERIAL	321 SS				TUBE-TUBESHEET JOINT					
40	SHELL	- 321 SS		ID	OD	SHELL COVER				(INTEG.) (REMOV.)	
41	CHANNEL/BONNET					CHANNEL COVER					
42	TUBESHEET-STATIONARY					TUBESHEET FLOATING					
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)					
44	BAFFLES-CROSS		TYPE			% CUT (DIA/AREA)		SPACING			
45	BAFFLES-LONG		SEAL TYPE			TUBE SUPPORTS					
46	INSUL. THK.: SHELL		CHAN.			EXPANSION JOINT					
47	GASKETS										
48	CODE REQUIREMENTS		STAMP (YES) (NO)			TEMA CLASS		SPECS			
49	WEIGHT: EACH SHELL		BUNDLE			FULL OF WATER					
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED					GAS COMPOSITION Vol %					
51	TUBE SIDE: H_2O (55), H_2 (17), CO (24), CO_2 (2.6), H_2S (0.3) ENTER HT DEW POINT										
52	SHELL SIDE: H_2O (35), H_2 (38), CO (3.5), CO_2 (23), H_2S (0-3) TOTALLY DRY										
53	50% OF FLOW NORMALLY BY PASS - 2 ← GOOD FOR TEMPERATURE CONTROL										
54											

REV.	DATE					JOB NO.	DRWG. NO.	REV.
2	1/14/81	REISSUED FOR TYPE CHANGE	HRN 2-WA		HNH	14222	08-12DS-E-04	1
1	11/13/80	ISSUED FOR PHASE ZERO						

BECHTEL

RGC SPE FORM 15B (6/79)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS, INC. BRECKINRIDGE CO., KY						EXCHANGER MANUFACTURER	12E-115A,B&C			
2	PLANT 12 GASIFICATION& PURIFICATION			EXCH. NO.	12E-215A,B&C			REQ. NO.				
3	SERVICE OF UNIT DEAERATOR FEED PREHEATER				12E-315A,B&C			ITEM NO.				
4	SIZE 46-240 △ TYPE BJU		HORIZ		CONNECTED IN	3		SERIES	1		PARALLEL	
5	SURF./UNIT (EFF/GROSS) 12918 △		SHELLS/UNIT		3			SURF/SHELL (EFF/GROSS)	4306 △			
6	PERFORMANCE OF ONE UNIT											
7	FLUID ALLOCATION		SHELLSIDE					TUBESIDE				
8	FLUID CIRCULATED		SYNGAS					BOILER FEED WATER				
9	TOTAL FLUID ENTERING	LB/HR	446149					543870				
10			IN		OUT			IN		OUT		
11	LIQUID											
12	VAPOR	LB/HR, MW										
13	NONCOND	LB/HR, MW	367288	18.6	367288	18.6						
14	STEAM		78861		17161							
15	WATER				61700			543870		543870		
16	FLUID VAPORIZED/CONDENSED				17161							
17	GRAVITY, LIQ.											
18	VISCOSITY, LIQ. (VAP.)	CP	0.019		0.018							
19	THERM. COND., LIQ. (VAP.)	BTU/HR-FT²-°F	0.0497		0.0487							
20	SPECIFIC HEAT, LIQ. (VAP.)	BTU/lb °F	0.503		0.48							
21		@ 32°F BASE										
22	TEMPERATURE	°F	325		192			120		275		
23	OPERATING PRESS.	(PSIA)	615		610			85		80		
24	NO. PASSES/SHELL											
25	VELOCITY	FT/SEC										
26	PRESS. DROP, ALLOW/CALC.	PSI	5 / 4.62					10 / 7.86				
27	FOULING RESISTANCE		0.001					0.001				
28	HEAT EXCHANGED	84.3MM BTU/HR; MTD (CORR) (WTD)						53.28 △				°F
29	TRANSFER RATE, SERVICE	122.48 △ CLEAN										BTU/HR. SQ. FT. °F
30	CONSTRUCTION											
31			SHELLSIDE		TUBESIDE							
32	DESIGN/TEST PRESS.	PSIG	700 /		100 /							
33	DESIGN TEMPERATURE	°F	375		325							
34	CORROSION ALLOWANCE	IN										
35	CONNECTIONS	INLET IN	26		10							
36	SIZE	OUTLET IN	2 x 16		10							
37	RATING	PSIG	400 AF		150 RF							
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH		PITCH	FLOW				
39	TUBE MATERIAL	304LSS			TUBE-TUBESHEET JOINT							
40	SHELL	C.S. CLAD w/ 304LSS	ID	OD	SHELL COVER					(INTEG.) (REMOV)		
41	CHANNEL/BONNET				CHANNEL COVER							
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING							
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)							
44	BAFFLES-CROSS	TYPE			% CUT (DIA/AREA)		SPACING					
45	BAFFLES-LONG	SEAL TYPE			TUBE SUPPORTS							
46	INSUL. THK.: SHELL	CHAN.			EXPANSION JOINT							
47	GASKETS											
48	CODE REQUIREMENTS	STAMP (YES) (NO)			TEMA CLASS		SPECS					
49	WEIGHT: EACH SHELL	BUNDLE			FULL OF WATER							
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED											
51	GAS COMPOSITION VOLUME% DRY BASIS CO₂ 39% H₂ 21%											
52	CO 0.1% H₂S 0.3%											
53												
54	SEE 12-05-E-013 SHEET 2 OF 2 FOR COOLING CURVE											

REV.	DATE						JOB NO.	DRWG. NO.	REV.
△	12/18/80	REISSUED FOR PHASE ZERO	HKM	GWP		HWH	19222	12-05-E-05	1
△	11/13/80	ISSUED FOR PHASE ZERO	KM						

BECHTEL

R&C SPE FORM 188 (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS, INC. BRECKINRIDGE CO., KY				12E-116A&B		EXCHANGER MANUFACTURER					
2	PLANT	12 GASIFICATION & PURIFICATION		EXCH. NO.	12E-216 A&B; 316A&B			REQ. NO.					
3	SERVICE OF UNIT	SHIFTED GAS TRIM COOLER						ITEM NO.					
4	SIZE	36 - 174	TYPE	BEU	HORIZ	CONNECTED IN	2	SERIES	1	PARALLEL			
5	SURF./UNIT (EFF/GROSS)	3925		SHELLS/UNIT	2			SURF/SHELL (EFF/GROSS)	1963				
6	PERFORMANCE OF ONE UNIT												
7	FLUID ALLOCATION			SHELLSIDE				TUBESIDE					
8	FLUID CIRCULATED			SYNGAS				WATER					
9	TOTAL FLUID ENTERING	LB/HR		446149				400000.					
10				IN		OUT		IN		OUT			
11	LIQUID												
12	VAPOR	LB/HR, MW											
13	NONCOND	LB/HR, MW		367288	18.6	367288	18.6						
14	STEAM			1584		679							
15	WATER			77277		78182		400000		400000			
16	FLUID VAPORIZED/CONDENSED					905							
17	GRAVITY, LIQ.												
18	VISCOSITY, LIQ. (VAP.), cp			(0.017)		(0.017)							
19	THERM. COND., LIQ. (VAP.) BTU/HR FT °F			(0.0455)		(0.0433)							
20	SPECIFIC HEAT, LIQ. (VAP.), BTU/lb °F			(0.44)		(0.42)							
21	IG 32°F BASE												
22	TEMPERATURE	°F		130		100		85		105			
23	OPERATING PRESS.	(PSIA)		595		590		55		50			
24	NO. PASSES/SHELL												
25	VELOCITY	FT/SEC											
26	PRESS. DROP, ALLOW/CALC.	PSI		5				5					
27	FOULING RESISTANCE			0.001				0.003					
28	HEAT EXCHANGED			20 MM BTU/HR; MTD (CORR) (WTD)				18.22 ⚠		°F			
29	TRANSFER RATE, SERVICE			111.86 ⚠ CLEAN						BTU/HR. SQ. FT. °F			
30	CONSTRUCTION												
31				SHELLSIDE		TUBESIDE							
32	DESIGN/TEST PRESS.	PSIG		660 /		75 /							
33	DESIGN TEMPERATURE	°F		300		300							
34	CORROSION ALLOWANCE	IN											
35	CONNECTIONS	INLET	IN	24		8							
36	SIZE	OUTLET	IN	20		8							
37	RATING		PSIG	300 RF		150 RF							
38	TUBES NO.	OD		THK (MIN/AVG)		LENGTH		PITCH		FLOW ◁ △ ◇ □			
39	TUBE MATERIAL	304LSS				TUBE-TUBESHEET JOINT							
40	SHELL	C.S. CLAD W/ 304LSS ID		OD		SHELL COVER				(INTEG.) (REMOV)			
41	CHANNEL/BONNET					CHANNEL COVER							
42	TUBESHEET-STATIONARY					TUBESHEET FLOATING							
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)							
44	BAFFLES-CROSS			TYPE		% CUT (DIA/AREA)		SPACING					
45	BAFFLES-LONG			SEAL TYPE		TUBE SUPPORTS							
46	INSUL. THK.: SHELL			CHAN.		EXPANSION JOINT							
47	GASKETS												
48	CODE REQUIREMENTS			STAMP (YES) (NO)		TEMA CLASS		SPECS					
49	WEIGHT: EACH SHELL			BUNDLE		FULL OF WATER							
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED												
51	GAS COMPOSITION VOLUME % (DRY BASIS) CO_2 39%, H_2 60%,												
52	CO 0.7%, H_2S 0.3%												
53													
54	SEE 12-05-E-013 SHEET 2 OF 2 FOR COOLING CURVE.												

REV.	DATE						JOB NO.	DRWG. NO.	REV.
⚠	12/18/80	REISSUED FOR PHASE ZERO	HRM	OWP		HNH	14222	12-05-E-06	F
⚠	11/13/80	ISSUED FOR PHASE ZERO	633						

BECHTEL

R&C SPE FORM 139 (6/79)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASEI BRECKINRIDGE CO KY							EXCHANGER MANUFACTURER					
2	PLANT 12 Gasification Unit				EXCH. NO. 12E122A,B,C				REQ. NO.					
3	SERVICE OF UNIT UNSHIFTED GAS H.P. STM. GEN.								ITEM NO.					
4	SIZE 72/45-240 △ TYPE BKU △				(HORIZ/VERT)		CONNECTED IN	1	SERIES 3			PARALLEL		
5	SURF/UNIT (EFF/GROSS) 15,619 /1				SHELLS/UNIT	3			SURF/SHELL (EFF/GROSS) 5206 /1					
6	PERFORMANCE OF ONE UNIT													
7	FLUID ALLOCATION		SHELLSIDE						TUBESIDE					
8	FLUID CIRCULATED		BFW						Fuel gas (H_2, CO, CO_2, H_2S)					
9	TOTAL FLUID ENTERING	LB/HR	/2 142,623						409936					
10			IN		OUT				IN		OUT			
11	LIQUID													
12	VAPOR	LB/HR, MW												
13	NONCOND	LB/HR, MW							187252	18.9	187252	18.7		
14	STEAM				128360				222684		97104			
15	WATER		142623		14263						125580			
16	FLUID VAPORIZED/CONDENSED										125580			
17	GRAVITY, LIQ.													
18	VISCOSITY, LIQ. (VAP.)								0.017		0.018			
19	THERM. COND., LIQ. (VAP.) BTU/HR FT °F								(0.0478)		(0.0456)			
20	SPECIFIC HEAT, LIQ. (VAP.)								0.375(v)		0.373(v)			
21														
22	TEMPERATURE	°F	292 /2		366				438		385			
23	OPERATING PRESS.	(PSIG)	151		150				655		661			
24	NO. PASSES/SHELL													
25	VELOCITY	FT/SEC												
26	PRESS. DROP, ALLOW/CALC.	PSI	1						4					
27	FOULING RESISTANCE		0.001						0.001					
28	HEAT EXCHANGED	/2	12.2,		MM BTU/HR; MTD (CORR) (WTD)				39.7 /4				°F	
29	TRANSFER RATE, SERVICE		/2 200.5		CLEAN								BTU/HR. SQ. FT. °F	
30	CONSTRUCTION													
31			SHELLSIDE		TUBESIDE									
32	DESIGN/TEST PRESS.	PSIG	490 / CODE		750 / CODE									
33	DESIGN TEMPERATURE	°F	410		500									
34	CORROSION ALLOWANCE	IN	1/8		—									
35	CONNECTIONS	INLET IN	4		12									
36	SIZE	OUTLET IN	9		10									
37	RATING	PSIG	150 RF		400 RF									
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH		PITCH		FLOW ⟶ ◁ △ ◇ □					
39	TUBE MATERIAL 12' CR.				TUBE-TUBESHEET JOINT									
40	SHELL C.S.	ID	OD		SHELL COVER							(INTEG.) (REMOV)		
41	CHANNEL/BONNET				CHANNEL COVER									
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING									
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)									
44	BAFFLES-CROSS	TYPE			% CUT (DIA/AREA)		SPACING							
45	BAFFLES-LONG	SEAL TYPE			TUBE SUPPORTS									
46	INSUL. THK.: SHELL	CHAN.			EXPANSION JOINT									
47	GASKETS													
48	CODE REQUIREMENTS	STAMP (YES) (NO)			TEMA CLASS		SPECS							
49	WEIGHT: EACH SHELL	BUNDLE			FULL OF WATER									
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED													
51	SEE 12-05-E-22 SHEET 2 OF 2 FOR COND. CURVE													
52														
53	Dry gas composition volume% H_2-39, CO-54, CO_2-6.													
54														

/1

REV.	DATE					JOB NO.	DRWG. NO.	REV.
/3	9/28/81	REV. STM RATE, QTY, HTD	AAP		WWL	14222	12-05-E-12	2
/2	1/15/81	REISSUED FOR PHASE ZERO	HKW	Qwp	HWH			
/1	11/13/80	ISSUED FOR PHASE ZERO	[illegible]					

BECHTEL

RGC SPE FORM 1 SS (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASEL BRECKINRIDGE CO KY							EXCHANGER MANUFACTURER					
2	PLANT	L2 Gasification		EXCH. NO.	L2E-123A,B				REQ. NO.					
3	SERVICE OF UNIT	UNSHIFTED GAS LP STM. BOILER							ITEM NO.					
4	SIZE	58/35-240	TYPE	BKU	HORIZ	CONNECTED IN	1	SERIES	2	PARALLEL				
5	SURF/UNIT (EFF/GROSS)	5633		SHELLS/UNIT	2			SURF/SHELL (EFF/GROSS)	2816					
6	PERFORMANCE OF ONE UNIT													
7	FLUID ALLOCATION	SHELLSIDE						TUBESIDE						
8	FLUID CIRCULATED	BFW						Fuel Gas (H2, CO, CO2, H2S)						
9	TOTAL FLUID ENTERING LB/HR	87,671						409936						
10		IN		OUT				IN		OUT				
11	LIQUID							125580		187863				
12	VAPOR LB/HR, MW							97108	18	34825	18			
13	NONCOND LB/HR, MW							187248	18.9	187248	18.9			
14	STEAM			78,904										
15	WATER	87,671		8767										
16	FLUID CONDENSED									62283				
17	GRAVITY, LIQ.													
18	VISCOSITY, LIQ. (VAP.)							(0.018)		(0.019)				
19	THERM. COND., LIQ. (VAP.) BTU/HR FT OF							(0.0456)		(0.0500)				
20	SPECIFIC HEAT, LIQ. (VAP.)							(0.373)		(0.37)				
21														
22	TEMPERATURE °F	292		298				385		335				
23	OPERATING PRESS. (PSIG)	51		50				660		656				
24	NO. PASSES/SHELL													
25	VELOCITY FT/SEC							38.29						
26	PRESS. DROP, ALLOW/CALC. PSI	1 / 1.0						4 / 12.51						
27	FOULING RESISTANCE	0.001						0.001						
28	HEAT EXCHANGED	72.6		MUBTU/HR; MTD (CORR) (WTD)				63.14		°F				
29	TRANSFER RATE, SERVICE	204.2		CLEAN				BTU/HR. SQ. FT. °F						
30	CONSTRUCTION													
31		SHELLSIDE		TUBESIDE										
32	DESIGN/TEST PRESS. PSIG	500 / CODE		750 / CODE										
33	DESIGN TEMPERATURE °F	350		435										
34	CORROSION ALLOWANCE IN	1/8"		CLAD										
35	CONNECTIONS INLET	4"		12"										
36	SIZE OUTLET	12"		12"										
37	RATING	150 LB RF		400 LB RF										
38	TUBES NO. OD	THK (MIN/AVG)		LENGTH		PITCH		FLOW						
39	TUBE MATERIAL	T2 CR.		TUBE-TUBESHEET JOINT										
40	SHELL CARBON STEEL	ID	OD	SHELL COVER						(INTEG.) (REMOV.)				
41	CHANNEL/BONNET	C.S. CLAD W/ T2 CR.		CHANNEL COVER										
42	TUBESHEET-STATIONARY			TUBESHEET FLOATING										
43	FLOATING HEAD COVER			IMPINGEMENT PLATE (YES) (NO)										
44	BAFFLES-CROSS	TYPE		% CUT (DIA/AREA)		SPACING								
45	BAFFLES-LONG	SEAL TYPE		TUBE SUPPORTS										
46	INSUL. THK.: SHELL	CHAN.		EXPANSION JOINT										
47	GASKETS													
48	CODE REQUIREMENTS	STAMP (YES) (NO)		TEMA CLASS		SPECS								
49	WEIGHT: EACH SHELL	BUNDLE		FULL OF WATER										
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED													
51	SEE 12-DS-E-22 SHEET 2 OF 2 FOR COND. CURVE													
52	Dry gas composition values: H2=39, CO=54, CO2=6													
53														
54														

1/14/81

REV.	DATE						JOB NO.	DRWG. NO.	REV.
2		REISSUED FOR MATERIAL CHANGE	HKN	DWP		HNH	14222	12-DS-E-13	3
1	12/19/80	REISSUED FOR PHASE ZERO	HKN	DWP					
0	9/28/81	REV. STM FLOW, QT, H2O		ALP		WWL			

BECHTEL

RGC SPE FORM 1 SS (6/76)

AIR-COOLED HEAT EXCHANGER SPECIFICATION SHEET

Customer and Plant Location	ASFI, BRECKINRIDGE CO., KY		Manufacturer:		
Plant	12 GASIFICATION & PURIFICATION	Exch. No.	12E-115, 225, 325	Req. No.	
Service	HOT SHIFTED GAS: AIR COOLER			Item No.	
Size & Type	10-325			(Induced)(Forced) Draft	No. of Bays
Surface per Unit-Finned Tube	80342 ft²			Bare Tube	3818 ft²
Heat Exchanged	15.05 — MM Btu/h			MTD, Eff.	37.5 °F
Transfer Rate-Finned Tube	5.0	:Bare Tube, Service	105.1	Clean	Btu/h-ft²-°F

PERFORMANCE DATA—TUBE SIDE

		IN	OUT			IN	OUT
Fluid Name	SYNGAS			Lethal Service(Yes)(No)			
Total Fluid Entering	446149 lb/h			Density, Liquid	lb/ft³		
		IN	OUT	Specific Heat Capacity	Btu/lb °F	(0.46)	(0.44)
Temperature	°F	179	130	Cond. Vap.	Btu/h-ft °F	(0.0481)	(0.0454)
Liquid	lb/h			(Pour)(Freeze)Point	°F		
Vapor	lb/h, mol. wt.			Bubble Point	°F		
Noncond.	lb/h, mol. wt.	367288 18.6	367288 18.6	Latent Heat	Btu/lb		
Steam	lb/h	12611	1584	Inlet Pressure	(psig)(psia)		
Water	lb/h	66250	77277	Pressure Drop, Allow./Calc.	psi	5	
Viscosity(Liq.)(Vap.)	cP	(0.018)	(0.017)	Fouling Resist., Inside	h-ft² °F/Btu	0.001	

PERFORMANCE DATA—AIR SIDE

Air Quantity, Total	418080 (std. ft³/min)	Altitude above Sea Level	420 ft.		
Air Quantity/Fan	110791 act. ft³/min	Temperature In(Design Dry Bulb)	96 °F		
Actual Static Pressure	0.63 + 0.045 in. water	Temperature Out	129 °F		
Face Velocity	570 std. ft/min	Mass Velocity(Net Free Area)	lb/h-ft²	Minimum Design Ambient	°F

DESIGN—MATERIALS—CONSTRUCTION

Design Pressure	670 psig	Test Pressure	psig	Design Temperature	°F
TUBE BUNDLE		HEADER, Type	PLUG	TUBE, Material	304L SS
Size	10-325	Material	304L SS		(Seamless)(Welded)
No./Bay	1 No. Tube Rows 5	No. Passes	1 Slope 1/8 in./ft	OD 1 in.	Min. Thick. 0.083 in.
Arrangement		Plug Material	S.S.	No./Bundle 228	Length 32 ft.
Bundles In Parallel	In Series	Gasket Material		Pitch	2 1/2 in.△
Bays 2 In Parallel	In Series	Corrosion Allowance	in.	FIN, Type	EXT
Bundle Frame		No., Size Inlet Nozzle	in.	Material	ALU
MISCELLANEOUS		No., Size Outlet Nozzle	in.	OD 2 1/4 in.	Stock Thick. in.
Struct. Mount.(Grade)(Pipe rack)	c/c	Special Nozzles	in.	No./in. 10	Fin Design Temp. °F
Surface Preparation		Rating & Facing		Code ASME VIII, Div. 1	Stamp(Yes)
Louvers Auto	Manual	TI	PI AP2661	SPECS.	
Vibration Switches		Chem. Cleaning			

MECHANICAL EQUIPMENT

FAN, Mfr & Model		DRIVER, Type		SPEED REDUCER, Type	
No./Bay 2	rev/min	Mfr.	ELECTRIC MOTOR	Mfr. & Model	V - BELT
Dia. 9 ft	No. Blades 4 MIN	No./Bay 2	hp/Driver 30	No./Bay	2
Pitch Adj.	Angle	rev/min		AGMA Rating hp	Ratio A
Material, Blade	Hub	Enclosure	TEFC	Support(Structure)(Pedestal)	
hp/Fan, Des. 22	Minimum Amb.	Volt;Phase;Cycle	460/3/60		

Control Action on Air Failure-Fan Pitch (Minimum)(Maximum)(Lockup); Louvers (Open)(Close)(Lockup)

Degree Control of Outlet Process Temperature (Maximum Cooling)(± °F)

Recirculation (None) (Internal) (External Over Side) (External Over End) Steam Coil (Yes)(No)

NOTES: *Give tube count of each pass when irregular.

GAS COMPOSITION VOLUME % (DRY BASIS) CO_2 - 39% H_2 - 60%
CO - 0.7% H_2S 0.3%

SEE 12-DS-A-017 SHEET 2 OF 2 FOR COOLING CURVE

Plot Area | Weight—Bundle | lb Shipping lb

REV.	DATE		JOB NO.	DRWG. NO.	REV.
△					
△					
△	12/31/80	ISSUED FOR PHASE ZERO	14222	12-DS-E-15	0

FORM 318 (6/78)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASEI BRECKINRIDGE CO KY						EXCHANGER MANUFACTURER				
2	PLANT 12 Gasification			EXCH. NO. 12E-126A&B				REQ. NO.				
3	SERVICE OF UNIT	STRIPPED WATER PREHEATER						ITEM NO.				
4	SIZE 38-240	TYPE BEM	HORIZ	CONNECTED IN 1				SERIES 3		PARALLEL		
5	SURF./UNIT (EFF/GROSS) 11768		SHELLS/UNIT 3					SURF/SHELL (EFF/GROSS) 3923				
6	PERFORMANCE OF ONE UNIT											
7	FLUID ALLOCATION		SHELLSIDE					TUBESIDE				
8	FLUID CIRCULATED		Wash water					Fuel gas (H2, CO, CO2)				
9	TOTAL FLUID ENTERING	LB/HR	240000					232073				
10			IN		OUT			IN		OUT		
11	LIQUID											
12	VAPOR	LB/HR, MW										
13	NONCOND	LB/HR, MW						197252	18.9	197252	18.9	
14	STEAM							34821		1181		
15	WATER		240000		240000					33640		
16	FLUID VAPORIZED/CONDENSED									33640		
17	GRAVITY, LIQ.											
18	VISCOSITY, LIQ. (VAP.)							(0.018)		(0.017)		
19	THERM. COND., LIQ. (VAP.)	BTU/HR FT °F						(0.0600)		(0.0488)		
20	SPECIFIC HEAT, LIQ. (VAP.)							(0.37)		(0.367)		
21												
22	TEMPERATURE	°F	100		302			325		150		
23	OPERATING PRESS.	(PSIA) (PSIG)	690		675			655		651		
24	NO. PASSES/SHELL											
25	VELOCITY	FT/SEC						8.67				
26	PRESS. DROP, ALLOW/CALC.	PSI	5 / 1.09					4 / 0.66				
27	FOULING RESISTANCE		0.002					0.001				
28	HEAT EXCHANGED		49.3 MM	BTU/HR; MTD (CORR) (WTD)				-34.77		°F		
29	TRANSFER RATE, SERVICE		120.5	CLEAN						BTU/HR. SQ. FT. °F		
30	CONSTRUCTION											
31			SHELLSIDE		TUBESIDE							
32	DESIGN/TEST PRESS.	PSIG	750 /		725 /							
33	DESIGN TEMPERATURE	°F	350		375							
34	CORROSION ALLOWANCE	IN	1/8"		1/8" - CHAN & TS							
35	CONNECTIONS INLET		1 - 8"		18							
36	SIZE OUTLET		1 - 8"		16							
37	RATING		400 LB RF		400 LB RF							
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH		PITCH	FLOW				
39	TUBE MATERIAL 304L SS				TUBE-TUBESHEET JOINT							
40	SHELL C. STEEL	ID	OD		SHELL COVER					(INTEG.) (REMOV)		
41	CHANNEL/BONNET				CHANNEL COVER							
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING							
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)							
44	BAFFLES-CROSS	TYPE			% CUT (DIA/AREA)		SPACING					
45	BAFFLES-LONG	SEAL TYPE			TUBE SUPPORTS							
46	INSUL. THK.: SHELL	CHAN.			EXPANSION JOINT							
47	GASKETS											
48	CODE REQUIREMENTS	STAMP (YES) (NO)			TEMA CLASS		SPECS					
49	WEIGHT: EACH SHELL	BUNDLE			FULL OF WATER							
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED											
51	SEE 12-05-E-022 SHEET 2 OF 2 FOR COND. COOLING											
52	My Gas Composition Volume% H2-39, CO-34, CO2											
53												
54												

REV.	DATE			W/L	JOB NO.	DRWG. NO.	REV.
1	9/28/81	REV. Ua, QT	MLP	WW/L	14222	12-05-E-16	2
0	12/19/80	REISSUED FOR PHASE ZERO	HHN	HHN			
	11/13/80	ISSUED FOR PHASE ZERO	[illegible]				

BECHTEL

RBC SPE FORM 1 SB (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASU BRECKINRIDGE CO KY					EXCHANGER MANUFACTURER				
2	PLANT 2 Gasification		EXCH. NO.	12E-127			REQ. NO.				
3	SERVICE OF UNIT	HOT FUEL GAS COOLER					ITEM NO.				
4	SIZE	29-150 △	TYPE	BEU △	HORIZ	CONNECTED IN	1	SERIES	1	PARALLEL	
5	SURF./UNIT (EFF/GROSS)	1803 △		SHELLS/UNIT	1		SURF/SHELL (EFF/GROSS)	1803 △			
6	PERFORMANCE OF ONE UNIT										
7	FLUID ALLOCATION			SHELLSIDE			TUBESIDE				
8	FLUID CIRCULATED			Cooling Water			Fuel Gas (H_2 CO CO_2)				
9	TOTAL FLUID ENTERING	LB/HR		4428600			323973				
10				IN		OUT	IN		OUT		
11	LIQUID										
12	VAPOR	LB/HR, MW									
13	NONCOND	LB/HR, MW					187252	18.9	187252	18.9	
14	STEAM						1181		311		
15	WATER			4428600		4428600	33640		34510		
16	FLUID VAPORIZED/CONDENSED								870		
17	GRAVITY, LIQ.										
18	VISCOSITY, LIQ. (VAP.)						0.018		0.017		
19	THERM. COND., LIQ. (VAP.)	BTU/HR FT °F					(0.0488)		(0.0454)		
20	SPECIFIC HEAT, LIQ. (VAP.)						0.361		0.366		
21											
22	TEMPERATURE	°F		85		99	150		100		
23	OPERATING PRESS.	(PSIG)		80		75	649		645		
24	NO. PASSES/SHELL										
25	VELOCITY	FT/SEC									
26	PRESS. DROP, ALLOW/CALC.	PSI		5			4				
27	FOULING RESISTANCE			0.002			0.001				
28	HEAT EXCHANGED		△	64 MM	BTU/HR; MTD (CORR) (WTD)		24.43 △		°F		
29	TRANSFER RATE, SERVICE		△	145.3	CLEAN				BTU/HR. SQ. FT. °F		
30	CONSTRUCTION										
31				SHELLSIDE		TUBESIDE					△
32	DESIGN/TEST PRESS.	PSIG		480 / CODE		715 / CODE					
33	DESIGN TEMPERATURE	°F		300		300					
34	CORROSION ALLOWANCE	IN		1/8"							
35	CONNECTIONS	INLET	IN	8		12					
36	SIZE	OUTLET	IN	8		12					
37	RATING		PSIG	150 RF		300 RF					
38	TUBE3 NO.	OD		THK (MIN/AVG)		LENGTH	PITCH	FLOW ═	↓ △ ◇ □		
39	TUBE MATERIAL	304 L S.S.				TUBE-TUBESHEET JOINT					
40	SHELL	C. S.	ID	OD		SHELL COVER				(INTEG.) (REMOV)	
41	CHANNEL/BONNET					CHANNEL COVER					
42	TUBESHEET-STATIONARY					TUBESHEET FLOATING					
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)					
44	BAFFLES-CROSS		TYPE			% CUT (DIA/AREA)	SPACING				
45	BAFFLES-LONG		SEAL TYPE			TUBE SUPPORTS					
46	INSUL. THK.: SHELL		CHAN.			EXPANSION JOINT					
47	GASKETS										
48	CODE REQUIREMENTS		STAMP (YES) (NO)			TEMA CLASS	SPECS				
49	WEIGHT: EACH SHELL		BUNDLE			FULL OF WATER					
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED										
51	See Attached cooling curve										
52											
53	Dry Gas composition volume % H_2 - 39, CO - 54 CO_2 - 6										
54											

REV.		DATE				MAP	WWL	JOB NO.	DRWG. NO.	REV.
△	9/28/81	REV. Q, U6								
△	12/19/80	REISSUED FOR PHASE ZERO		HKN	°WP	HNH		14222	12-DS-E-17	2
△	11/13/80	ISSUED FOR PHASE ZERO		EJJ						

R&C SPE FORM 150 (6/74)

HEAT-EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS INC. BRECKINRIDGE CO., KY, 12E-128 A&B						EXCHANGER MANUFACTURER			
2	PLANT	GASIFICATION & PURIFICATION	EXCH. NO.	12E-228 A&B, 328 A&B				REQ. NO.			
3	SERVICE OF UNIT	GASIFIER QUENCH WATER PREHEATER						ITEM NO.			
4	SIZE	25-144	TYPE	BEU	HORIZ	CONNECTED IN	1	SERIES	2	PARALLEL	
5	SURF./UNIT (EFF/GROSS)	1272			SHELLS/UNIT	2		SURF/SHELL (EFF/GROSS)	636		
6	PERFORMANCE OF ONE UNIT										
7	FLUID ALLOCATION			SHELLSIDE				TUBESIDE			
8	FLUID CIRCULATED			WATER *				SYNGAS			
9	TOTAL FLUID ENTERING		LB/HR	195098				533336.			
10				IN		OUT		IN		OUT	
11	LIQUID										
12	VAPOR		LB/HR, MW								
13	NONCOND		LB/HR, MW					367264	18.6	367264	18.6
14	STEAM							166072		166072	
15	WATER			195098		195098					
16	FLUID VAPORIZED/CONDENSED										
17	GRAVITY, LIQ.										
18	VISCOSITY, LIQ. (VAP.)		CP					(0.019)		(0.019)	
19	THERM. COND., LIQ. (VAP.)		BTU/HR FT °F					(0.0495)		(0.0460)	
20	SPECIFIC HEAT, LIQ. (VAP.)		BTU/LB °F					(0.478)			
21			IG 32°F BASE								
22	TEMPERATURE		°F	223		325		471		393	
23	OPERATING PRESS.		(PSIA)	600		595		625		620	
24	NO. PASSES/SHELL										
25	VELOCITY		FT/SEC								
26	PRESS. DROP, ALLOW/CALC.		PSI	5 /				5 /			
27	FOULING RESISTANCE			0.002				0.001			
28	HEAT EXCHANGED			19.9 MM	BTU/HR	MTD (CORR) (WTD)		148.93		°F	
29	TRANSFER RATE, SERVICE			105.02	CLEAN					BTU/HR. SQ. FT. °F	
30	CONSTRUCTION										
31				SHELLSIDE		TUBESIDE					
32	DESIGN/TEST PRESS.		PSIG	645 / CODE		675 / CODE					
33	DESIGN TEMPERATURE		°F	375		525					
34	CORROSION ALLOWANCE		IN	1/8"		1/8"					
35	CONNECTIONS	INLET	IN	16"		4"					
36	SIZE	OUTLET	IN	16		4"					
37	RATING		PSIG	400 RF		400 RF					
38	TUBES NO.	OD		THK (MIN/AVG)		LENGTH		PITCH		FLOW → ◁ △ ◇ □	
39	TUBE MATERIAL	304 L S.S. △1				TUBE-TUBESHEET JOINT					
40	SHELL	C.S.	ID	OD		SHELL COVER				(INTEG.) (REMOV)	
41	CHANNEL/BONNET	C.S.				CHANNEL COVER					
42	TUBESHEET-STATIONARY	C.S.				TUBESHEET FLOATING					
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)					
44	BAFFLES-CROSS		TYPE			% CUT (DIA/AREA)		SPACING			
45	BAFFLES-LONG		SEAL TYPE			TUBE SUPPORTS					
46	INSUL. THK.: SHELL		CHAN.			EXPANSION JOINT					
47	GASKETS										
48	CODE REQUIREMENTS		STAMP (YES) (NO)			TEMA CLASS		SPECS			
49	WEIGHT: EACH SHELL		BUNDLE			FULL OF WATER					
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED										
51	* This water contains traces of dissolved organic										
52	CO_2, H_2S and ammonia										
53	WELD HARDNESS 200 BHN MAX △1										
54											

BECHTEL	REV.	DATE					JOB NO.	DRWG. NO.	REV.
	△	11/14/81	REISSUED FOR MATERIAL CHANGE	HKM	Qvp	HNH	14222	12-05-E-1B	1
	△	11/13/80	ISSUED FOR PHASE TWO						

BECHTEL SFE FORM 1SD (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS, INC. BRECKENRIDGE CO., KY						EXCHANGER MANUFACTURER	12E-129		
2	PLANT	12 GASIFICATION & PURIFICATION	EXCH. NO.	12E-129, 329				REQ. NO.			
3	SERVICE OF UNIT	GASIFIER QUENCH PREHEATER						ITEM NO.			
4	SIZE	30-228	TYPE	CEU	(HORIZ/VERT)	CONNECTED IN	1	SERIES	1	PARALLEL	
5	SURF./UNIT (EFF/GROSS)	1448		SHELLS/UNIT	1			SURF/SHELL (EFF/GROSS)	1448		
6	PERFORMANCE OF ONE UNIT										
7	FLUID ALLOCATION			SHELLSIDE				TUBESIDE			
8	FLUID CIRCULATED			SYNGAS				WASTE WATER			
9	TOTAL FLUID ENTERING	LB/HR		446149				116350			
10				IN		OUT		IN		OUT	
11	LIQUID										
12	VAPOR	LB/HR, MW									
13	NONCOND	LB/HR, MW		367288	18.6	367288	18.6				
14	STEAM			17161		12611					
15	WATER			61700		66250		116350		116350	
16	FLUID VAPORIZED/CONDENSED					4550					
17	GRAVITY, LIQ.										
18	VISCOSITY, LIQ. (VAP.)	CP		(0.018)		(0.018)					
19	THERM. COND., LIQ. (VAP.)	BTU/HR FT °F		(0.0485)		(0.0460)					
20	SPECIFIC HEAT, LIQ. (VAP.)	BTU/LB °F		(0.48)		(0.46)					
21		IG 32°F BASE									
22	TEMPERATURE	°F		192		179		100		170	
23	OPERATING PRESS.	(PSIA)		610		605		610		605	
24	NO. PASSES/SHELL										
25	VELOCITY	FT/SEC									
26	PRESS. DROP, ALLOW/CALC.	PSI		5	14.33			10	17.12		
27	FOULING RESISTANCE			0.001				.002			
28	HEAT EXCHANGED			BTU/HR; MTD (CORR) (WTD)				4265		°F	
29	TRANSFER RATE, SERVICE			131.2		CLEAN				BTU/HR SQ FT °F	
30	CONSTRUCTION										
31				SHELLSIDE		TUBESIDE					
32	DESIGN/TEST PRESS.	PSIG		675/ CODE		675/ CODE					
33	DESIGN TEMPERATURE	°F		300		300					
34	CORROSION ALLOWANCE	IN		CLAD		CLAD					
35	CONNECTIONS	INLET	IN	18		4					
36	SIZE	OUTLET	IN	18		4					
37	RATING		PSIG	300 RF		300 RF					
38	TUBES NO.	OD		THK (MIN/AVG)		LENGTH		PITCH		FLOW	
39	TUBE MATERIAL	304LSS				TUBE-TUBESHEET JOINT					
40	SHELL	C.S. CLAD W/304LSS		OD		SHELL COVER				(INTEGL) (REMOV)	
41	CHANNEL/BONNET	C.S. CLAD W/304SS				CHANNEL COVER					
42	TUBESHEET-STATIONARY	304LSS.				TUBESHEET FLOATING					
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)					
44	BAFFLES-CROSS		TYPE			% CUT (DIA/AREA)		SPACING			
45	BAFFLES-LONG		SEAL TYPE			TUBE SUPPORTS					
46	INSUL. THK.: SHELL		CHAN.			EXPANSION JOINT					
47	GASKETS										
48	CODE REQUIREMENTS		STAMP (YES) (NO)			TEMA CLASS		SPECS			
49	WEIGHT: EACH SHELL		BUNDLE			FULL OF WATER					
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED										
51	Gas composition dry volum CO_2 39% H_2 60% CO 0.7%										
52	H_2S 0.3%										
53											
54	SEE 12-05-E-013 SHEET 2 OF 2 FOR COOLING CURVE										

REV	DATE	REISSUED FOR MATERIAL CHANGE	HKN	CWP			JOB NO.	DRWG. NO.	REV.
2	12/18/80	REISSUED FOR PHASE ZERO	HKN	CWP			14222	12-05-E-13	2
1	11/13/80	ISSUED FOR PHASE ZERO	[illegible]						

R&C SPE FORM 158 (6/79)

SURFACE CONDENSER DATA SHEET

Customer	ASHLAND OIL			Manufacturer		
Project Location	BRECKINRIDGE KY.					
Plant	12	Cond. No.	12-E-131,231,331	Req. No.		
Service Of Unit	SURFACE CONDENSER			Item No.		
Size	MODEL 3636 - 24TAL	Horizontal		No. Required	3 (1 EA TRAIN)	
Surf (Eff/Gross)	3200 FT²	ft²				

PERFORMANCE

Fluid Allocation		Shellside		Tubeside	
Fluid Circulated		Wet Steam		COOLING WATER	
Total Fluid Entering	lb/h	39,000		1,325,000	
		Design	Normal	Design	Normal
Water	lb/h			1,325,000	1,325,000
Steam	lb/h, MW	39,000	39,000		
Steam Condensed	lb/h	NOT REQ'D BY VENDOR		NOT REQ'D BY VENDOR	
Density, Liq.	lb/ft³	↓		↓	
Viscosity, Liq. (Vap.)	cP				
Therm. Cond., Liq. (Vap.)	Btu/h-ft² °F				
Specific Heat, Liq. (Vap.)	Btu/lb °F				
Latent Heat, Vap.	Btu/lb				
Temperature In/Out	°F	120 / 120	/	85 / 112	/
Operating Press.	(Psia)	1.7		65	
No. Passes		One	One		
Velocity Allow/Calc.	ft/sec	/	/	/	/
Press. Drop, Allow/Calc.	psi	/	/	/	/
Cleanliness Factor					
Heat Exchanged	39,000,000	Btu/h,MTD	~ 18		°F
Transfer Rate, Service	~ 670	Clean			Btu/h-ft². °F

CONSTRUCTION

Tubes					Hotwell:		lb
Main Condensing Sections:					Type:	Capacity:	
No.:	OD: 3/4	in. Thk:	18	BWG	Material:		
Length, effective:		ft. Overall:	24	ft	Thickness.		
Material:	ADMIRALTY	Tube Pitch:		in	Tube sheets		
Gas Removal Sections:					Number and size:		
No.:	OD: 3/4	in. Thk.:	18	BWG.	Material:	Thickness:	in.
Length, effective:		ft Overall:		ft			
Material:	ADMIRALTY	Tube Pitch:		in	Tube support plates		
Impingement Sections:					Number:		
No.:	OD: 3/4	in. Thk:	18	BWG	Material:	Thickness:	in.
Length, effective:		ft Overall:		ft			
Material:	ADMIRALTY	Tube Pitch:		in	Steam inlet neck and exhaust connection		
Tube – Tubesheet Joint:					Material.	C.S. w/ SS NOZZLE	
Water boxes & Covers					Thickness:	Number of sections:	
Material (Water box):	C.S.				Connection to:shell – (flanged) or (welded)	Turbine – (flanged) or (Welded):	
Material (Covers):					Height – top of water box flange to turbine	Exhaust Including	
Divided or non-divided:					expansion joint (if any):		
Design pressure:	35 psig	Temperature	135	°F	Provision for vertical expansion (condenser hung);		
Nozzles Number and Size – Inlet:		Outlet:			(spring supports)(expansion joint):		
Shell:					Spring supports Type:		
Material:	C.S.				Expansion joint Type:		
Thickness:		in Number of sections:			Material:		
Provision for tube expansion					Height:	Ends – (Flanged)	(Welded)
Number and size of venting connections:							
Design pressure	35 psig	Temperature	170	°F And Full Vacuum			

REV.						JOB NO.	DRWG. NO.	REV.
Δ	12/11/80	ISSUE FOR PHASE ZERO	AV	MP		14222	12DS-E-21	0

SURFACE CONDENSER DATA SHEET (CONTINUED)

55	Steam Jet Air Ejector(s)	12H-104, 204, 304					
56	Total number of Ejector Units:	3 (1 EACH TRAIN)					
57	Size and type:		No. of elements:	2	No. of stages:	2	
58			Surface Inter-and After-Condensers	1 EACH PER UNIT			
59	Operating Conditions and Performance						
60	Design capacity – 100 per cent –						
61	Suction pressure:	3.5	in. Hg. abs	Suction temperature:	120	°F	
62	Dry air leakage:		SCFM corresponding to:				lb per h
63	Non-condensible gases other than air leakage:						lb per h
64	Associated saturated water vapor:		lb per h	Total gas-vapor mixture:			lb per h
65	Design capacity each element:						per cent
66	Number of elements operating for 100% capacity:						
67	Curve(s) of approximate capacity vs. suction pressure:						
68	Steam conditions –						
69	Maximum initial pressure:	150	psig	Total temp:	366	°F	
70	Minimum operating pressure (at nozzles):		psig	Total temp:		°F	
71	Steam Consumption (100 per cent design capacity):						lb per h
72	Inter/After Condenser Data						
73	Surfacesq ft: Inter-Condenser			After-Condenser			
74	Heat Exchanged Btu/h Inter-Condenser			After-Condenser			
75	Tubes. No:	OD	in	Thk	BWG:	Length (Effective-overall) ft	
76	Tube-Tubesheet Joint:						
77	Cooling Water (condensate) (raw water):						
78	Minimum flow required at:			per cent design capacity:			lb/h
79	Maximum design flow:			lb/h			
80	Pressure drop allowable/calculated			psig			
81	Shell/Water boxes – Design pressure	• /		psig Design Temperature	• /		°F
82	Materials:						
83	Suction chambers:	C.S.		Condenser shells:	•		
84	Diffusers:	C.S.		Water chambers:			
85	Steam nozzles:	S.S.		Tube sheets:			
86	Steam chests (nozzle heads):			Tubes:	•		
87	Fittings and Accessories included						
88	Air leakage meter:						
89	Other:						
90	Hogging Ejectors						
91	(Steam) (Air) (Water) Operated. Number per condenser			Size	NA		
92	Operating Conditions and Performance						
93	Capacity:	NA	lb per h dry air at			in. Hg abs Suction Pressure	
94	Steam consumption:		lb per h at			psig	°F
95	Maximum design steam conditions:					psig	°F
96	Consumption: Air	SCFM at	psig Water			lb/hr at	psig
97							
98	Fittings and accessories included:						
99	Priming Ejector(s)	NOT REQUIRED					
100	(Steam) (Air) (Water) Operated.	•		Size	•		
101	Operating Conditions and Performance						
102	Capacity:	•	lb per h dry air at			in. Hg abs Suction Pressure	
103	Steam consumption:		lb per h at			psig	°F
104	Maximum design steam conditions:					psig	°F
105	Consumption: Air	SCFM at	psig Water			lb/h at	psig
106							
107	Approximate weight:						
108	Condenser Dry		lb.	Ejectors: Priming			lb.
109	Flooded		lb.	Hogging			lb.
110				Air			lb.
111							

DATA SHEET _____ REV. _____ SHEET 2 OF 2

DOUBLE PIPE HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASEI BRECKINRIDGE			EXCHANGER MANUFACTURER	
2	PLANT		EXCH. NO.	12E-134, 234, 334	REQ. NO.	
3	SERVICE OF UNIT	ACID GAS HEATER			ITEM NO.	
4	SIZE	TYPE DOUBLE PIPE (HORIZ/VERT)	CONNECTED IN		SERIES	PARALLEL
5	SURF/UNIT (EFF/GROSS)	107 / 1	SHELLS/UNIT		SURF/SHELL (EFF/GROSS)	107 / 1
6	PERFORMANCE OF ONE UNIT					
7	FLUID ALLOCATION		SHELLSIDE		TUBESIDE	
8	FLUID CIRCULATED		CONDENSING STEAM		ACID GAS	
9	TOTAL FLUID ENTERING	LB/HR	735		2463	
10			IN	OUT	IN	OUT
11	LIQUID					
12	VAPOR	LB/HR, MW				
13	NONCOND	LB/HR, MW			23220	23220
14	STEAM		735		1411	1411
15	WATER			735		
16	FLUID VAPORIZED/CONDENSED			735		
17	GRAVITY, LIQ.					
18	VISCOSITY, LIQ. (VAP.)	cP			0.015	0.018
19	THERM. COND., LIQ. (VAP.)	BTU/HR=FT.°F			0.030	0.040
20	SPECIFIC HEAT, LIQ. (VAP.)	BTU/#.°F			0.26	0.26
21						
22	TEMPERATURE	°F	298	298	145	250
23	OPERATING PRESS.	(PSIA)	65	65	28	27
24	NO. PASSES/SHELL					
25	VELOCITY	FT/SEC				
26	PRESS. DROP, ALLOW/CALC.	PSI	/		1 /	
27	FOULING RESISTANCE		0.001		0.001	
28	HEAT EXCHANGED	/ 0.9X10⁶	BTU/HR; MTD (CORR) (WTD)			°F
29	TRANSFER RATE, SERVICE		CLEAN			BTU/HR. SQ. FT. °F
30	CONSTRUCTION					
31			SHELLSIDE	TUBESIDE		
32	DESIGN/TEST PRESS.	PSIG	/	/		
33	DESIGN TEMPERATURE	°F				
34	CORROSION ALLOWANCE	IN				
35	CONNECTIONS	INLET				
36	SIZE	OUTLET				
37	RATING					
38	TUBES NO.	OD	THK (MIN/AVG)	LENGTH	PITCH	FLOW → ◁ △ ◇ □
39	TUBE MATERIAL C.S.			TUBE-TUBESHEET JOINT		
40	SHELL C.S.	ID OD		SHELL COVER		(INTEG.) (REMOV.)
41	CHANNEL/BONNET			CHANNEL COVER		
42	TUBESHEET-STATIONARY			TUBESHEET FLOATING		
43	FLOATING HEAD COVER			IMPINGEMENT PLATE (YES) (NO)		
44	BAFFLES-CROSS	TYPE		% CUT (DIA/AREA)	SPACING	
45	BAFFLES-LONG	SEAL TYPE		TUBE SUPPORTS		
46	INSUL. THK.: SHELL	CHAN.		EXPANSION JOINT		
47	GASKETS					
48	CODE REQUIREMENTS	STAMP (YES) (NO)		TEMA CLASS	SPECS	
49	WEIGHT: EACH SHELL	BUNDLE		FULL OF WATER		
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED					
51	a) The inlet gas is saturated with water					
52	b) Dry gas volume CO_2 83% H_2S 17%					
53						
54						

REV	DATE				JOB NO.	DRWG. NO.	REV.
2	9/29/81	REV. PER C.O. A	ARP	WWL	14722	12-05-E-24	1
1	11/13/80	ISSUED FOR PHASE ZERO	[illegible]	HWH			

BECHTEL

RGC SPE FORM 158 (6/78)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASEE BRECKINRIDGE					EXCHANGER MANUFACTURER					
2	PLANT	12		EXCH. NO.	12E-138		REQ. NO.					
3	SERVICE OF UNIT	EXPANDER FEED HEATER					ITEM NO.					
4	SIZE	19-120	TYPE BEU	HORIZ	CONNECTED IN	1	SERIES	/	PARALLEL			
5	SURF./UNIT (EFF/GROSS)	550		SHELLS/UNIT	1		SURF/SHELL (EFF/GROSS)	550				
6	PERFORMANCE OF ONE UNIT											
7	FLUID ALLOCATION			SHELLSIDE			TUBESIDE					
8	FLUID CIRCULATED			Steam			H_2 + CO					
9	TOTAL FLUID ENTERING		LB/HR	11,200			178,399					
10				IN		OUT	IN			OUT		
11	LIQUID											
12	VAPOR		LB/HR, MW									
13	NONCOND		LB/HR, MW				178,399	30		178,399	30	
14	STEAM			11,200		11,200						
15	WATER											
16	FLUID VAPORIZED/CONDENSED											
17	GRAVITY, LIQ.											
18	VISCOSITY, _ (VAP.)						0.016			0.016		
19	THERM. COND., LIQ. (VAP.)											
20	SPECIFIC HEAT, LIQ. (VAP.)											
21												
22	TEMPERATURE		°F	298		298	99			250		
23	OPERATING PRESS.		(PSIG)	50			6.45			6.25		
24	NO. PASSES/SHELL											
25	VELOCITY		FT/SEC									
26	PRESS. DROP, ALLOW/CALC.		PSI	1.0 / 0.0			20 / 13.91					
27	FOULING RESISTANCE											
28	HEAT EXCHANGED		10.2 MM	BTU/HR; MTD (CORR) (WTD)			106.18			°F		
29	TRANSFER RATE, SERVICE		174.66	CLEAN						BTU/HR, SQ. FT. °F		
30	CONSTRUCTION											
31				SHELLSIDE		TUBESIDE						
32	DESIGN/TEST PRESS.		PSIG	75 / CODE		725 / CODE						
33	DESIGN TEMPERATURE		°F	350		300						
34	CORROSION ALLOWANCE		IN	1/8"		1/8" - CHANNELS						
35	CONNECTIONS	INLET		2 - 6"		10"						
36	SIZE	OUTLET		1 - 3"		10"						
37	RATING			150 LB RF		400 LB RF						
38	TUBES NO.	OD		THK (MIN/AVG)		LENGTH	PITCH		FLOW → ◁ △ ◇ □			
39	TUBE MATERIAL	304 SS				TUBE-TUBESHEET JOINT						
40	SHELL	C.S.	ID	OD		SHELL COVER				(INTEG.) (REMOV)		
41	CHANNEL/BONNET					CHANNEL COVER						
42	TUBESHEET-STATIONARY					TUBESHEET FLOATING						
43	FLOATING HEAD COVER					IMPINGEMENT PLATE (YES) (NO)						
44	BAFFLES-CROSS		TYPE			% CUT (DIA/AREA)	SPACING					
45	BAFFLES-LONG		SEAL TYPE			TUBE SUPPORTS						
46	INSUL. THK.: SHELL		CHAN.			EXPANSION JOINT						
47	GASKETS											
48	CODE REQUIREMENTS		STAMP (YES) (NO)			TEMA CLASS	SPECS					
49	WEIGHT: EACH SHELL		BUNDLE			FULL OF WATER						
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED											
51	Gas composition volume H_2 39%, CO 50%, CO_2 11%											
52	H_2S, COS, C_1, N_2 + AIR < 1%											
53												
54												

REV.	DATE						JOB NO.	DRWG. NO.	REV.
	11/13/80	ISSUED FOR PHASE-ZERO	BKT				14222	DS-12DS-E-138	0

BECHTEL

BSC SPE FORM 156 (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASFI BRECKINRIDGE				EXCHANGER MANUFACTURER			
2	PLANT		EXCH. NO.	12E-139		REQ. NO.			
3	SERVICE OF UNIT	EXPANDER INTERSTATE HEATER				ITEM NO.			
4	SIZE	23-240	TYPE	BEU	HORIZ.	CONNECTED IN	SERIES	PARALLEL	
5	SURF./UNIT (EFF/GROSS)	1642	SHELLS/UNIT	1		SURF/SHELL (EFF/GROSS)	1642		
6	PERFORMANCE OF ONE UNIT								
7	FLUID ALLOCATION		SHELLSIDE			TUBESIDE			
8	FLUID CIRCULATED		Steam			$H_2 + CO_2$			
9	TOTAL FLUID ENTERING	LB/HR	13,100			35,107			
10			IN		OUT	IN		OUT	
11	LIQUID								
12	VAPOR	LB/HR, MW				35,107	18.1	35,107	18.1
13	NONCOND	LB/HR, MW							
14	STEAM		13,100						
15	WATER				13,100				
16	FLUID VAPORIZED/CONDENSED								
17	GRAVITY, LIQ.								
18	VISCOSITY, (VAP.)					0.017		0.017	
19	THERM. COND., LIQ. (VAP.)								
20	SPECIFIC HEAT, LIQ. (VAP.)								
21									
22	TEMPERATURE	°F	298		298	101		255	
23	OPERATING PRESS.	(PSIG)	50			212		207	
24	NO. PASSES/SHELL								
25	VELOCITY	FT/SEC							
26	PRESS. DROP, ALLOW/CALC.	PSI	10 / 0			5 / 3.28			
27	FOULING RESISTANCE								
28	HEAT EXCHANGED		1 12.6 MM	BTU/HR; MTD (CORR) (WTD)		101.18		°F	
29	TRANSFER RATE, SERVICE		75.8	CLEAN		BTU/HR. SQ. FT. °F			
30	CONSTRUCTION								
31			SHELLSIDE		TUBESIDE				
32	DESIGN/TEST PRESS.	PSIG	75 / CODE		250 / CODE				
33	DESIGN TEMPERATURE	°F	350		305				
34	CORROSION ALLOWANCE	IN	1/8"		1/8" - CHANNELS				
35	CONNECTIONS	INLET	8		6				
36	SIZE	OUTLET	3		8				
37	RATING		300 LB RF		300 LB RF				
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH	PITCH	FLOW → ◁ △ ◇ □		
39	TUBE MATERIAL	304 LSS			TUBE-TUBESHEET JOINT				
40	SHELL	C.S.	ID	OD	SHELL COVER		(INTEG.) (REMOV)		
41	CHANNEL/BONNET				CHANNEL COVER				
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING				
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)				
44	BAFFLES-CROSS		TYPE		% CUT (DIA/AREA)	SPACING			
45	BAFFLES-LONG		SEAL TYPE		TUBE SUPPORTS				
46	INSUL. THK.: SHELL		CHAN.		EXPANSION JOINT				
47	GASKETS								
48	CODE REQUIREMENTS		STAMP (YES) (NO)		TEMA CLASS	SPECS			
49	WEIGHT: EACH SHELL		BUNDLE		FULL OF WATER				
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED								
51	Gas Composition volume H_2 39%, CO 55%,								
52	CO_2 5%, $N_2 + AR$ 0.4%, C; COS; H_2S <0.1%								
53									
54									

REV.	DATE				JOB NO.	DRWG. NO.	REV.
2	9/29/81	Rev. Qa & Ua	MLP	NWL	14222	DS-12-DS-5-29	1
1	11/13/80	ISSUED FOR PHASE ZERO	SRT	MWH			

BECHTEL

RGC SPE FORM 158 (6/76)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	BRECKINRIDGE						EXCHANGER MANUFACTURER					
2	PLANT	12		EXCH. NO.	12E-145 Hunt 545			REQ. NO.					
3	SERVICE OF UNIT	HYDROGEN COMPRESSOR INTERSTAGE COOLER						ITEM NO.					
4	SIZE	29-240	TYPE	DEU/1	(HORIZ	CONNECTED IN	1	SERIES		PARALLEL			
5	SURF./UNIT (EFF/GROSS)	1484		SHELLS/UNIT	1			SURF/SHELL (EFF/GROSS)		1484			
6	PERFORMANCE OF ONE UNIT												
7	FLUID ALLOCATION			SHELLSIDE				TUBESIDE					
8	FLUID CIRCULATED			Cooling Water				Hydrogen					
9	TOTAL FLUID ENTERING	LB/HR		600,000				47835					
10				IN		OUT		IN			OUT		
11	LIQUID												
12	VAPOR	LB/HR, MW											
13	NONCOND	LB/HR, MW						47835	3.21		47835	3.21	
14	STEAM												
15	WATER			600,000		600000							
16	FLUID VAPORIZED/CONDENSED												
17	GRAVITY, LIQ.												
18	VISCOSITY, (VAP.)							0.011			0.009		
19	THERM. COND., LIQ. (VAP.)							0.075			0.075		
20	SPECIFIC HEAT, LIQ. (VAP.)												
21													
22	TEMPERATURE	°F		85		105		318			105		
23	OPERATING PRESS.	(PSIA)		60		60		1750			1730		
24	NO. PASSES/SHELL												
25	VELOCITY	FT/SEC											
26	PRESS. DROP, ALLOW/CALC.	PSI		5 /				30 /					
27	FOULING RESISTANCE			0.001				0.001					
28	HEAT EXCHANGED	23.0 MM	BTU/HR; MTD (CORR) (WTD)					43.99					°F
29	TRANSFER RATE, SERVICE	183.89	CLEAN										BTU/HR. SQ. FT. °F
30	CONSTRUCTION												
31				SHELLSIDE		TUBESIDE							
32	DESIGN/TEST PRESS.	PSIG		750 / CODE		1925 / CODE							
33	DESIGN TEMPERATURE	°F		155		270							
34	CORROSION ALLOWANCE	IN		1/8"		1/8" - CHANNELS							
35	CONNECTIONS	INLET		2"		2"							
36	SIZE	OUTLET		8"		8"							
37	RATING			150 LB RF		900 LB RF							
38	TUBES NO.	OD	THK (MIN/AVG)		LENGTH		PITCH	FLOW → ◁ △ ◇ □					
39	TUBE MATERIAL	C.S.			TUBE-TUBESHEET JOINT								
40	SHELL	C.S.	ID	OD	SHELL COVER						(INTEG.) (REMOV)		
41	CHANNEL/BONNET				CHANNEL COVER								
42	TUBESHEET-STATIONARY				TUBESHEET FLOATING								
43	FLOATING HEAD COVER				IMPINGEMENT PLATE (YES) (NO)								
44	BAFFLES-CROSS		TYPE		% CUT (DIA/AREA)		SPACING						
45	BAFFLES-LONG		SEAL TYPE		TUBE SUPPORTS								
46	INSUL. THK.: SHELL		CHAN.		EXPANSION JOINT								
47	GASKETS												
48	CODE REQUIREMENTS		STAMP (YES) (NO)		TEMA CLASS		SPECS						
49	WEIGHT: EACH SHELL		BUNDLE		FULL OF WATER								
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED												
51	GAS COMPOSITION VOLUME 95% H_2 2% CO 1% CH_4												
52	3% $N_2 + Ar + CO_2$												
53													
54													

REV.		DATE					JOB NO.	DRWG. NO.	REV.
	△	1/14/81	REISSUED FOR TYPE CHANGE	FARM	CWP	HWH	14222	DS-1205 E-35	1
	△	11/13/80	--ISSUED FOR PHASE ZERO	[illegible]	DN				

BECHTEL

RBC SPE FORM 188 (6/78)

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION	ASHLAND SYNTHETIC FUELS INC. BRECKINRIDGE Co., Ky					EXCHANGER MANUFACTURER			
2	PLANT Selexol Gas Pur. CO_2 Removal		EXCH. NO. 12E-046				REQ. NO.			
3	SERVICE OF UNIT HYDROGEN Compressor Spillback Cooler						ITEM NO.			
4	SIZE 15-180	TYPE DEU △3	HORIZ		CONNECTED IN 1		SERIES 1		PARALLEL	
5	SURF./UNIT (EFF/GROSS) 1180 △4		SHELLS/UNIT 1				SURF/SHELL (EFF/GROSS) 1160 △1			
6	PERFORMANCE OF ONE UNIT									
7	FLUID ALLOCATION		SHELLSIDE				TUBESIDE			
8	FLUID CIRCULATED		Cooling Water				Hydrogen			
9	TOTAL FLUID ENTERING LB/HR		150,000				11,959			
10			IN		OUT		IN		OUT	
11	LIQUID									
12	VAPOR LB/HR, MW									
13	NONCOND LB/HR, MW						11,959	3.2	11,959	3.2
14	STEAM									
15	WATER		150,000		150,000					
16	FLUID VAPORIZED/CONDENSED									
17	GRAVITY, LIQ.									
18	VISCOSITY, (VAP.) Cp.						0.011		0.009	
19	THERM. COND., (VAP.) BTU/hr ft °F						0.075		0.075	
20	SPECIFIC HEAT, (VAP.) Btu/lb °F						2.04		2.04	
21										
22	TEMPERATURE °F		85		105		228		105	
23	OPERATING PRESS. (PSIA) (PSIG)						3480		3460	
24	NO. PASSES/SHELL									
25	VELOCITY FT/SEC									
26	PRESS. DROP, ALLOW/CALC. PSI		5 /				20 /			
27	FOULING RESISTANCE		0.001				0.001			
28	HEAT EXCHANGED		3x10⁶ BTU/HR; MTD (CORR) (WTD)				46.53			°F
29	TRANSFER RATE, SERVICE	272.08	CLEAN							BTU/HR. SQ. FT. °F
30	CONSTRUCTION									
31			SHELLSIDE		TUBESIDE					
32	DESIGN/TEST PRESS. PSIG		1800 / CODE		3800 / CODE					
33	DESIGN TEMPERATURE °F		300.		300					
34	CORROSION ALLOWANCE IN		1/8"		1/8" - CHANNELS					
35	CONNECTIONS INLET		4"		4"					
36	SIZE OUTLET		4"		4"					
37	RATING		150LB RF		2500LB RF					
38	TUBES NO. OD	THK (MIN/AVG)	LENGTH	PITCH	FLOW → ◁ △ ◇ □					
39	TUBE MATERIAL C.S.		TUBE-TUBESHEET JOINT							
40	SHELL C.S. ID OD		SHELL COVER						(INTEG.) (REMOV)	
41	CHANNEL/BONNET		CHANNEL COVER							
42	TUBESHEET-STATIONARY		TUBESHEET FLOATING							
43	FLOATING HEAD COVER		IMPINGEMENT PLATE (YES) (NO)							
44	BAFFLES-CROSS	TYPE	% CUT (DIA/AREA)	SPACING						
45	BAFFLES-LONG	SEAL TYPE	TUBE SUPPORTS							
46	INSUL. THK.: SHELL	CHAN.	EXPANSION JOINT							
47	GASKETS									
48	CODE REQUIREMENTS	STAMP (YES) (NO)	TEMA CLASS	SPECS						
49	WEIGHT: EACH SHELL	BUNDLE	FULL OF WATER							
50	REMARKS: MARK (SR) AND PERCENT (RT) AS REQUIRED									
51	Gas Composition volume 95% H_2, 2% CO, 1% CH_4,									
52	2% N_2 + Ar + CO_2									
53	Designed For 25% Spillback									
54										

1/14/81

REV.	DATE						JOB NO.	DRWG. NO.	REV.
△2	12/16/80	REISSUED FOR PHASE ZERO	HRN	DWP		HNH	14222	DS-12-DS-E-36	2
△1	11/13/80	ISSUED FOR PHASE ZERO	DH						

BECHTEL

RGC SFE FORM 138 (6/76)

4.4 Data Sheets for Fired Heaters

12-DS-F-01: Start-Up Heater (12F-001)

FIRED HEATER DATA SHEET

Customer	ASFI	Manufacturer	
Location	BRECKINRIDGE CO. KY.	Equip. No	12E-001
Unit	START-UP HEATER (3)	Req. No.	
Number Required		Item No.	
Total Heat Absorbed mm Btu/h	10.0	Type of Heater	V.C.

HEATER PERFORMANCE

Heater Section				
Service				
Fluid Name		SYNGAS		
Heat Absorption	mm Btu/h	10		
Flow Rate (MAX.)	lb/h	270000		
Pressure Drop (Allowable - Clean/Fouled)	psi	50		
Pressure Drop (Calculated - Clean/Fouled)	psi			
Coking Allowance	in			
Average Radiant Flux Density (Allowable)	Btu/h-sq ft			
Average Radiant Flux Density (Calculated)	Btu/h-sq ft			
Maximum Radiant Flux Density	Btu/h-sq ft	12000		
Average Convection Flux Density	Btu/h-sq ft			
Velocity Limitation	ft/sec			
Maximum Allowable Inside Film Temperature	°F			
Fouling Resistance Inside	$h\text{-}ft^2\text{-}°F/Btu$			
Inlet Conditions:				
Temperature	°F	438		
Pressure	(psig)	665		
Liquid Flow	lb/h			
Vapor Flow (NORMAL STARTUP)	lb/h	270000		
Density, (Vapor) At P&T	lb/cu ft	0.995		
Gravity, Liquid	Sp Gr at 60 °F			
Vapor	mol wt	18.93		
Viscosity, Liquid (Vapor)	CP			
Specific Heat, Liquid (Vapor)	Btu/lb-°F			
Conductivity, Liquid (Vapor)	Btu-ft/h-ft² °F			
Outlet Conditions:				
Temperature	°F	500 (6)		
Pressure	(psig)	615		
Liquid Flow	lb/h			
Vapor Flow	lb/h	270000		
Density, (Vapor) At P&T	lb/cu ft	0.595		
Gravity, Liquid	(Sp Gr at 60°F)			
Vapor	mol wt	18.93		
Viscosity, (Vapor)	CP	( )		
Specific Heat, Liquid (Vapor)	Btu/lb-°F	( )		
Conductivity, Liquid (Vapor)	Btu-ft/h-ft² °F			

Remarks and Special Requirements:

Data sheet reference for vaporization curve. (3) This is a startup heater. Economic design is desirable. (4) 10% excess air (5) Feed gas is saturated with water (at its dew point) gas comp. 56% H_2O, 2.6% CO_2, 24% CO, 17% H_2, H_2S 0.39% (1) Preheat to 510°F above the inlet temperature, but not less than 450°F (7) The natural gas HHV 1100 Btu/SCF as a primary fuel

REV.								JOB NO. 14222	
								DATA SHEET	REV.
								12-05-F-1	0
Δ	12/18/12	ISSUE FOR PHASE ZERO	TJS	WWS	DWP	HW H			

Form 378A (11/79)

COMBUSTION AND FUEL DATA

51.	Type of Fuel		GAS		
52.	Excess Air	%			
53.	Calculated Heat Release	mm Btu/h(LHV)			
54.	Calculated Efficiency, Percent (LHV)				
55.	Guaranteed Efficiency, Percent (LHV) See Note				
56.	Radiation Loss, Percent of Heat Release (LHV)				
57.	Flue Gas Temp. Leaving Radiant Section	°F			
58.	Flue Gas Temp. Leaving Convection Section	°F			
59.	Flue Gas Temp. (Uncorr) Leaving Air Heater	°F			
60.	Flue Gas Mass Velocity-Conv. Section	lb/sq ft-sec			
61.	Volumetric Heat Release	Btu/h-cu ft			
62.	Altitude Above Sea Level	ft			
63.	Air Temperature, Combustion	°F			
64.	Air Temperature, Draft	°F			
65.	Minimum Furnace Draft/Location	in H_2O			
66.	Draft at Burners	in H_2O			
67.	Note: A Fuel Savings of _____ mm Btu/h	Fuel Value $_____			
68.	Will Offset a $1000 increase in	mm Btu			
69.	Furnace Cost (Erected)				
70.	Fuel Characteristics				
71.	Heating Value	HHV	1,100		
72.	Heating Value	LLV			
73.	Specific Gravity				
74.	Molecular Weight				
75.	Viscosity, At _____ °F	SSU			
76.	Viscosity, At _____ °F	SSU			
77.	Fuel Pressure Available at Burner	psig			
78.	Atomizing Steam Pressure	psig			
79.	Compositions:				
80.	Vanadium	ppm			
81.	Sodium	ppm			
82.	Salt Content	ppm			
83.	Ash	% wt			
84.	Sulfur	% wt			
85.	Hydrogen	% wt			
86.	Carbon	% wt			
87.	Nitrogen	% wt/% vol			
88.	Oxygen	% wt			
89.	CH_4	% vol			
90.	C_2H_4	% vol			
91.	C_2H_6	% vol			
92.	C_3H_8	% vol			
93.	H_2S	% vol			
94.	H_2O	% vol			
95.					
96.					
97.					
98.					
99.					
100.					
101.					
102.					
103.					

MECHANICAL DESIGN
COIL DATA

105.	General:				
106.	Plot Limitations _____ Minimum Stack Height _____				
107.	Tube Length Limitations _____				
108.	Coil:				
109.	Coil Design:				
110.	Heater Section				
111.	Design Basis for Wall Thickness				
112.	Design Life				
113.	Design Pressure, psig	750			
114.	Corrosion Allowance, Tubes, in	1/8			
115.	Weld Stress Relieve				
116.	Weld Inspection Requirements X-ray or Others				
117.	Maximum Wall Temperature (Calculated-Clean), °F				
118.	Maximum Wall Temperature (Design-Fouled), °F				
119.	Inside Film Coefficient, Btu/h–°F sq ft				
120.	Overall Heat Transfer Coefficient, Btu/h–°F sq ft				
121.	Corrected Mean Temperature Difference, °F				
122.	Bare Tubes, Total Exposed Surface, sq ft				
123.	Extended Surface Tubes, Total Exposed Surface, sq ft				
124.	Coil Configuration:				
125.	Tubes, Vertical or Horizontal				
126.	Number of Flow Passes/Tubes Per Pass				
127.	Effective Tube Length, ft				
128.	Bare Tubes, Number				
129.	Extended Surface Tubes, Number				
130.	Tube Spacing, Center to Center (Staggered) (In Line), in				
131.	Tube Center to Furnace Wall, in				
132.	Tubes:				
133.	Material (ASTM Specification and Grade)	1¼Cr ½Mo			
134.	Outside Diameter, in				
135.	Wall Thickness (Minimum) (Average), in				
136.	Overall Tube Length, ft - in				
137.	Description of Extended Surface:				
138.	Type				
139.	Fin or Stud Material				
140.	Fin or Stud Material				
141.	Fin or Stud Dimensions, in				
142.	Fin or Stud Dimensions, in				
143.	Fin or Stud Spacing, per in				
144.	Fin or Stud Spacing, per in				
145.	Maximum Fin or Stud Temperature, °F				
146.	Maximum Fin or Stud Temperature, °F				
147.	Plug-Type Headers:				
148.	Location				
149.	Manufacturer and Type				
150.	Nominal Rating				
151.	Welded or Rolled Joint				
152.					
153.					
154.					
155.					
156.					
157.					
158.					

MECHANICAL DESIGN
(COIL DATA)

161.	Return Bends:				
162.	Location				
163.	Material (ASTM Specification and Grade)				
164.	Wall Thickness or Schedule				
165.	Crossovers:				
166.	Location (Internal) (External)				
167.	Pipe Material (ASTM Specification and Grade)				
168.	Wall Thickness (Minimum) (Average) in				
169.	Flange Material (ASTM Specification and Grade)				
170.	Flange Size and Rating				
171.	Terminals or Manifolds:				
172.	Location				
173.	(Welded) (Flanged)				
174.	Wall Thickness (Minimum) (Average) in				
175.	Flange Material (ASTM Specification and Grade)				
176.	Flange Size and Rating				
177.	Tube Supports:				
178.	Location (End) (Top) (Bottom)				
179.	Material (ASTM Specification and Grade)				
180.	Web Thickness in				
181.	Insulation, Type and Thickness				
182.	Anchor Type and Material				
183.	Intermediate Tube Supports:				
184.	Material (ASTM Specification and Grade)				
185.	Spacing ft				
186.	Coating, Type and Thickness				
187.	Tube Guides:				
188.	Location (Top) (Bottom) (Intermediate)				
189.	Material (ASTM Specification and Grade)				
190.	Coil Terminal Movements and Forces:				
191.	Nozzle Movement in				
192.	Direction				
193.	External Nozzle Load lb				
194.	Direction				
195.	Pipe Load Supported by Heater				
196.	Special Support Brackets Required				
197.	Notes				
198.					
199.					
200.					
201.					
202.					
203.					
204.					
205.					
206.					
207.					
208.					
209.					

MECHANICAL DESIGN
CONSTRUCTION DATA

Settings:
Floor:
Refractory: Thickness _____ Hot Face Temp: Calculated _____ °F Design _____ °F
Construction _____
_____
Casing: Thickness _____ Material _____ Temperature _____ °F

Exposed Vertical Walls:
Refractory: Thickness _____ Hot Face Temp: Calculated _____ °F Design _____ °F
Construction _____
_____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Shielded Vertical Walls:
Refractory: Thickness _____ Hot Face Temp: Calculated _____ °F Design _____ °F
Construction _____
_____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Arch:
Refractory: Thickness _____ Hot Face Temp: Calculated _____ °F Design _____ °F
Construction _____
_____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Convection Sidewalls:
Refractory: Thickness _____ Hot Face Temp: Calculated _____ °F Design _____ °F
Construction _____
_____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Breeching:
Refractory: Thickness _____ Hot Face Temp: Calculated _____ °F Design _____ °F
Construction _____
_____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Bridgewall:
Thickness _____ Height _____ Material _____

Notes: _____

MECHANICAL DESIGN
CONSTRUCTION DATA

Flue Gas Duct:
Refractory: Thickness _____ Material _____ Hot Face Temp. Design _____ °F
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Combustion Air Duct:
Lining: Thickness _____ Material _____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____ Temperature _____ °F

Header Boxes:
Location _____ Doors, Bolted-Hinged _____
Refractory: Thickness _____ Material _____
Anchor Type and Material _____
Casing and Door: Thickness _____ Material _____

Plenum Chamber:
Location _____
Lining: Thickness _____ Material _____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Casing: Thickness _____ Material _____

Stack:
Location _____ Number _____
Lining: Thickness _____ Material _____
Extent of Lining _____
Anchor Type and Material _____
Method of Attaching Anchor to Casing _____
Plate: Thickness _____ Material _____ Corrosion Allow. _____
Outside Metal Diameter _____ Stack Length _____ ft Height Above Grade _____ ft

Dampers:
Location _____
Material: Blade _____ Shaft _____
Multiple or Single Leaf _____
Description of Provision for Operation From Grade _____

Notes

MECHANICAL DESIGN
CONSTRUCTION DATA

Miscellaneous:

Platforms:

Type of Flooring _____

Radiant Section, Width and Location _____

_____

Convection Section, Width and Location _____

_____

_____

Stairs, Width and Location _____

Ladders, Location _____

_____

Doors:

Radiant, Access, Size and Location _____

Convection/Stack, Access, Size and Location _____

Observation, Size and Location _____

Tube Removal, Size and Location _____

Explosion, Size and Location _____

Instrument Connections:	Number	Size
Draft		
Temperature		
Flue Gas Sample		
Smothering Steam		
Drains		

Painting and Galvanizing Requirements _____

_____

_____

Auxiliary Equipment:

Burners:

Manufacturer and Type _____ Quantity _____

Design and Size _____ Location and Orientation _____

Heat Release mm Btu/h Per Burner at Design Excess Air and Draft:

Minimum _____ Normal _____ Maximum _____

Design Draft Loss Across Burners, in H_2O _____

Burner Pilot:

Heat Release (Capacity), mBtu/h _____ Fuel _____

Type of Ignition _____

Special Requirements (Flame Detection Devices) Etc. _____

_____

Sootblowers

Number			
Type			
Spacing and Arrangement			
(Drawing Reference)			
Orientation			
Blowing Medium			
Blowing Medium Conditions			
Materials of Construction			
Type Driver			
Control System Type			

_____

_____

_____

_____

_____

MECHANICAL DESIGN
CONSTRUCTION DATA

384. Painters Trolley and Rail Included _____
385. Extent of Tube Handling Facilities _____
386. Thermocouples, Number and Location _____
387. _____
388. Thermowells, Number and Location _____
389. _____

			Air Side Conditions	Flue Gas Heating Fluid Side Conditions
370.	Air Heater			
371.	Duty	mm Btu/h		
372.	Quantity	lb/h		
373.	Entering			
374.	Leaving			
375.	Temperature			
376.	Entering	°F		
377.	Leaving	°F		
378.	Pressure Drop			
379.	Allowable	in H_2O		
380.	Calculated	in H_2O		

381. Sootblower _____
382. Water Wash Facilities _____

383. Materials of Construction _____
384. _____
385. Cold Air Bypass Description _____
386. _____

			F. D.	I. D.
387.	Fans:			
388.	Quantity	lb/h		
389.	Temperature	°F		
390.	Static Pressure	in		
391.	RPM			
392.	BHP			
393.	Type			
394.	Arrangement			
395.	Damper Control			
396.	Drives:			
397.	Electric Motor			
398.	Installed HP			
399.	Voltage			
400.	RPM			
401.	Turbine			
402.	Installed HP			
403.	Normal HP			
404.	Water Rate	lb/BHP		
405.	Steam Condition			
406.	Inlet			
407.	Outlet			

408. Damper Actuators _____
409. Type-Size _____

4.5 Data Sheets for Pumps and Drivers

12-DS-G-09: Selexol Solvent Make-up Pump (12G-009)

12-DS-G-11: Flash Gas K. O. Pump (12G-111, 211, 311)

12-DS-G-13: Cold Condensate Pump (12G-113 A, B, 213 A, B, 313 A, B)

12-DS-G-31: Selexol Sump Pump (12G-031)

12-DS-G-37: Gasifier Quench Water Pump (12G-037 A, B)

12-DS-G-45: Condensate Pump (12G-145 A, B, 245 A, B, 345 A, B)

12-DS-G-47: 50 psig Condensate Pump (12G-047 A, B)

CENTRIFUGAL PUMP DATA SHEET

JOB NO. 14222 ITEM NO. 12G-009
PURCHASE ORDER NO.
REQUISITION NO.
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER;
☐ BY MANUFACTURER

FOR BRECKINRIDGE PROJECT SITE BRECKINRIDGE COUNTY, KY
UNIT PLANT 12 SERVICE SELEXOL SOLVENT MAKE UP PUMP
NO. PUMPS REQ'D 1 NO. MOTORS REQ'D 1 ITEM NO. PROVIDED BY VENDOR MTD BY VENDOR
NO. TURBINES REQ'D ITEM NO. PROVIDED BY MTD BY
PUMP MFR SIZE AND TYPE STAGES SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID H_2O & SELEXOL U.S. GPM at PT. NOR. 105 RATED 100
DISCH. PRESS., PSIG 5
PT. F. NOR. 28 MAX. SUCT. PRESS., PSIG MAX. RATED -2.6
SP. GR. at PT. 1.051 DIFF. PRESS., PSI 7.6
VAP. PRESS. at PT. PSIA ~~<.0001 mm Hg~~ DIFF. HEAD, FT 16.7
VIS. at PT. Sss CP 19.97 NPSHA, FT 34.6
CORR/EROS. CAUSED BY HYD. HP .44

PERFORMANCE

PROPOSAL CURVE NO.
RPM 1800 NPSHR (WATER)
EFF. .50 BHP RATED .85
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
-SPLIT: ☐ AXIAL ☐ RAD; TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
-PRESS: ☐ MAX. ALLOW. PSIG °F: ☐ HYDRO TEST PSIG
-CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED ☐ MAX. ☐ TYPE:
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM/CLRNC
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ PLUNGER ☐ PRESSURE ☐
COUPLING: ☐ MFR: ☐ MODEL
DRIVER HALF MTD BY: ☒ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL API CLASS. CODE
☐ MFR CODE

SHOP TESTS

☒ NON-WIT. PERF. ○ WIT. PERF.
☒ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
○ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○ S-1
CARBON STEEL / CAST IRON
BASEPLATE: ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CU; ○ S.S.; ○ TUBING; ○ PIPE
☐ TOTAL COOLING WATER REQ'D, GPM ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
○ SEAL FLUSH PIPE PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 12 RPM 1800 FRAME 145T VOLTS/PHASE/CYCLES 460/3/60
MFR BEARINGS BALL LUBE GREASE
TYPE NEMA DESIGN INSUL CL B FULL LOAD AMPS 2.6
ENC. TEFC TEMP RISE, C LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB. SERVICE FACTOR

TURBINE DRIVER

APPROX. WT. PUMP & BASE
MOTOR 50 # TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

FORM NO 130 (REVISED SEPT 72)

NO.	DATE						JOB NO.	DRAWING NO.	REV.
0	10/15/80	ISSUED FOR PHASE ZERO	WJ	MV	DW	AH	14222	12-DS-G-09	0
							SHEET 1 OF 1		

123-311
126-211

CENTRIFUGAL PUMP DATA SHEET

JOB NO. 14222 ITEM NO. 126-111
PURCHASE ORDER NO.
REQUISITION NO.
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER;
☐ BY MANUFACTURER

FOR BRECKINRIDGE PROJECT — SITE BRECKINRIDGE COUNTY, KY
UNIT PLANT 12 — SERVICE FLASH GAS K.O. PUMP
NO. PUMPS REQ'D 3 NO. MOTORS REQ'D 3 ITEM NO. — PROVIDED BY VENDOR MTD BY VENDOR
NO. TURBINES REQ'D ITEM NO. — PROVIDED BY MTD BY
PUMP MFR SIZE AND TYPE STAGES SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID WATER — U.S. GPM at PT. NOR. 10 RATED 12
DISCH. PRESS., PSIG 65.3
PT. F. NOR. 94 MAX. — SUCT. PRESS., PSIG MAX. RATED 18.3
SP. GR. at PT 0.995 — DIFF. PRESS., PSI 47
VAP. PRESS. at PT. PSIA 35 — DIFF HEAD, FT 109
VIS. at PT. Ssu — CP 0.706 NPSHA, FT 10.4
CORR/EROS. CAUSED BY — HYD. HP 0.33

PERFORMANCE

PROPOSAL CURVE NO.
RPM 3600 NPSHR (WATER)
EFF. .30 BHP RATED 1.1
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
SPLIT: ☐ AXIAL ☐ RAD; TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
PRESS: ☐ MAX. ALLOW. PSIG °F; ☐ HYDRO TEST PSIG
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED ☐ MAX. ☐ TYPE:
MOUNT: ☐ BETWEEN BRGS. ☐ OVERHUNG ☐ WEAR RG. DIAM/CLRNC
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☐
COUPLING: ☐ MFR ☐ MODEL
DRIVER HALF MTD BY: ☒ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL API CLASS. CODE
☐ MFR CODE

SHOP TESTS

☒ NON-WIT. PERF. ○ WIT. PERF.
☒ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
○ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○ S-1 / S-1
BASEPLATE: ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CU; ○ S.S.; ○ TUBING; ○ PIPE
☐ TOTAL COOLING WATER REQ'D, GPM ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
○ SEAL FLUSH PIPE PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 1 1/2 RPM 3600 FRAME 143T VOLTS/PHASE/CYCLES 460/3/60
MFR BEARINGS BALL LUBE GREASE
TYPE NEMA DES B INSUL CL B FULL LOAD AMPS 2.6
ENC TEFC TEMP RISE, C LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB SERVICE FACTOR

TURBINE DRIVER

APPROX. WT. PUMP & BASE
MOTOR 45 II TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

FORM NO 130 (REVISED SEPT 72)

NO.	DATE							JOB NO.	DRAWING NO.	REV.
0	10/15/80	ISSUED FOR PHASE ZERO	WW	[illegible]	[illegible]	[illegible]		14222	12-DS-G-11	0
NO.	DATE							SHEET 1 OF 1		

CENTRIFUGAL PUMP DATA SHEET

JOB NO. 14222 ITEM NO. 12G-113A&B
PURCHASE ORDER NO. 12G-213 A&B
REQUISITION NO. 12G-313 A&B
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER;
☐ BY MANUFACTURER

FOR BRECKINRIDGE PROJECT SITE BRECKINRIDGE COUNTY, KY
UNIT PLANT 12 SERVICE COLD CONDENSATE PUMP
NO. PUMPS REQ'D 6 NO. MOTORS REQ'D 6 ITEM NO. PROVIDED BY VENDOR MTO BY VENDOR
NO. TURBINES REQ'D ITEM NO. PROVIDED BY MTO BY
PUMP MFR UNION SIZE AND TYPE 4X6 X10 ½ HHS STAGES 1 SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID SOUR CONDENSATE U.S. GPM at PT. NOR 233 RATED 280
DISCH. PRESS. PSIG A* 627.5
PT. F, NOR 100 MAX. SUCT. PRESS. PSIG MAX. RATED* 589.5
SP. GR. at PT 0.99 DIFF. PRESS. PSI * 38
VAP. PRESS. at PT, PSIA DIFF. HEAD, FT * 89
VIS. at PT, Ssu CP NPSHA, FT As Required 15
CORR/EROS. CAUSED BY HYD. HP * 6.2

PERFORMANCE

PROPOSAL CURVE NO. 761431-2
RPM 1780 NPSHR (WATER) 8
EFF. 70 BHP RATED 8.85
MAX. BHP RATED IMP 15.4
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION	6"	300#	RF	END
DISCHARGE	4"	300#	RF	TOP

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
-SPLIT: ☐ AXIAL ☐ RAD; TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
-PRESS: ☐ MAX. ALLOW. PSIG P; ☐ HYDRO TEST PSIG
-CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA: ☐ RATED ☐ MAX ☐ TYPE:
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM./CLRNC
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☒ LUBED ☐ PRESSURE ☐
COUPLING: ☒ TYPE T. Hounds ☐ MODEL
DRIVER HALF MTD BY: ☒ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL J CRANE 88I API CLASS CODE BSTFL
☐ MFR CODE

SHOP TESTS

○ NON-WIT. PERF. ○ WIT. PERF.
○ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
☒ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○ S-6 / S-6
BASEPLATE: ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CU; ○ S.S.; ○ TUBING; ○ PIPE
☐ TOTAL COOLING WATER REQ'D, GPM ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
☒ SEAL FLUSH PIPE PLAN 12 ☒ C.S. ○ S.S. ○ TUBING ☒ PIPE SCH 80
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 15 RPM 1800 FRAME VOLTS/PHASE/CYCLES 460-3-60
MFR BEARINGS LUBE
TYPE INSUL FULL LOAD AMPS
ENC. TEFC TEMP RISE, C 80 LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB SERVICE FACTOR 1.0

TURBINE DRIVER

APPROX. WT. PUMP & BASE 1000
MOTOR 250 TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED * REVISED 12/29 JPM

FORM NO 130 (REVISED SEPT 72)

NO.	DATE						JOB NO.	DRAWING NO.	REV.
							14222	12-A5*G-018	0
0	10/24/80	ISSUED FOR PHASE ZERO	JPM	ALP		JPM			
NO.	DATE						SHEET 1 OF 1		

CENTRIFUGAL PUMP DATA SHEET

JCS NO. 14222 ITEM NO. 12-G-031
PURCHASE ORDER NO.
REQUISITION NO.
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER;
☐ BY MANUFACTURER

FOR BRECKINRIDGE SITE BRECKINRIDGE KY.
UNIT PLANT 12 SERVICE SELEXOL SUMP PUMP
NO. PUMPS REQ'D 1 NO. MOTORS REQ'D 1 ITEM NO. 12-G-031 PROVIDED BY MTD BY
NO. TURBINES REQ'D ITEM NO. PROVIDED BY MTD BY
PUMP MFR GOULDS SIZE AND TYPE 1½X3-13 STAGES SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID SELEXOL U.S. GPM at PT. NOR. 200 RATED
DISCH. PRESS. PSIG 28.6
PT. F. NOR. 80 MAX. SUCT. PRESS. PSIG MAX. 0 RATED
SP. GR. at PT 1.007 DIFF. PRESS. PSI 28.6
VAP. PRESS. at PT. PSIA DIFF. HEAD. FT 100
VIS. at PT. Sus CP 6 NPSHA, FT As Req'd
CORR/EROS. CAUSED BY HYD. HP 3.3

PERFORMANCE

PROPOSAL CURVE NO.
RPM 1800 NPSHR (WATER)
EFF. 54% BHP RATED 10.6
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☒ CENTERLINE ☐ FOOT ☐ BRACKET ☒ VERT. (TYPE) SUMP
SPLIT: ☒ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
PRESS: ☐ MAX. ALLOW. PSIG °F; ☐ HYDRO TEST PSIG
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED ☐ MAX. ☐ TYPE:
MOUNT: ☐ BETWEEN BRGS ☒ OVERHUNG ☐ WEAR RG. DIAM./CLRNC.
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☒ SLINGER ☐ PRESSURE ☐
COUPLING: ☐ MFR ☐ MODEL
DRIVER HALF MTD BY: ○ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL API CLASS. CODE
☐ MFR CODE

SHOP TESTS

☒ NON-WIT. PERF. ○ WIT. PERF.
☒ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
☒ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○
316 SS
BASEPLATE: ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CI; ○ S.S.; ○ TUBING; ○ PIPE
☐ TOTAL COOLING WATER REQ'D. GPM ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
○ SEAL FLUSH PIPE PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○ 8½"
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 15 RPM 1800 FRAME VOLTS/PHASE/CYCLES 460/3/60
MFR BEARINGS LUBE
TYPE INSUL FULL LOAD AMPS
ENC. TEFC TEMP RISE, C LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB SERVICE FACTOR

TURBINE DRIVER

APPROX. WT. PUMP & BASE
MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

FORM NO 130 (REVISED SEPT 72)

NO.	DATE						JOB NO.	DRAWING NO.	REV.
0	12/31/80	ISSUE FOR PHASE 0	DO	MV	[illegible]		14222	12-DS-G-031	0
NO.	DATE						SHEET 1 OF 1		

CENTRIFUGAL PUMP DATA SHEET

JOB NO. 14222 ITEM NO. 1ZG-037A&B
PURCHASE ORDER NO.
REQUISITION NO.
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER:
☐ BY MANUFACTURER

FOR BRECKINRIDGE PROJECT SITE BRECKINRIDGE COUNTY, KY
UNIT PLANT 12 SERVICE GASIFIER QUENCH WATER PUMP
NO. PUMPS REQ'D 2 NO. MOTORS REQ'D 2 ITEM NO. PROVIDED BY VENDOR MTD BY VENDOR
NO. TURBINES REQ'D ITEM NO. PROVIDED BY MTD BY
PUMP MFR BYRON JACKSON SIZE AND TYPE 8X10X15HDSJH STAGES 1 SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID HOT SOUR CONDENSATE U.S. GPM at PT. NOR. 2076 RATED 2500
DISCH. PRESS., PSIG 760
PT. F, NOR 325 MAX. SUCT. PRESS., PSIG MAX. RATED 558
SP. GR. at PT 0.9 DIFF. PRESS., PSI 202
VAP. PRESS. at PT. PSIA 575 DIFF. HEAD, FT 518
VIS. at PT. Ssu CP NPSHA, FT 15'
CORR/EROS. CAUSED BY HYD. HP 294.3

PERFORMANCE

PROPOSAL CURVE NO. 2437-2
RPM 3570 NPSHR (WATER) 16
EFF. 76 BHP RATED 387
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
-SPLIT: ☐ AXIAL ☐ RAD; TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
-PRESS: ☐ MAX. ALLOW. PSIG °F: ☐ HYDRO TEST PSIG
-CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA: ☐ RATED ☐ MAX. ☐ TYPE:
MOUNT: ☐ BETWEEN BRGS. ☐ OVERHUNG ☐ WEAR RG. DIAM./CLRNC.
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ PLUNGER ☐ PRESSURE ☐
COUPLING: ☐ MFR ☐ MODEL
DRIVER HALF MTD BY: ☒ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL API CLASS CODE BSIF
☐ MFR CODE

SHOP TESTS

○ NON-WIT. PERF. ○ WIT. PERF.
○ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
☒ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○ 316SS/316SS
BASEPLATE ☐

AUXILIARY PIPING

☒ C.W. PIPE PLAN 1 ○ CI: ☒ S.S.: ☒ TUBING: ○ PIPE
☐ TOTAL COOLING WATER REQ'D, GPM: ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
☒ SEAL FLUSH PIPE PLAN 22 ○ C.S. ☒ S.S. ☒ TUBING ○ PIPE
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 500 RPM 3600 FRAME VOLTS/PHASE/CYCLES 4000-3-60
MFR BEARINGS LUBE
TYPE INSUL. FULL LOAD AMPS
ENC. TEFC-WPII TEMP RISE °C LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB SERVICE FACTOR

TURBINE DRIVER

APPROX. WT., PUMP & BASE
MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

FORM NO. 130 (REVISED SEPT 72)

NO.	DATE						JOB NO.	DRAWING NO.	REV.
0	10/6/80	ISSUED FOR PHASE ZERO	JMV	DWP		HWW	14222	12-DS-G-37	0
							SHEET 1 OF 1		

12G-145 A & B
12G-245 A & B
12G-345 A & B

CENTRIFUGAL PUMP DATA SHEET

JOB NO. 14222 ITEM NO. 12G-345 A & B
PURCHASE ORDER NO.
REQUISITION NO.
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER;
☐ BY MANUFACTURER

FOR BRECKIN RIDGE PROJECT SITE BRECKINRIDGE COUNTY, KY
UNIT PLANT 12 SERVICE CONDENSATE PUMP
NO. PUMPS REQ'D 6 NO. MOTORS REQ'D 6 ITEM NO. PROVIDED BY MTD BY
NO. TURBINES REQ'D ITEM NO. PROVIDED BY MTD BY
PUMP MFR GOULDS SIZE AND TYPE 1½x3-7 STAGES SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID WATER U.S. GPM at PT. NOR. RATED 80
CONDENSATE DISCH. PRESS., PSIG 91.7
PT. F. NOR. 120 MAX. SUCT. PRESS., PSIG MAX. RATED 1.7
SP. GR. at PT 1 DIFF. PRESS., PSI 90
VAP. PRESS. at PT. PSIA 1.7 DIFF. HEAD, FT 208
VIS. at PT. SSU CP .52 NPSHA, FT 2
CORR/EROS. CAUSED BY HYD. HP 4

PERFORMANCE

PROPOSAL CURVE NO.
RPM NPSHR (WATER)
EFF. 44 BHP RATED 9.09
MAX. BHP RATED IMP 11.6
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION	3	300	RF	
DISCHARGE	1½	300	RF	

CASE-MOUNT: ☒ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
SPLIT: ☐ AXIAL ☐ RAD: TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
PRESS: ☐ MAX. ALLOW. PSIG °F: ☐ HYDRO TEST PSIG
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED 7" ☐ MAX. 7 3/8" ☐ TYPE
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM/CLRNC
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☐
COUPLING: ☐ MFR ☐ MODEL
DRIVER HALF MTD BY: ○ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH SEAL: ☐ MFR & MODEL API CLASS CODE
☐ MFR CODE

SHOP TESTS

○ NON-WIT. PERF. ○ WIT. PERF.
○ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
○ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○
C.S. / CAST IRON
BASEPLATE: ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CU: ○ S.S.: ○ TUBING: ○ PIPE
☐ TOTAL COOLING WATER REQ'D. GPM ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
○ SEAL FLUSH PIPE PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS. ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 20 RPM 3500 FRAME VOLTS/PHASE/CYCLES 460/3/60
MFR BEARINGS LUBE
TYPE INSUL FULL LOAD AMPS
ENC TEFC TEMP RISE C LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB SERVICE FACTOR

TURBINE DRIVER

APPROX. WT. PUMP & BASE
MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

FORM NO 130 (REVISED SEPT 72)

NO.	DATE						JOB NO.	DRAWING NO.	REV.
0	12/30/80	ISSUED FOR PHASE 0	DMA JMV	ARP		RWH	14222	12-DS-G-045	0
							SHEET 1 OF 1		

CENTRIFUGAL PUMP DATA SHEET

JOB NO. 14222 ITEM NO. 12G-047A&B
PURCHASE ORDER NO.
REQUISITION NO.
INQUIRY NO.
DATE REVISION

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER:
☐ BY MANUFACTURER

FOR ASHLAND SITE BRECKINRIGE, KY
UNIT PLANT 12 SERVICE 50 PSIG COND. PUMP
NO. PUMPS REQ'D 2 NO. MOTORS REQ'D 2 ITEM NO. PROVIDED BY VENDOR MTD BY
NO. TURBINES REQ'D ITEM NO. PROVIDED BY MTD BY
PUMP MFR SIZE AND TYPE STAGES SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID COND. U.S. GPM at PT. NOR. 213 RATED
DISCH. PRESS., PSIG 114
PT. F. NOR. 281 MAX. SUCT. PRESS., PSIG MAX. 47 RATED
SP. GR. at PT 0.91 DIFF. PRESS., PSI 67
VAP. PRESS. at PT, PSIA 60 DIFF. HEAD, FT 170
VIS. at PT, Sss CP .22 NPSHA, FT 5
CORR/EROS. CAUSED BY HYD. HP 8.32

PERFORMANCE

PROPOSAL CURVE NO.
RPM NPSHR (WATER)
EFF. 50 BHP RATED 17
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
-SPLIT: ☐ AXIAL ☐ RAD: TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
-PRESS: ☐ MAX. ALLOW. PSIG °F: ☐ HYDRO TEST PSIG
-CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED ☐ MAX. ☐ TYPE
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM./CLRNC.
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ PLUNGER ☐ PRESSURE ☐
COUPLING: ☐ MFR ☐ MODEL
DRIVER HALF MTD BY: ○ PUMP MFR ○ DRIVER MFR ○ PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL API CLASS. CODE
☐ MFR CODE

SHOP TESTS

○ NON-WIT. PERF. ○ WIT. PERF.
○ NON-WIT. HYDRO ○ WIT. HYDRO
○ NPSH REQ'D. ○ WIT. NPSH
○ SHOP INSPECTION
○ DISMANT. & INSP. AFTER TEST
○ OTHER

MATERIALS

API CASE/TRIM CLASS ○ C.S. / CAST IRON
BASEPLATE ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CU: ○ S.S.: ○ TUBING: ○ PIPE
☐ TOTAL COOLING WATER REQ'D, GPM ○ SIGHT F.I. REQ'D
○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
○ SEAL FLUSH PIPE PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE
○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH ○
MIN. SUBMERGENCE REQ'D. ☐
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRGS: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP 17 RPM 1800 FRAME VOLTS/PHASE/CYCLES 460/3/60
MFR BEARINGS LUBE
TYPE INSUL FULL LOAD AMPS
ENC. TEMP RISE, C LOCKED ROTOR AMPS
○ VHS ○ VSS VERT. THRUST CAP., LB SERVICE FACTOR

TURBINE DRIVER

APPROX. WT, PUMP & BASE
MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

FORM NO 130 (REVISED SEPT 72)

NO.	DATE						JOB NO.	DRAWING NO.	REV.
0	12/16/80	ISSUED FOR PHASE ZERO	HWA	Dwp		MBH	14222	12-DS-G-47	0
							SHEET 1 OF 1		

4.6 Data Sheets for Compressors and Drivers

12-DS-K-02: Recycle Shift Gas Blower (12K-102 A, B, 202 A, B, 302 A, B)

12-DS-K-09: CO_2 Stripper Air Compressor (12K-009, 109, 209, 309)

12-DS-K-11: First Stage Fuel Gas Turboexpander (12K-111)

12-DS-K-12: Second Stage Fuel Gas Turboexpander (12K-112)

12-DS-K-14: Hydrogen Compressor (12K-114, 214, 314, 414, 514)

APPLICABLE TO: ● PROPOSAL ○ PURCHASE ○ AS BUILT DATE _____ REVISION _____

FOR THE BRECKINRIDGE PROJECT UNIT 12K-102 A B, 202 A,B 302 A,B

SITE BRECKINRIDGE, KY SERIAL NO. _____

SERVICE RECYCLE SHIFT GAS BLOWER NO. REQUIRED 6

MANUFACTURER TURBONETICS, INC. MODEL SC-10 DRIVER MOTOR

NOTE ■ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ■ BY MANUFACTURER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

	NORMAL	RATED	OTHER CONDITIONS A	B	C	D
	12K-102	(6 UNITS)				
■ GAS HANDLED (ALSO SEE PAGE 2)	SYN GAS					
■ MMSCFD/~~SCFM~~ (14.7 PSIA & 60°F DRY)	48 MM					
■ WEIGHT FLOW, #/MIN (WET) (DRY)	1621					
INLET CONDITIONS:						
■ PRESSURE (PSIA)	635.5					
■ TEMPERATURE (°F)	536					
■ RELATIVE HUMIDITY (%)	SAT.					
■ MOLECULAR WEIGHT (M)	18.43					
■ $C_p/C_v (K_1)$ OR (K_{AVG})	1.35					
■ COMPRESSIBILITY (Z_1) OR (Z_{AVG})	1.0					
■ INLET VOLUME, (CFM-WET)	1490					
DISCHARGE CONDITIONS:						
■ PRESSURE (PSIA)	677.5					
■ TEMPERATURE (°F)	558					
■ $C_p/C_v (K_2)$ OR (K_{AVG})	1.35					
■ COMPRESSIBILITY (Z_2) OR (Z_{AVG})	1.0					
RATIO	1.07					
■ BHP REQUIRED (ALL LOSSES INCL)	379					
■ SPEED (RPM)	11,000					
■ ESTIMATED SURGE, ICFM (AT SPEED ABOVE)						
■ POLYTROPIC HEAD (FT)						
■ POLYTROPIC EFFICIENCY (%)						
○ GUARANTEE POINT						
■ PERFORMANCE CURVE NO.						

PROCESS CONTROL:

METHOD: ○ BYPASS FROM _____ TO _____

● ANTI-SURGE BYPASS: ○ MANUAL ● AUTO

○ SUCTION THROTTLING FROM _____ TO _____

○ SPEED VARIATION FROM _____ TO _____

○ OTHER _____

SIGNAL: ○ SOURCE _____

○ TYPE _____

○ RANGE: FOR PNEUMATIC CONTROL _____ RPM @ _____ PSIG @ _____ RPM @ _____ PSIG _____

OTHER _____

SERVICE: ● CONTINUOUS ○ INTERMITTENT ○ STAND BY

REMARKS: _____

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG'R	PROJ ENG'R	APP'R
0	11/25/80	ISSUED FOR PHASE 0	VJ	VJ				HNH

SCALE _____ DESIGNED _____ DRAWN _____ CHIEF ENGR _____

ORIGIN

BECHTEL

CENTRIFUGAL COMPRESSOR DATA SHEET

JOB No. 14222

DRAWING No. 12-DS-K-02 REV. 0

Form 187 (5/80) Sheet 1 of 6

"A" SIZE R&C

CENTRIFUGAL COMPRESSOR DATA SHEET

GAS ANALYSIS ○ MOL % ○	M.W.	NORMAL	RATED	OTHER CONDITIONS A	B	C	D	REMARKS
AIR	28.966							
OXYGEN	32.000							
NITROGEN	28.016	0.1						
WATER VAPOR	18.016	350						
CARBON MONOXIDE	28.010	3.6						
CARBON DIOXIDE	44.010	230						
HYDROGEN SULFIDE	34.076	0.3						
HYDROGEN	2.016	38.0						
METHANE	16.042							
ETHYLENE	28.052							
ETHANE	30.068							
PROPYLENE	42.078							
PROPANE	44.094							
i - BUTANE	58.120							
n - BUTANE	58.120							
i - PENTANE	72.146							
n - PENTANE	72.146							
HEXANE PLUS								
TOTAL		100						
AVG. MOL. WT.		18.43						

LOCATION:
- ○ INDOOR ○ HEATED ◉ UNDER ROOF
- ◉ OUTDOOR ◉ UNHEATED ○ PARTIAL SIDES
- ○ GRADE ○ MEZZANINE ○ _____
- ◉ ELECTRICAL AREA CLASS I GR. D DIV. 2
- ○ WINTERIZATION REQD. ○ TROPICALIZATION REQD.

SITE DATA:
- ○ ELEVATION 400 FT. BAROMETER 14.7 PSIA
- ○ RANGE OF AMBIENT TEMPS.:

	DRY BULB	WET BULB
SITE RATED °F		
NORMAL °F		
MAXIMUM °F	96°F	78°F
MINIMUM °F	-10°F	

UNUSUAL CONDITIONS: ○ DUST ○ FUMES ○ OTHER _____

NOISE SPECIFICATIONS:
- ○ APPLICABLE TO MACHINE:
  SEE SPECIFICATION _____
- ○ APPLICABLE TO NEIGHBORHOOD
  SEE SPECIFICATION _____
- ACOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:
API 617 CENTRIFUGAL COMPR. FOR GEN. REFINERY SERVICES

PAINTING:
- ◉ MANUFACTURER'S STD. SUBJECT TO REVIEW
- ○ OTHERS _____

SHIPMENT:
- ◉ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD.
- ◉ OUTDOOR STORAGE OVER 6 MONTHS

REMARKS: _____

REC Form 187 (5/80) Sheet 2 of 6

CENTRIFUGAL COMPRESSOR DATA SHEET

CONSTRUCTION FEATURES

SPEEDS:
MAX. CONT 11000 RPM TRIP _____ RPM
MAX. TIP SPEEDS: _____ FPS @ RATED SPEED
_____ FPS @ MAX. CONT SPEED

LATERAL CRITICAL SPEEDS:
FIRST CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
SECOND CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
THIRD CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
FOURTH CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
LATERAL CRITICAL SPEED — BASIS.
☐ DAMPED UNBALANCE RESPONSE ANALYSIS
☐ SHOP TEST
☐ OTHER TYPE ANALYSIS

TORSIONAL CRITICAL SPEEDS:
FIRST CRITICAL _____ RPM
SECOND CRITICAL _____ RPM
THIRD CRITICAL _____ RPM
FOURTH CRITICAL _____ RPM

VIBRATION:
ALLOWABLE TEST LEVEL (PEAK TO PEAK) _____ MILS

ROTATION, VIEWED FROM DRIVEN END:

CASING:
MODEL SC-10
CASING SPLIT VERTICAL (BARREL)
MATERIAL FAB. STEEL
THICKNESS (IN.) _____ CORR ALLOW (IN.) _____
MAX. WORK PRESS _____ PSIG MAX DESIGN PRESS _____ PSIG
TEST PRESS (PSIG) HELIUM _____ HYDRO _____
MAX OPER TEMP _____ F MIN. OPER TEMP _____ F
MAX NO OF IMPELLERS FOR CASING _____
MAX CASING CAPACITY (ICFM) _____
RADIOGRAPH QUALITY ○ YES _____ ○ NO _____
CASING SPLIT SEALING _____

☐ DIAPHRAGMS:
MATERIAL _____

IMPELLERS:
NO 1 DIAMETERS 11.5
NO VANES EA IMPELLER 1

TYPE (OPEN, ENCLOSED, ETC.) _____
TYPE FABRICATION _____
MATERIAL _____
MAX. YIELD STRENGTH (PSI) _____
BRINNEL HARDNESS MAX. _____ MIN. _____
SMALLEST TIP INTERNAL WIDTH (IN.) _____
MAX. MACH NO. @ IMPELLER EYE _____
MAX. IMPELLER HEAD @ RATED SPEED (FT.) _____

SHAFT:
MATERIAL _____
DIA. @ IMPELLERS (IN.) _____ DIA. @ COUPLING (IN.) _____
SHAFT END: ☐ TAPERED ☐ CYLINDRICAL
MAX. YIELD STRENGTH (PSI) _____

BALANCE PISTON:
MATERIAL _____ AREA _____ (IN.²)
FIXATION METHOD _____

SHAFT SLEEVES:
AT INTERSTG. CLOSE CLEAR. PTS. MATL _____
AT SHAFT SEALS _____ MATL _____

LABYRINTHS:
INTERSTAGE
TYPE _____ MATERIAL _____
BALANCE PISTON
TYPE _____ MATERIAL _____

SHAFT SEALS:
TYPE COMBINED LUBE & SEAL
○ SEAL SYSTEM TYPE _____
○ SETTLING OUT PRESSURE _____
INNER OIL LEAKAGE GUAR. (GAL/DAY/SEAL) _____
TYPE BUFFER GAS _____
BUFFER GAS FLOW (PER SEAL). _____
NORMAL _____ #/MIN @ _____ PSI Δ P _____
MAX. _____ #/MIN @ _____ PSI Δ P _____
BUFFER GAS REQUIRED FOR:
☐ START-UP
☐ AIR RUN-IN
☐ OTHER _____
BUFFER GAS CONTROL
SYSTEM SUPPLIED BY _____

BEARING HOUSING CONSTRUCTION:
TYPE (SEPARATE, INTEGRAL) _____ SPLIT _____
MATERIAL _____

REMARKS: _____

R&C Form 187 (5/80) Sheet 3 of 6

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET (Cont'd)

CONSTRUCTION FEATURES. CONT'D

RADIAL BEARINGS:

TYPE _____ SPAN (IN.) _____

AREA (IN.²) _____ LOADING (PSI) ACT _____ ALLOW _____

CENTER PIVOT _____

OFFSET PIVOT _____

" _____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

THRUST BEARING:

LOCATION _____ TYPE _____

MFR _____ AREA (IN.²) _____

LOADING (PSI) _____ ACTUAL _____ ALLOWABLE _____

GAS LOADING (LB) _____ CPLG SLIP LOAD (LB) _____

CPLG COEFF FRICT _____ CPLG GEAR PITCH DIA (IN.) _____

BAL PISTON COMPENSATING LOAD _____ LB

CENTER PIVOT _____

OFFSET PIVOT _____

" _____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

MAIN CONNECTIONS:

	SIZE	ANSI RATING	FACING	POSITION	FLANGE VEL FPS
INLET					
DISCHARGE					

OTHER CONNECTIONS:

SERVICE	NO	SIZE	TYPE
LUBE-OIL INLET			
LUBE-OIL OUTLET			
SEAL-OIL INLET			
SEAL-OIL OUTLET			
CASING DRAINS			
STAGE DRAINS			
VENTS			
COOLING WATER			
PRESSURE			
TEMPERATURE			
PURGE FOR			
BRG HOUSING			
BETWEEN BRG & SEAL			
BETWEEN SEAL & GAS			
SOLVENT INJECTION			

ALLOWABLE PIPING FORCES AND MOMENTS:

	INLET		DISCHARGE			
	FORCE LB	MOMT FT LB.	FORCE LB	MOMT FT LB.	FORCE LB	MOMT FT LB
AXIAL						
VERTICAL						
HORIZ. 90°						
	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB.	FORCE LB	MOMT FT LB
AXIAL						
VERTICAL						
HORIZ. 90°						

INSTRUMENTATION

PANEL SUPPLIED BY OWNER

	INDICATOR	ALARM	SHUTDOWN
HIGH GAS DISCHARGE TEMPERATURE (EACH SECTION)	●	●	○
REFERENCE GAS PRESSURE	●	●	○
BALANCE DRUM DIFFERENTIAL PRESSURE	●	●	○
BUFFER GAS DIFFERENTIAL PRESSURE	●	●	○
IMBEDDED TEMPERATURE SENSORS			
RADIAL BEARINGS TYPE _____ NO. PER BRG _____ LOCATION _____	●	●	○
THRUST BEARINGS TYPE _____ NO. PER BRG _____ LOCATION _____	●	●	○

PHASE ANGLE TRANSDUCER NUMBER _____ LOCATION _____

VIBRATION DETECTORS:

● TYPE _____ ☐ MODEL _____

● MFR _____

● NO AT EACH SHAFT BEARING 2 TOTAL NO 4

○ OSCILLATOR-DETECTORS SUPPLIED BY COMPR. MFR

○ MFR _____ ☐ MODEL _____

● MONITOR SUPPLIED BY OTHERS

○ LOCATION _____ ENCLOSURE _____

○ MFR _____ ☐ MODEL _____

☐ SCALE RANGE ___ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ___ SEC

AXIAL POSITION DETECTOR:

○ TYPE _____ ☐ MODEL _____

● MFR _____ ○ NO REQUIRED 1

○ OSCILLATOR-DEMODULATOR SUPPLIED BY COMPR. MFG.

○ MFR. _____ ☐ MODEL _____

○ MONITOR SUPPLIED BY OTHERS

○ LOCATION _____ ENCLOSURE _____

○ MFR _____ ☐ MODEL _____

☐ SCALE RANGE ___ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ___ SEC.

R&C Form 3187 (5/80) SHEET 4 OF 6

CENTRIFUGAL COMPRESSOR DATA SHEET (Cont'd)

CONSTRUCTION FEATURES, CONT'D

COUPLINGS:

	DRIVER-COMP OR DRIVER-GEAR	GEAR-COMP
MAKE	MFG. STD.	
MODEL		
LUBRICATION		
MOUNT CPLG HALVES	BY SUPPLIER	
SPACER REQD		
○ LIMITED END FLOAT REQD		
○ IDLING ADAPTOR REQD		
CPLG. RATING (HP/100 RPM)		
KEYED (1) OR (2); OR HYDR. FIT		

SHOP INSPECTION AND TESTS:

	REQD	WITNESS	OBSERVED
SHOP INSPECTION	●	○	○
HYDROSTATIC	●	●	○
HELIUM LEAK	○	○	○
MECHANICAL RUN FOUR HOURS	●	●	○
MECH. RUN SPARE ROTOR	●	●	○
FIT IN SPARE ROTOR	○	○	○
PERFORMANCE TEST (AIR)	●	●	○
COMP. WITH DRIVER	○	○	○
COMP. LESS DRIVER	○	○	○
USE SHOP LUBE & SEAL SYS	○	○	○
USE JOB LUBE & SEAL SYS	○	○	○
USE SHOP VIBRATION PROBES, ETC	○	○	○
USE JOB VIB & AXIAL DISP PROBES, OSCILLATOR-DETECTORS & MONITOR	○	○	○
PRESSURE COMP. TO FULL OPER. PRESS	○	○	○
DISASSEMBLE-REASSEMBLE COMP AFTER TEST	○	○	○
CHECK BRGS & SEALS AFTER TEST	●	●	○
NOISE LEVEL TEST	●	●	○
RESIDUAL ELECTRICAL MECH. RUNOUT	○	○	○
_____	○	○	○

BASEPLATE & SOLEPLATES:

SOLEPLATES FOR: ● COMPRESSOR ○ GEAR ● DRIVER

BASEPLATE:

- ● COMMON (UNDER COMP., GEAR & DRIVER)
- ○ UNDER COMP ONLY ○ OTHER _____
- ○ DECKED WITH NON-SKID DECK PLATE ○ OPEN CONSTR.
- ○ DRIP RIM ○ WITH OPEN DRAIN
- ● HORIZ. ADJUSTING SCREWS FOR EQUIPMENT
- ○ SUITABLE FOR POINT SUPPORT
- ○ SUITABLE FOR PERIMETER SUPPORT
- ● STAINLESS SHIMS THICKNESS _____
- ● GROUTING TYPE _____

● WEIGHTS (LB):

COMPR. _____ GEAR _____ DRIVER _____ BASE _____

ROTORS, COMPR. _____ DRIVER _____ GEAR _____

COMPR. UPPER CASE _____

L.O. CONSOLE _____ S.O. CONSOLE _____

MAX. FOR MAINTENANCE (IDENTIFY) _____

TOTAL SHIPPING WEIGHT _____

● SPACE REQUIREMENTS (FT & IN.):

COMPLETE UNIT L _____ W _____ H _____

L.O. CONSOLE L _____ W _____ H _____

S.O. CONSOLE. L _____ W _____ H _____

MISCELLANEOUS:

- ● RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION _____
- ● VENDOR'S REVIEW & COMMENTS ON PURCHASER'S PIPING & FOUNDATION
- ● OPTICAL ALIGNMENT FLATS REQUIRED ON COMPRESSOR, GEAR & DRIVER
- ○ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY _____ _____
- ● TORSIONAL ANALYSIS REPORT REQUIRED

REMARKS:

CENTRIFUGAL COMPRESSOR DATA SHEET

UTILITIES

UTILITY CONDITIONS:

STEAM	DRIVERS		HEATING	
INLET MIN	____ PSIG	____ F	____ PSIG	____ F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F
EXHAUST MIN	____ PSIG	____ F	____ PSIG	____ F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F

ELECTRICITY:

	DRIVERS	HEATING	CONTROL	SHUTDOWN
VOLTAGE	460	460	120	120
HERTZ	60	60	60	60
PHASE	3	3	1	1

COOLING WATER:

TEMP INLET 85 F — MAX RETURN 115 F
PRESS NORM 50 PSIG — DESIGN 50 PSIG
MIN RETURN 35 PSIG — MAX ALLOW Δ P 35 PSI
WATER SOURCE CWT

INSTRUMENT AIR:

MAX PRESS 115 PSIG — MIN PRESS — PSIG

TOTAL UTILITY CONSUMPTION:

COOLING WATER ____ GPM
STEAM, NORMAL ____ #/HR
STEAM, MAX ____ #/HR
INSTRUMENT AIR ____ SCFM
HP (DRIVER) ____ HP
HP (AUXILIARIES) ____ HP

REMARKS: DRIVER
ELECTRIC MOTOR - 450HP
1800 RPM TEFC

APPLICABLE TO ○ PROPOSAL ○ PURCHASE ○ AS BUILT DATE _____ REVISION _____

FOR BRECKINRIDGE UNIT 12K-009, 109, 209, 309

SITE BRECKIRIDGE COUNTY, KENTUCKY SERIAL NO. _____

SERVICE CO_2 STRIPPER AIR COMPRESSOR NO. REQUIRED 4

MANUFACTURER ROOTS-DRESSER MODEL 1442-RAS-J DRIVER MOTOR

NOTE ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ☐ BY MANUFACTURER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

	NORMAL	RATED	OTHER CONDITIONS A	B	C	D
○ GAS HANDLED (ALSO SEE PAGE ___)						
○ SCFM (14.7 PSIA & 60°F DRY)						
○ WEIGHT FLOW, #/MIN (WET) (DRY)		AIR				
INLET CONDITIONS:						
○ PRESSURE (PSIA)		13.9				
○ TEMPERATURE (°F)		96				
○ RELATIVE HUMIDITY (%)						
○ MOLECULAR WEIGHT (M)		28.97				
☐ C_p/C_v (K_1) OR (K_{AVG})		1.4				
☐ COMPRESSIBILITY (Z_1) OR ($\bar{Z}_{AVG}$)		1				
☐ INLET VOLUME, (CFM-WET)						
DISCHARGE CONDITIONS:						
○ PRESSURE (PSIA)		19.5				
■ TEMPERATURE (°F)		173				
☐ C_p/C_v (K_2) OR (K_{AVG})						
☐ COMPRESSIBILITY (Z_2) OR ($\bar{Z}_{AVG}$)						
■ BHP REQUIRED (ALL LOSSES INCL)						
■ SPEED (RPM)		1175				
■ ESTIMATED SURGE, ICFM (AT SPEED ABOVE)						
■ POLYTROPIC HEAD (FT)						
■ POLYTROPIC EFFICIENCY (%)						
● GUARANTEE POINT						
☐ PERFORMANCE CURVE NO.						

PROCESS CONTROL:

METHOD: ○ BYPASS FROM _____ TO _____

○ ANTI-SURGE BYPASS: ○ MANUAL ○ AUTO

○ SUCTION THROTTLING FROM _____ TO _____

○ SPEED VARIATION FROM _____ TO _____

○ OTHER BLOWOFF OF EXCESSIVE AIR THROUGH SILENCER

SIGNAL: ○ SOURCE _____

○ TYPE _____

○ RANGE: FOR PNEUMATIC CONTROL _____ RPM @ _____ PSIG & _____ RPM @ _____ PSIG

OTHER _____

SERVICE: ● CONTINUOUS ○ INTERMITTENT ○ STAND BY

REMARKS: _____

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG'R	PROJ ENGR	APPR
0	11/13/80	ISSUED FOR PHASE ZERO	JMV					HWH

SCALE _____ DESIGNED _____ DRAWN _____ CHIEF ENGR _____

ORIGIN

CENTRIFUGAL COMPRESSOR DATA SHEET

JOB No. 14222

DRAWING No. 12-DS-K-09 REV. 0

"A" SIZE R&C Form 187 (5/80) Sheet 1 of 6

CENTRIFUGAL COMPRESSOR DATA SHEET

GAS ANALYSIS ○ MOL % ○	M.W.	NORMAL	RATED	OTHER CONDITIONS A	B	C	D	REMARKS
AIR	28.966		✓					
OXYGEN	32.000							
NITROGEN	28.016							
WATER VAPOR	18.016							
CARBON MONOXIDE	28.010							
CARBON DIOXIDE	44.010							
HYDROGEN SULFIDE	34.076							
HYDROGEN	2.016							
METHANE	16.042							
ETHYLENE	28.052							
ETHANE	30.068							
PROPYLENE	42.078							
PROPANE	44.094							
i - BUTANE	58.120							
n - BUTANE	58.120							
i - PENTANE	72.146							
n - PENTANE	72.146							
HEXANE PLUS								
TOTAL								
AVG. MOL. WT.								

LOCATION:
○ INDOOR ○ HEATED ○ UNDER ROOF
● OUTDOOR ● UNHEATED ○ PARTIAL SIDES
○ GRADE ○ MEZZANINE ○ _____
○ ELECTRICAL AREA CLASS I GR. D DIV. 2
○ WINTERIZATION REQD. ○ TROPICALIZATION REQD.

SITE DATA:
○ ELEVATION 400 FT. BAROMETER 14.7 PSIA
○ RANGE OF AMBIENT TEMPS.:

	DRY BULB	WET BULB
SITE RATED °F		
NORMAL °F		
MAXIMUM °F	96°F	78°F
MINIMUM °F	-10°F	

UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER _____

NOISE SPECIFICATIONS:
○ APPLICABLE TO MACHINE:
SEE SPECIFICATION _____
○ APPLICABLE TO NEIGHBORHOOD
SEE SPECIFICATION _____
ACCOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:
API 617 CENTRIFUGAL COMPR. FOR GEN. REFINERY SERVICES

PAINTING:
● MANUFACTURER'S STD. SUBJECT TO REVIEW
○ OTHERS _____

SHIPMENT:
● DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD.
● OUTDOOR STORAGE OVER 6 MONTHS

REMARKS: _____

R&C Form 187 (5/80) Sheet 2 of 6

CENTRIFUGAL COMPRESSOR DATA SHEET

CONSTRUCTION FEATURES

SPEEDS:
MAX CONT 1290 RPM TRIP N/A RPM
MAX TIP SPEEDS N/A FPS @ RATED SPEED
_____ FPS @ MAX. CONT SPEED

LATERAL CRITICAL SPEEDS:
FIRST CRITICAL NONE RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
SECOND CRITICAL N/A RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
THIRD CRITICAL N/A RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
FOURTH CRITICAL N/A RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
LATERAL CRITICAL SPEED — BASIS
☐ DAMPED UNBALANCE RESPONSE ANALYSIS
☐ SHOP TEST
☐ OTHER TYPE ANALYSIS

TORSIONAL CRITICAL SPEEDS:
FIRST CRITICAL _____ RPM
SECOND CRITICAL _____ RPM
THIRD CRITICAL _____ RPM
FOURTH CRITICAL _____ RPM

VIBRATION:
ALLOWABLE TEST LEVEL _____ MILS (PEAK TO PEAK)

ROTATION, VIEWED FROM DRIVEN END: EITHER

CASING:
MODEL _____
CASING SPLIT _____
MATERIAL CAST IRON
THICKNESS (IN.) _____ CORR. ALLOW (IN.) _____
MAX WORK PRESS _____ PSIG MAX DESIGN PRESS _____ PSIG
TEST PRESS (PSIG) HELIUM _____ HYDRO _____
MAX OPER TEMP _____ F MIN OPER TEMP _____ F
MAX NO OF IMPELLERS FOR CASING ONE
MAX CASING CAPACITY (ICFM) _____
RADIOGRAPH QUALITY ○ YES _____ ○ NO _____
CASING SPLIT SEALING _____

☐ **DIAPHRAGMS:**
MATERIAL _____

IMPELLERS:
NO _____ DIAMETERS APPROX 1.7 x TIME GEAR DIA.
NO VANES EA IMPELLER _____

TYPE (OPEN, ENCLOSED, ETC.) N/A
TYPE FABRICATION DUCTILE IRON-CAST
MATERIAL _____
MAX. YIELD STRENGTH (PSI) _____
BRINNEL HARDNESS MAX. _____ MIN. _____
SMALLEST TIP INTERNAL WIDTH (IN.) _____
MAX. MACH NO. @ IMPELLER EYE N/A
MAX. IMPELLER HEAD @ RATED SPEED (FT.) _____

SHAFT:
MATERIAL ALLOY STEEL
DIA. @ IMPELLERS (IN.) _____ DIA. @ COUPLING (IN.) _____
SHAFT END. ☐ TAPERED ☐ CYLINDRICAL
MAX. YIELD STRENGTH (PSI) _____

BALANCE PISTON:
MATERIAL N/A AREA _____ (IN.²)
FIXATION METHOD _____

SHAFT SLEEVES: NOT AVAILABLE
● AT INTERSTG. CLOSE CLEAR. PTS. ■ MATL _____
● AT SHAFT SEALS _____ ■ MATL _____

LABYRINTHS:
INTERSTAGE
TYPE N/A MATERIAL _____
BALANCE PISTON
TYPE N/A MATERIAL _____

SHAFT SEALS:
■ TYPE HEAD PLATE - LABYRINTH BEARING-LIP TYPE
○ SEAL SYSTEM TYPE _____
○ SETTLING OUT PRESSURE _____
☐ INNER OIL LEAKAGE GUAR (GAL/DAY/SEAL) _____
○ TYPE BUFFER GAS _____
☐ BUFFER GAS FLOW (PER SEAL) _____
NORMAL _____ #/MIN @ _____ PSI Δ P _____
MAX _____ #/MIN @ _____ PSI Δ P _____
○ BUFFER GAS REQUIRED FOR:
☐ START-UP
☐ AIR RUN-IN
☐ OTHER _____
☐ BUFFER GAS CONTROL SYSTEM SUPPLIED BY _____

BEARING HOUSING CONSTRUCTION:
TYPE (SEPARATE, INTEGRAL) SEPARATE SPLIT No
MATERIAL CAST IRON

REMARKS: _____

R&C Form 187 (5/80) Sheet 3 of 6

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET (Cont'd)

CONSTRUCTION FEATURES CONT'D

RADIAL BEARINGS:

TYPE ROLLER _____ SPAN (IN.) _____

AREA (IN.²) _____ LOADING (PSI) ACT _____ ALLOW _____

CENTER PIVOT _____

OFFSET PIVOT _____

_____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

THRUST BEARING: NONE

LOCATION _____ TYPE _____

MFR _____ AREA (IN.²) _____

LOADING (PSI) ACTUAL _____ ALLOWABLE _____

GAS LOADING (LB) _____ CPLG SLIP LOAD (LB) _____

CPLG COEFF FRICT _____ CPLG GEAR PITCH DIA (IN.) _____

BAL PISTON COMPENSATING LOAD _____ LB

CENTER PIVOT _____

OFFSET PIVOT _____

_____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

MAIN CONNECTIONS:

	SIZE	ANSI RATING	FACING	POSITION	FLANGE VEL FPS
INLET	24"	125	FF		
DISCHARGE	20"	125	FF		

OTHER CONNECTIONS: NONE

SERVICE	NO	SIZE	TYPE
LUBE-OIL INLET			
LUBE-OIL OUTLET			
SEAL-OIL INLET			
SEAL-OIL OUTLET			
CASING DRAINS			
STAGE DRAINS			
VENTS			
COOLING WATER			
PRESSURE			
TEMPERATURE			
PURGE FOR			
BRG HOUSING			
BETWEEN BRG & SEAL			
BETWEEN SEAL & GAS			
SOLVENT INJECTION			

ALLOWABLE PIPING FORCES AND MOMENTS: ZERO

	INLET		DISCHARGE			
	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB
AXIAL						
VERTICAL						
HORIZ 90°						
	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB
AXIAL						
VERTICAL						
HORIZ 90°						

INSTRUMENTATION PANEL SUPPLIED BY OWNER

	INDICATOR	ALARM	SHUTDOWN
HIGH GAS DISCHARGE TEMPERATURE (EACH SECTION)	●	●	○
REFERENCE GAS PRESSURE	○	○	○
BALANCE DRUM DIFFERENTIAL PRESSURE	○	○	○
BUFFER GAS DIFFERENTIAL PRESSURE	○	○	○
IMBEDDED TEMPERATURE SENSORS			
RADIAL BEARINGS	●	●	○
TYPE _____			
NO. PER BRG. _____			
LOCATION _____			
THRUST BEARINGS	●	●	○
TYPE _____			
NO. PER BRG. _____			
LOCATION _____			

PHASE ANGLE TRANSDUCER NUMBER _____ LOCATION _____

VIBRATION DETECTORS:

● TYPE _____ ☐ MODEL _____

● MFR _____

● NO AT EACH SHAFT BEARING 2 TOTAL NO 4

● OSCILLATOR-DETECTORS SUPPLIED BY COMPR. MFR

○ MFR _____ ☐ MODEL _____

● MONITOR SUPPLIED BY OTHERS

○ LOCATION _____ ENCLOSURE _____

○ MFR _____ ☐ MODEL _____

☐ SCALE RANGE ___ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ___ SEC

AXIAL POSITION DETECTOR:

○ TYPE _____ ☐ MODEL _____

● MFR _____ ○ NO REQUIRED 1

● OSCILLATOR-DEMODULATOR SUPPLIED BY COMPR. MFG

○ MFR _____ ☐ MODEL _____

● MONITOR SUPPLIED BY OTHERS

○ LOCATION _____ ENCLOSURE _____

○ MFR _____ ☐ MODEL _____

☐ SCALE RANGE ___ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ___ SEC

CENTRIFUGAL COMPRESSOR DATA SHEET (Cont'd)

CONSTRUCTION FEATURES, CONT'D.

COUPLINGS:

	DRIVER-COMP OR DRIVER-GEAR	GEAR-COMP
● MAKE	MFG. STD	
□ MODEL		
○ LUBRICATION		
◐ MOUNT CPLG HALVES	By Supplier	
◐ SPACER REQD		
○ LIMITED END FLOAT REQD		
○ IDLING ADAPTOR REQD.		
■ CPLG. RATING (HP/100 RPM)		
◐ KEYED (1) OR (2); OR HYDR. FIT		

SHOP INSPECTION AND TESTS:

	REQD	WITNESS	OBSERVED
SHOP INSPECTION	◐	○	○
HYDROSTATIC	●	◐	○
HELIUM LEAK	○	○	○
MECHANICAL RUN Four Hours	◐	◐	○
MECH RUN SPARE ROTOR	●	●	○
FIT IN SPARE ROTOR	○	○	○
PERFORMANCE TEST (GAS) (AIR)	●	◐	○
COMP WITH DRIVER	○	○	○
COMP LESS DRIVER	○	○	○
USE SHOP LUBE & SEAL SYS	○	○	○
USE JOB LUBE & SEAL SYS	○	○	○
USE SHOP VIBRATION PROBES, ETC	○	○	○
USE JOB VIB & AXIAL DISP PROBES :OSCILLATOR-DETECTORS & MONITOR	○	○	○
PRESSURE COMP TO FULL OPER PRESS	○	○	○
DISASSEMBLE-REASSEMBLE COMP AFTER TEST	○	○	○
CHECK BRGS & SEALS AFTER TEST	●	●	○
NOISE LEVEL TEST	◐	◐	○
RESIDUAL ELECTRICAL/MECH RUNOUT	○	○	○
_____	○	○	○

BASEPLATE & SOLEPLATES:

SOLEPLATES FOR ○ COMPRESSOR ○ GEAR ○ DRIVER

BASEPLATE

- ◐ COMMON (UNDER COMP., GEAR & DRIVER)
- ○ UNDER COMP ONLY ○ OTHER _____
- ○ DECKED WITH NON-SKID DECK PLATE ○ OPEN CONSTR
- ○ DRIP RIM ○ WITH OPEN DRAIN
- ◐ HORIZ. ADJUSTING SCREWS FOR EQUIPMENT
- ○ SUITABLE FOR POINT SUPPORT
- ○ SUITABLE FOR PERIMETER SUPPORT
- ◐ STAINLESS SHIMS THICKNESS _____
- ◐ GROUTING TYPE _____

◐ **WEIGHTS (LB):** 20,000 LBS

COMPR _____ GEAR _____ DRIVER _____ BASE _____

ROTORS COMPR. _____ DRIVER _____ GEAR _____

COMPR UPPER CASE _____

LO CONSOLE _____ S.O CONSOLE _____

MAX FOR MAINTENANCE (IDENTIFY) _____

TOTAL SHIPPING WEIGHT _____

◐ **SPACE REQUIREMENTS (FT & IN.):**

COMPLETE UNIT L _____ W _____ H _____

LO CONSOLE L _____ W _____ H _____

S.O CONSOLE L _____ W _____ H _____

MISCELLANEOUS:

- ◐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION _____
- ● VENDOR'S REVIEW & COMMENTS ON PURCHASER'S PIPING & FOUNDATION
- ◐ OPTICAL ALIGNMENT FLATS REQUIRED ON COMPRESSOR, GEAR & DRIVER
- ○ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY _____
- ◐ TORSIONAL ANALYSIS REPORT REQUIRED

REMARKS:

CENTRIFUGAL COMPRESSOR DATA SHEET

UTILITIES

UTILITY CONDITIONS:

STEAM	DRIVERS		HEATING	
INLET MIN	____ PSIG	____ F	____ PSIG	____ F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F
EXHAUST MIN	____ PSIG	____ F	____ PSIG	____ F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F

ELECTRICITY:

	DRIVERS	HEATING	CONTROL	SHUTDOWN
VOLTAGE	4000	460	120	120
HERTZ	60	60	60	60
PHASE	3	3	1	1

COOLING WATER:

TEMP INLET 85 F — MAX RETURN 115 F

PRESS NORM 50 PSIG — DESIGN 50 PSIG

MIN RETURN 35 PSIG — MAX ALLOW ΔP 35 PSI

WATER SOURCE ____

INSTRUMENT AIR:

MAX PRESS 115 PSIG — MIN PRESS — PSIG

TOTAL UTILITY CONSUMPTION:

COOLING WATER ____ GPM

STEAM NORMAL ____ #/HR

STEAM MAX ____ #/HR

INSTRUMENT AIR ____ SCFM

HP (DRIVER) ____ HP

HP (AUXILIARIES) ____ HP

REMARKS:

R&C Form 187 (5/80) Sheet 6 of 6

Data Sheet No. 12-DS-K-09 REV. 0 SHEET 6 OF 6

ONLY ONE REQUIRED

APPLICABLE TO ○ PROPOSAL ○ PURCHASE ○ AS BUILT DATE _____ REVISION A

FOR _____ UNIT PLANT 12-TURBOEXPANDER

SITE _____ SERIAL NO. 12K-111

SERVICE FIRST STAGE FUELGAS TURBOEXPANDER NO. REQUIRED _____

MANUFACTURER ROTO FLOW MODEL _____ DRIVEN ELECTRIC GENERATOR

NOTE ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: □ BY MANUFACTUPER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

	NORMAL	RATED	OTHER CONDITIONS A	B	C	D
○ GAS HANDLED (ALSO SEE PAGE ____)	FUELGAS					
○ SCFM (14.7 PSIA & 60°F DRY)	60927					
○ WEIGHT FLOW, #/MIN (WET) (DRY)	2,976					
INLET CONDITIONS:						
○ PRESSURE (PSIA)	625					
○ TEMPERATURE (°F)	250					
○ RELATIVE HUMIDITY (%)	-					
○ MOLECULAR WEIGHT (M)	18.5					
□ $C_p/C_v (K_1)$ OR (K_{AVG})	-					
□ COMPRESSIBILITY (Z_1) OR (Z_{AVG})	1.01					
□ INLET VOLUME, (CFM WET)	1983					
DISCHARGE CONDITIONS:						
○ PRESSURE (PSIA)	225					
□ TEMPERATURE (°F)	18°					
□ $C_p/C_v (K_2)$ OR (K_{AVG})	=					
□ COMPRESSIBILITY (Z_2) OR (Z_{AVG})	=					
□ BHP DEVELOPED (ALL LOSSES INCL)	3552 SHAFT EST.					
□ SPEED (RPM)	21,000 EST.					
□ ESTIMATED SURGE, ICFM (AT SPEED ABOVE)						
□ POLYTROPIC HEAD (FT)						
□ POLYTROPIC EFFICIENCY (%)						
○ GUARANTEE POINT						
□ PERFORMANCE CURVE NO.						

PROCESS CONTROL:

METHOD: ○ BYPASS FROM _____ TO _____

○ ANTI-SURGE BYPASS: ○ MANUAL ○ AUTO

○ SUCTION THROTTLING FROM 60% TO 120% (APPROX) OF NORMAL

○ SPEED VARIATION FROM 60% TO 120% (APPROX) OF NORMAL

○ OTHER _____

SIGNAL: ○ SOURCE _____

○ TYPE _____

○ RANGE: FOR PNEUMATIC CONTROL _____ RPM @ _____ PSIG & _____ RPM @ _____ PSIG

OTHER _____

SERVICE: ◉ CONTINUOUS ○ INTERMITTENT ○ STAND BY

REMARKS: _____

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG'R	PROJ ENGR	APP'D
1	12/19/80	ISSUED FOR PURCHASE	JHV					HNH

SCALE _____ DESIGNED _____ DRAWN _____ CHIEF ENGR _____

ORIGIN

BECHTEL

FIRST STAGE FUEL GAS TURBOEXPANDER 12K-111

JOB No. _____

DRAWING No. 12-05-K-11 REV. 0

Form 187 (5/80) Sheet 1 of 6

"A" SIZE R&C

Sheet 1 of 6

TURBOEXPANDER 12K-111

GAS ANALYSIS ○ MOL % ○ Mol %	M.W.	NORMAL	RATED	OTHER CONDITIONS A	B	C	D	REMARKS
AIR	28.966							
OXYGEN	32.000							
NITROGEN	28.016	0.38						
WATER VAPOR	18.016	—						
CARBON MONOXIDE	28.010	55.29						
CARBON DIOXIDE	44.010	4.76						
HYDROGEN SULFIDE	34.076	TR						
HYDROGEN	2.016	39.48						
METHANE	16.042	0.06						
ETHYLENE	28.052							
ETHANE	30.068							
PROPYLENE	42.078							
PROPANE	44.094							
i - BUTANE	58.120							
n - BUTANE	58.120							
i - PENTANE	72.146							
n - PENTANE	72.146							
HEXANE PLUS								
CO2		0.03						
TOTAL Mol/HR		96454						
AVG. MOL. WT.		18.5						

LOCATION:
○ INDOOR ○ HEATED ● UNDER ROOF
● OUTDOOR ● UNHEATED ○ PARTIAL SIDES
● GRADE LEVEL ○ MEZZANINE ○ _____
○ ELECTRICAL AREA CLASS GR. ____ DIV. ____
● WINTERIZATION REQD. ○ TROPICALIZATION REQD.

SITE DATA:
○ ELEVATION 400 FT. BAROMETER 14.4 PSIA
○ RANGE OF AMBIENT TEMPS.:

	DRY BULB	WET BULB
SITE RATED °F		78°F
NORMAL °F		
MAXIMUM °F	96°F	
MINIMUM °F	10°F	

UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER COAL FINES IN ATMOSPHERE
PREVAILING WIND - SW
SEISMIC - UBC ZONE 2

NOISE SPECIFICATIONS:
○ APPLICABLE TO MACHINE: OSHA . API STD
SEE SPECIFICATION (WALSH-HEALY) MFR'S STD
○ APPLICABLE TO NEIGHBORHOOD @ 3 FT. FROM SOURCE
SEE SPECIFICATION _____
ACCOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:

PAINTING:
● MANUFACTURER'S STD. SUBJECT TO APPROVAL
○ OTHERS _____

SHIPMENT:
● DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD.
○ OUTDOOR STORAGE OVER 6 MONTHS

REMARKS:

R&C Form 187 (5/80) Sheet 2 of 6

TURBOEXPANDER 12 K-111

CONSTRUCTION FEATURES

☐ **SPEEDS:**

MAX. CONT. _____ RPM TRIP _____ RPM

MAX. TIP SPEEDS: _____ FPS @ RATED SPEED

_____ FPS @ MAX. CONT. SPEED

☐ **LATERAL CRITICAL SPEEDS:**

FIRST CRITICAL _____ RPM

DAMPED _____ UNDAMPED _____

MODE SHAPE _____

SECOND CRITICAL _____ RPM

DAMPED _____ UNDAMPED _____

MODE SHAPE _____

THIRD CRITICAL _____ RPM

DAMPED _____ UNDAMPED _____

MODE SHAPE _____

FOURTH CRITICAL _____ RPM

DAMPED _____ UNDAMPED _____

MODE SHAPE _____

LATERAL CRITICAL SPEED — BASIS.

☐ DAMPED UNBALANCE RESPONSE ANALYSIS

☐ SHOP TEST

☐ OTHER TYPE ANALYSIS

☐ **TORSIONAL CRITICAL SPEEDS:**

FIRST CRITICAL _____ RPM

SECOND CRITICAL _____ RPM

THIRD CRITICAL _____ RPM

FOURTH CRITICAL _____ RPM

☐ **VIBRATION:**

ALLOWABLE TEST LEVEL _____ MILS (PEAK TO PEAK)

☐ **ROTATION, VIEWED FROM DRIVEN END:**

☐ **CASING:**

MODEL _____

CASING SPLIT _____

MATERIAL _____

THICKNESS (IN.) _____ CORR. ALLOW. (IN.) _____

MAX. WORK PRESS _____ PSIG MAX DESIGN PRESS. _____ PSIG

TEST PRESS (PSIG) HELIUM _____ HYDRO _____

MAX OPER TEMP _____ F MIN. OPER TEMP _____ F

MAX NO OF IMPELLERS FOR CASING _____

MAX CASING CAPACITY (ICFM) _____

RADIOGRAPH QUALITY ○ YES _____ ○ NO _____

CASING SPLIT SEALING _____

☐ **DIAPHRAGMS:**

MATERIAL _____

NO _____ DIAMETERS _____

NO VANES EA. _____

TYPE (OPEN, ENCLOSED, ETC.) _____

TYPE FABRICATION _____

MATERIAL _____

MAX. YIELD STRENGTH (PSI) _____

BRINNEL HARDNESS. MAX. _____ MIN. _____

SMALLEST TIP INTERNAL WIDTH (IN.) _____

MAX. MACH NO. @ IMPELLER EYE _____

MAX. IMPELLER HEAD @ RATED SPEED (FT.) _____

☐ **SHAFT:**

MATERIAL _____

DIA. @ IMPELLERS (IN.) _____ DIA. @ COUPLING (IN.) _____

SHAFT END: ☐ TAPERED ☐ CYLINDRICAL

MAX. YIELD STRENGTH (PSI) _____

☐ **[redacted]:**

MATERIAL _____ AREA _____ (IN.²)

FIXATION METHOD _____

SHAFT SLEEVES:

○ AT INTERSTG. CLOSE CLEAR. PTS. ☐ MATL _____

○ AT SHAFT SEALS _____ ☐ MATL _____

☐ **LABYRINTHS:**

INTERSTAGE

TYPE _____ MATERIAL _____

BALANCE PISTON

TYPE _____ MATERIAL _____

SHAFT SEALS:

☐ TYPE _____

○ SEAL SYSTEM TYPE _____

○ SETTLING OUT PRESSURE _____

☐ INNER OIL LEAKAGE GUAR. (GAL/DAY/SEAL) _____

○ TYPE BUFFER GAS _____

☐ BUFFER GAS FLOW (PER SEAL). _____

NORMAL. _____ #/MIN @ _____ PSI Δ P _____

MAX.. _____ #/MIN @ _____ PSI Δ P _____

○ BUFFER GAS REQUIRED FOR:

☐ START-UP

☐ AIR RUN-IN

☐ OTHER _____

☐ BUFFER GAS CONTROL SYSTEM SUPPLIED BY _____

☐ **BEARING HOUSING CONSTRUCTION:**

TYPE (SEPARATE, INTEGRAL) _____ SPLIT _____

MATERIAL _____

REMARKS: _____

TURBO EXPANDER 12K-111

CONSTRUCTION FEATURES. CONT'D

☐ **RADIAL BEARINGS:**

TYPE _____ SPAN (IN.) _____

AREA (IN.²) _____ LOADING (PSI) ACT _____ ALLOW _____

CENTER PIVOT _____

OFFSET PIVOT _____

" _____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

☐ **THRUST BEARING:**

LOCATION _____ TYPE _____

MFR _____ AREA (IN.²) _____

LOADING (PSI) ACTUAL _____ ALLOWABLE _____

GAS LOADING (LB) _____ CPLG SLIP LOAD (LB) _____

CPLG COEFF FRICT _____ CPLG GEAR PITCH DIA (IN.) _____

BAL PISTON COMPENSATING LOAD _____ LB

CENTER PIVOT _____

OFFSET PIVOT _____

" _____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

☐ **MAIN CONNECTIONS:**

	SIZE	ANSI RATING	FACING	POSITION	FLANGE VEL. FPS
INLET					
DISCHARGE					

☐ **OTHER CONNECTIONS:**

SERVICE	NO	SIZE	TYPE
LUBE-OIL INLET			
LUBE-OIL OUTLET			
SEAL-OIL INLET			
SEAL-OIL OUTLET			
CASING DRAINS			
STAGE DRAINS			
VENTS			
COOLING WATER			
PRESSURE			
TEMPERATURE			
PURGE FOR			
BRG HOUSING			
BETWEEN BRG & SEAL			
BETWEEN SEAL & GAS			
SOLVENT INJECTION			

☐ **ALLOWABLE PIPING FORCES AND MOMENTS:**

	INLET		DISCHARGE			
	FORCE LB	MOMT FT. LB.	FORCE LB	MOMT FT. LB.	FORCE LB	MOMT FT. LB
AXIAL						
VERTICAL						
HORIZ. 90°						
	FORCE LB	MOMT FT. LB.	FORCE LB	MOMT FT. LB.	FORCE LB	MOMT FT. LB.
AXIAL						
VERTICAL						
HORIZ. 90°						

INSTRUMENTATION

PANEL SUPPLIED BY _____

	INDICATOR	ALARM	SHUTDOWN
HIGH GAS DISCHARGE TEMPERATURE (EACH SECTION)	●	○	○
REFERENCE GAS PRESSURE	●	○	○
BALANCE DRUM DIFFERENTIAL PRESSURE	○	○	○
BUFFER GAS DIFFERENTIAL PRESSURE	○	○	○
IMBEDDED TEMPERATURE SENSORS			
RADIAL BEARINGS	●	●	●
TYPE _____			
NO. PER BRG. _____			
LOCATION _____			
THRUST BEARINGS	●	●	●
TYPE _____			
NO. PER BRG. _____			
LOCATION _____			

PHASE ANGLE TRANSDUCER NUMBER _____ LOCATION _____

VIBRATION DETECTORS:

☒ TYPE PROXIMITY ☐ MODEL _____

☒ MFR BENTLEY-NEVADA OR EQUAL

☒ NO AT EACH SHAFT BEARING 2 TOTAL NO _____

☒ OSCILLATOR-DETECTORS SUPPLIED BY TURBOEXPANDER VENDOR

☒ MFR BENTLEY-NEVADA ☐ MODEL _____

☒ MONITOR SUPPLIED BY TURBOEXPANDER VENDOR

☒ LOCATION PANEL ENCLOSURE _____

☒ MFR. BENTLEY-NEVADA OR EQUAL ☐ MODEL _____

☐ SCALE RANGE ___ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ___ SEC

AXIAL POSITION DETECTOR:

☒ TYPE PROXIMITY ☐ MODEL _____

☒ MFR BENTLEY-NEVADA ○ NO REQUIRED _____

☒ OSCILLATOR-DEMODULATOR SUPPLIED BY TURBOEXPANDER VENDOR OR EQUAL

☒ MFR BENTLEY-NEVADA ☐ MODEL _____

☒ MONITOR SUPPLIED BY TURBOEXPANDER

☒ LOCATION PANEL ENCLOSURE _____

☒ MFR BENTLEY-NEV. ☐ MODEL _____

☐ SCALE RANGE ___ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN: ☐ SET @ ___ MILS ○ TIME DELAY ___ SEC.

TURBO EXPANDER 12K-111

CONSTRUCTION FEATURES, CONT'D

COUPLINGS:

	DRIVER-GEN OR DRIVE-GEAR	GEAR-GEN.
☒ MAKE	BENDIX	BENDIX
☐ MODEL		
☒ LUBRICATION	DRY	DRY
☒ MOUNT CPLG. HALVES	TURBOEXPANDER	VENDOR
○ SPACER REQD		
○ LIMITED END FLOAT REQD.		
○ IDLING ADAPTOR REQD		
☐ CPLG. RATING (HP/100 RPM)		
☐ KEYED (1) OR (2); OR HYDR FIT		

SHOP INSPECTION AND TESTS:

	REQD	WITNESS	OBSERVED
SHOP INSPECTION	☒	○	☒
HYDROSTATIC	○	○	○
HELIUM LEAK	☒	○	☒
MECHANICAL RUN	☒	☒	○
MECH RUN SPARE ROTOR	☒	☒	○
FIT IN SPARE ROTOR	○	○	○
PERFORMANCE TEST (GAS) (AIR)	☒	☒	○
WITH DRIVER	☒	☒	○
LESS DRIVER	○	○	○
USE SHOP LUBE & SEAL SYS	○	○	○
USE JOB LUBE & SEAL SYS	☒	○	○
USE SHOP VIBRATION PROBES, ETC	○	○	○
USE JOB VIB & AXIAL DISP PROBES OSCILLATOR-DETECTORS & MONITOR	☒	☒	○
PRESSURE COMP TO FULL OPER PRESS	☒	○	☒
DISASSEMBLE-REASSEMBLE EXPANDER AFTER TEST	☒	○	☒
CHECK BAGS & SEALS AFTER TEST	☒	○	☒
NOISE LEVEL TEST	☒	○	☒
RESIDUAL ELECTRICAL MECH. RUNOUT	○	○	○
RANGE FLOW FROM 60% TO 120% OF NOMINAL	☒	☒	○

BASEPLATE & SOLEPLATES:

SOLEPLATES FOR. ○ ○ GEAR ○ DRIVE

BASEPLATE. EXPANDER GENERATOR

☒ COMMON (UNDER ~~COMP~~. GEAR & DRIVER)

○ UNDER ONLY ○ OTHER _____

○ DECKED WITH NON-SKID DECK PLATE ○ OPEN CONSTR

○ DRIP RIM ○ WITH OPEN DRAIN

○ HORIZ. ADJUSTING SCREWS FOR EQUIPMENT

○ SUITABLE FOR POINT SUPPORT

○ SUITABLE FOR PERIMETER SUPPORT

○ STAINLESS SHIMS THICKNESS _____

☐ GROUTING TYPE _____

☐ **WEIGHTS (LB):**

COMPR _____ GEAR _____ DRIVER _____ BASE _____

ROTORS. COMPR. _____ DRIVER _____ GEAR _____

COMPR UPPER CASE _____

L.O. CONSOLE _____ S.O. CONSOLE _____

MAX. FOR MAINTENANCE (IDENTIFY) _____

TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS (FT & IN.):**

	L	W	H
COMPLETE UNIT	14'	8'	
L.O. CONSOLE			
S.O. CONSOLE.			

MISCELLANEOUS:

☐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION _____

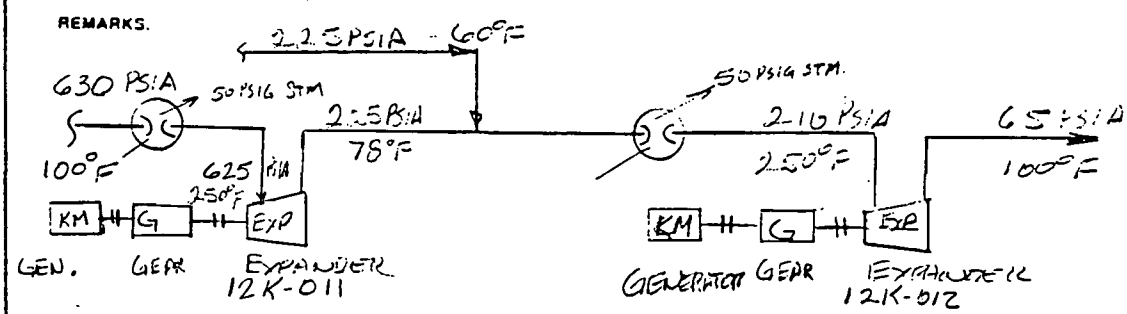
○ VENDOR'S REVIEW & COMMENTS ON PURCHASER'S PIPING & FOUNDATION

○ OPTICAL ALIGNMENT FLATS REQUIRED ON GEAR & DRIVE

○ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY _____

☒ TORSIONAL ANALYSIS REPORT REQUIRED

REMARKS.



TURBOEXPANDER 12K 111

UTILITIES

UTILITY CONDITIONS:

STEAM	DRIVERS		HEATING	
INLET MIN	____ PSIG	____ F	50 PSIG	SAT. F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F
EXHAUST MIN	____ PSIG	____ F	____ PSIG	____ F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F

ELECTRICITY:

	DRIVE S	HEATING	CONTROL	SHUTDOWN
VOLTAGE 4160	460V	____	120V	120V
HERTZ 60	60	____	60	60
PHASE 3	3	____	1	1

COOLING WATER:

TEMP INLET 85 F — MAX RETURN 115 F

PRESS NORM 50 PSIG — DESIGN 25 PSIG

MIN RETURN 35 PSIG — MAX ALLOW ΔP 15 PSI

WATER SOURCE ____

INSTRUMENT AIR:

MAX PRESS 115 PSIG — MIN PRESS — PSIG

☐ TOTAL UTILITY CONSUMPTION:

COOLING WATER ____ GPM

STEAM, NORMAL ____ #/HR

STEAM, MAX ____ #/HR

INSTRUMENT AIR ____ SCFM

HP (DRIVE) ____ HP

HP (AUXILIARIES) ____ HP

REMARKS:

GENERATOR

4000 HP, 3600 RPM

4000V/3 Ø/60 HZ.

TEMAC INDUCTION GENERATOR

R&C Form 187 (5/80) Sheet 6 of 6

Data Sheet NO. 12-USK-11 REV. 0 SHEET 6 OF 6

ONLY ONE REQUIRED

APPLICABLE TO ◯ PROPOSAL ◯ PURCHASE ◯ AS BUILT DATE _____ REVISION –
FOR FUEL GAS PIPELINE UNIT
SITE EMIRATE OF ABU DHABI SERIAL NO.
SERVICE SECOND STAGE FUEL GAS TURBOEXPANDER NO. REQUIRED 1
MANUFACTURER ROTOFLOW MODEL DRIVER
NOTE ◯ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ☐ BY MANUFACTURER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

	NORMAL	RATED	OTHER CONDITIONS A	B	C	D
◯ GAS HANDLED (ALSO SEE PAGE ____)	FUEL GAS					
◯ ~~LB~~/SCFM (14.7 PSIA & 60°F DRY)	68315					
◯ WEIGHT FLOW, #/MIN (WET) (DRY)	3561					
INLET CONDITIONS:						
◯ PRESSURE (PSIA)	210					
◯ TEMPERATURE (°F)	250					
◯ RELATIVE HUMIDITY (%)	–					
◯ MOLECULAR WEIGHT (M)	19.2					
☐ $C_p/C_v(K_1)$ OR (K_{Avg})	–					
☐ COMPRESSIBILITY (Z_1) OR (Z_{Avg})	1.0					
☐ INLET VOLUME, (CFM WET)	6546					
DISCHARGE CONDITIONS:						
◯ PRESSURE (PSIA)	65					
☐ TEMPERATURE (°F)	100					
☐ $C_p/C_v(K_2)$ OR (K_{Avg})						
☐ COMPRESSIBILITY (Z_2) OR (Z_{Avg})	1.0					
☐ ~~BHP REQUIRED (ALL LOSSES INCL)~~ DEVELOPED SHAFT EST.	3760					
☐ SPEED (RPM) EST.	21000					
☐ ESTIMATED SURGE, ICFM (AT SPEED ABOVE)	–					
☐ POLYTROPIC HEAD (FT)	–					
☐ POLYTROPIC EFFICIENCY (%)	–					
◯ GUARANTEE POINT	–					
☐ PERFORMANCE CURVE NO.	–					

PROCESS CONTROL:

METHOD: ◯ BYPASS FROM _____ TO _____
◯ ANTI-SURGE BYPASS: ◯ MANUAL ◯ AUTO
◯ SUCTION THROTTLING FROM 60% TO 120% (APPROX.) OF NORMAL
◯ SPEED VARIATION FROM 60% TO 120% (APPROX.) OF NORMAL
◯ OTHER _____

SIGNAL: ◯ SOURCE _____
◯ TYPE _____
◯ RANGE: FOR PNEUMATIC CONTROL _____ RPM @ _____ PSIG @ _____ RPM @ _____ PSIG _____
OTHER _____

SERVICE: ◉ CONTINUOUS ◯ INTERMITTENT ◯ STAND BY

REMARKS: _____

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG'D	PROJ ENGR	APPR
A	12/15/80	ISSUED FOR PHASE 0	JMV					HWH

SCALE _____ DESIGNED _____ DRAWN _____ CHIEF ENGR _____

ORIGIN

SECOND STAGE FUEL GAS TURBO EXPANDER 12K-112

JOB No.

DRAWING No. 12DS-K-12 REV. 0

"A" SIZE REC Form 187 (5/80) Sheet 1 of 6

TURBO EXPANDER 12K-112

GAS ANALYSIS ○ MOL % ○ Mol %	M.W.	NORMAL	RATED	OTHER CONDITIONS A	B	C	D	REMARKS
AIR	28.966							
OXYGEN	32.000							
NITROGEN	28.016	0.36						
WATER VAPOR	18.015	TR						
CARBON MONOXIDE	28.010	49.36						
CARBON DIOXIDE	44.010	11.41						
HYDROGEN SULFIDE	34.075	TR						
HYDROGEN	2.016	38.76						
METHANE	16.042	0.05						
ETHYLENE	28.052							
ETHANE	30.068							
PROPYLENE	42.078							
PROPANE	44.094							
i - BUTANE	58.120							
n - BUTANE	58.120							
i - PENTANE	72.146							
n - PENTANE	72.146							
HEXANE PLUS								
COS		0.02						
TOTAL LB MOL/HR		10035.3						
AVG. MOL. WT.		18.95						

LOCATION:
○ INDOOR ○ HEATED ● UNDER ROOF
○ OUTDOOR ● UNHEATED ○ PARTIAL SIDES
● GRADE LEVEL ○ MEZZANINE ○ _____
○ ELECTRICAL AREA CLASS GR. ____ DIV. ____
● WINTERIZATION REQD. ○ TROPICALIZATION REQD.

SITE DATA:
○ ELEVATION 400 FT. BAROMETER 14.4 PSIA
○ RANGE OF AMBIENT TEMPS.:

	DRY BULB	WET BULB
SITE RATED °F		78°F
NORMAL °F		
MAXIMUM °F	96 °F	
MINIMUM °F	-10°F	

UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER COAL FINES IN ATMOSPHERE
PREVAILING WIND - S.W.
SEISMIC - UBC ZONE 2

NOISE SPECIFICATIONS:
○ APPLICABLE TO MACHINE: OSHA - A01 STD
SEE SPECIFICATION (WALSH-HEALY) MEASURED @ 3 FT FROM SOURCE
○ APPLICABLE TO NEIGHBORHOOD
SEE SPECIFICATION _____
ACCOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:

PAINTING:
● MANUFACTURER'S STD. SUBJECT TO APPROVAL
○ OTHERS _____

SHIPMENT:
● DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD.
○ OUTDOOR STORAGE OVER 6 MONTHS

REMARKS:

REC Form 187 (5/80) Sheet 2 of 6

TURBO EXPANDER 12K-1/2

CONSTRUCTION FEATURES

☐ SPEEDS:
MAX CONT _____ RPM TRIP _____ RPM
MAX TIP SPEEDS. _____ FPS @ RATED SPEED
_____ FPS @ MAX. CONT SPEED

☐ LATERAL CRITICAL SPEEDS:
FIRST CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
SECOND CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
THIRD CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
FOURTH CRITICAL _____ RPM
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
LATERAL CRITICAL SPEED — BASIS
☐ DAMPED UNBALANCE RESPONSE ANALYSIS
☐ SHOP TEST
☐ OTHER TYPE ANALYSIS

☐ TORSIONAL CRITICAL SPEEDS:
FIRST CRITICAL _____ RPM
SECOND CRITICAL _____ RPM
THIRD CRITICAL _____ RPM
FOURTH CRITICAL _____ RPM

☐ VIBRATION:
ALLOWABLE TEST LEVEL _____ MILS
(PEAK TO PEAK)

☐ ROTATION, VIEWED FROM DRIVEN END:

☐ CASING:
MODEL _____
CASING SPLIT _____
MATERIAL _____
THICKNESS (IN.) _____ CORR. ALLOW. (IN.) _____
MAX WORK PRESS _____ PSIG MAX DESIGN PRESS. _____ PSIG
TEST PRESS (PSIG) HELIUM _____ HYDRO _____
MAX OPER TEMP _____ F MIN. OPER TEMP _____ F
MAX NO OF IMPELLERS FOR CASING _____
MAX CASING CAPACITY (ICFM) _____
RADIOGRAPH QUALITY ○ YES _____ ○ NO _____
CASING SPLIT SEALING _____

☐ DIAPHRAGMS:
MATERIAL _____
☐ :
NO _____ DIAMETERS _____
NO VANES EA. _____

TYPE (OPEN, ENCLOSED, ETC.) _____
TYPE FABRICATION _____
MATERIAL _____
MAX. YIELD STRENGTH (PSI) _____
BRINNEL HARDNESS. MAX. _____ MIN. _____
SMALLEST TIP INTERNAL WIDTH (IN.) _____
MAX. MACH NO. @ IMPELLER EYE _____
MAX. IMPELLER HEAD @ RATED SPEED (FT.) _____

☐ SHAFT:
MATERIAL _____
DIA. @ IMPELLERS (IN.) _____ DIA. @ COUPLING (IN.) _____
SHAFT END: ☐ TAPERED ☐ CYLINDRICAL
MAX. YIELD STRENGTH (PSI) _____

☐ BALANCE PISTON:
MATERIAL _____ AREA _____ (IN.²)
FIXATION METHOD _____

SHAFT SLEEVES:
○ AT INTERSTG. CLOSE CLEAR. PTS. ☐ MATL _____
○ AT SHAFT SEALS _____ ☐ MATL _____

☐ LABYRINTHS:
INTERSTAGE
TYPE _____ MATERIAL _____
BALANCE PISTON
TYPE _____ MATERIAL _____

SHAFT SEALS:
☐ TYPE _____
○ SEAL SYSTEM TYPE _____
○ SETTLING OUT PRESSURE _____
☐ INNER OIL LEAKAGE GUAR. (GAL/DAY/SEAL) _____
○ TYPE BUFFER GAS _____
☐ BUFFER GAS FLOW (PER SEAL). _____
NORMAL _____ #/MIN @ _____ PSI Δ P _____
MAX. _____ #/MIN @ _____ PSI Δ P _____
○ BUFFER GAS REQUIRED FOR:
☐ START-UP
☐ AIR RUN-IN
☐ OTHER _____
☐ BUFFER GAS CONTROL
SYSTEM SUPPLIED BY _____

☐ BEARING HOUSING CONSTRUCTION:
TYPE (SEPARATE, INTEGRAL) _____ SPLIT _____
MATERIAL _____

REMARKS: _____

RSC Form 187 (5/80) Sheet 3 of 6

Data Sheet No. 12 K-12 Rev. 0 Sheet 3 of 6

TURBOEXPANDER 12K-112

CONSTRUCTION FEATURES, CONT'D

☐ RADIAL BEARINGS:

TYPE _____ SPAN (IN.) _____

AREA (IN.²) _____ LOADING (PSI): ACT _____ ALLOW _____

CENTER PIVOT _____

OFFSET PIVOT _____

" _____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

☐ THRUST BEARING:

LOCATION _____ TYPE _____

MFR _____ AREA (IN.²) _____

LOADING (PSI): ACTUAL _____ ALLOWABLE _____

GAS LOADING (LB) _____ CPLG SLIP LOAD (LB) _____

CPLG COEFF FRICT _____ CPLG GEAR PITCH DIA (IN.) _____

BAL PISTON COMPENSATING LOAD _____ LB

CENTER PIVOT _____

OFFSET PIVOT _____

" _____

PAD MATERIAL _____

TYPE BABBITT _____

BABBITT THICKNESS _____

☐ MAIN CONNECTIONS:

	SIZE	ANSI RATING	FACING	POSITION	FLANGE VEL. FPS
INLET					
DISCHARGE					

☐ OTHER CONNECTIONS:

SERVICE	NO	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
SEAL OIL INLET			
SEAL OIL OUTLET			
CASING DRAINS			
STAGE DRAINS			
VENTS			
COOLING WATER			
PRESSURE			
TEMPERATURE			
PURGE FOR			
BRG HOUSING			
BETWEEN BRG & SEAL			
BETWEEN SEAL & GAS			
SOLVENT INJECTION			

☐ ALLOWABLE PIPING FORCES AND MOMENTS:

	INLET		DISCHARGE			
	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT. LB
AXIAL						
VERTICAL						
HORIZ. 90°						
	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT LB	FORCE LB	MOMT FT. LB
AXIAL						
VERTICAL						
HORIZ 90°						

INSTRUMENTATION

PANEL SUPPLIED BY _____

	INDICATOR	ALARM	SHUTDOWN
HIGH GAS DISCHARGE TEMPERATURE (EACH SECTION)	●	○	○
REFERENCE GAS PRESSURE	●	○	○
BALANCE DRUM DIFFERENTIAL PRESSURE	○	○	○
BUFFER GAS DIFFERENTIAL PRESSURE	○	○	○
IMBEDDED TEMPERATURE SENSORS			
RADIAL BEARINGS TYPE _____ NO. PER BRG. _____ LOCATION _____	●	●	●
THRUST BEARINGS TYPE _____ NO. PER BRG. _____ LOCATION _____	●	●	●

PHASE ANGLE TRANSDUCER NUMBER _____ LOCATION _____

VIBRATION DETECTORS:

● TYPE PROXIMITY ☐ MODEL _____

● MFR BENTLEY-NEVADA OR EQUAL

● NO AT EACH SHAFT BEARING 2 TOTAL NO _____

● OSCILLATOR-DETECTORS SUPPLIED BY TURBOEXPANDER VENDOR

● MFR BENTLEY-NEVADA ☐ MODEL _____

● MONITOR SUPPLIED BY TURBOEXPANDER VENDOR

● LOCATION PANEL ENCLOSURE _____

● MFR. _____ ☐ MODEL _____

☐ SCALE RANGE ____ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ____ MILS ○ TIME DELAY ____ SEC

AXIAL POSITION DETECTOR:

⊗ TYPE PROXIMITY ☐ MODEL _____

⊗ MFR BENTLEY-NEVADA ○ NO REQUIRED

⊗ OSCILLATOR-DEMODULATOR SUPPLIED BY TURBOEXPANDER VENDOR

⊗ MFR BENTLEY-NEVADA OR EQUAL ☐ MODEL _____

⊗ MONITOR SUPPLIED BY TURBO EXPANDER

⊗ LOCATION PANEL ENCLOSURE _____

⊗ MFR BENTLEY NEV. ☐ MODEL _____

☐ SCALE RANGE ____ ○ ALARM ☐ SET @ _____ MILS

○ SHUTDOWN ☐ SET @ ____ MILS ○ TIME DELAY ____ SEC

TURBO EXPANDER 12K-112

CONSTRUCTION FEATURES, CONT'D

COUPLINGS:

	DRIVEN (GEN) OR DRIVE GEAR	GEAR - GEN
○ MAKE	BENDIX	BENDIX
☐ MODEL		
○ LUBRICATION	DRY	DRY
○ MOUNT CPLG. HALVES	TURBINE SHAFT	VENDOR
○ SPACER REQD		
○ LIMITED END FLOAT REQD.		
○ IDLING ADAPTOR REQD.		
☐ CPLG. RATING (HP/100 RPM)		
☐ KEYED (1) OR (2); OR HYDR. FIT		

SHOP INSPECTION AND TESTS:

	REQD	WITNESS	OBSERVED
SHOP INSPECTION	X	○	X
HYDROSTATIC	○	○	○
HELIUM LEAK	X	○	X
MECHANICAL RUN	X	X	○
MECH. RUN SPARE ROTOR	X	X	○
FIT IN SPARE ROTOR	○	○	○
PERFORMANCE TEST (GAS) (AIR)	X	X	○
WITH DRIVER	X	X	○
LESS DRIVER	○	○	○
USE SHOP LUBE & SEAL SYS	○	○	○
USE JOB LUBE & SEAL SYS	X	○	○
USE SHOP VIBRATION PROBES, ETC	○	○	○
USE JOB VIB. & AXIAL DISP. PROBES, OSCILLATOR-DETECTORS & MONITOR	X	X	○
PRESSURE COMP. TO FULL OPER. PRESS	X	○	X
DISASSEMBLE-REASSEMBLE COMP. EXPANDER AFTER TEST	X	○	X
CHECK BHGS & SEALS AFTER TEST	X	○	X
NOISE LEVEL TEST	X	○	X
RESIDUAL ELECTRICAL/MECH. RUNOUT	○	○	○
RANGE FLOW FROM 60% TO 120% OF NOMINAL	X	X	○

BASEPLATE & SOLEPLATES:

SOLEPLATES FOR: ○ ○ GEAR ○ DRIVE

BASEPLATE. EXPANDER

☒ COMMON (UNDER COMP., GEAR & DRIVE N GENERATOR)

○ UNDER ONLY ○ OTHER _____

○ DECKED WITH NON-SKID DECK PLATE ○ OPEN CONSTR.

○ DRIP RIM ○ WITH OPEN DRAIN

○ HORIZ. ADJUSTING SCREWS FOR EQUIPMENT

○ SUITABLE FOR POINT SUPPORT

○ SUITABLE FOR PERIMETER SUPPORT

○ STAINLESS SHIMS THICKNESS _____

☐ GROUTING TYPE _____

☐ WEIGHTS (LB):

COMPR. _____ GEAR _____ DRIVER _____ BASE _____

ROTORS, COMPR. _____ DRIVER _____ GEAR _____

COMPR. UPPER CASE _____

L.O. CONSOLE _____ S.O. CONSOLE _____

MAX. FOR MAINTENANCE (IDENTIFY) _____

TOTAL SHIPPING WEIGHT _____

☐ SPACE REQUIREMENTS (FT & IN.):

	L	W	H
COMPLETE UNIT	14'	8'	
L.O. CONSOLE			
S.O. CONSOLE			

MISCELLANEOUS:

☐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION _____

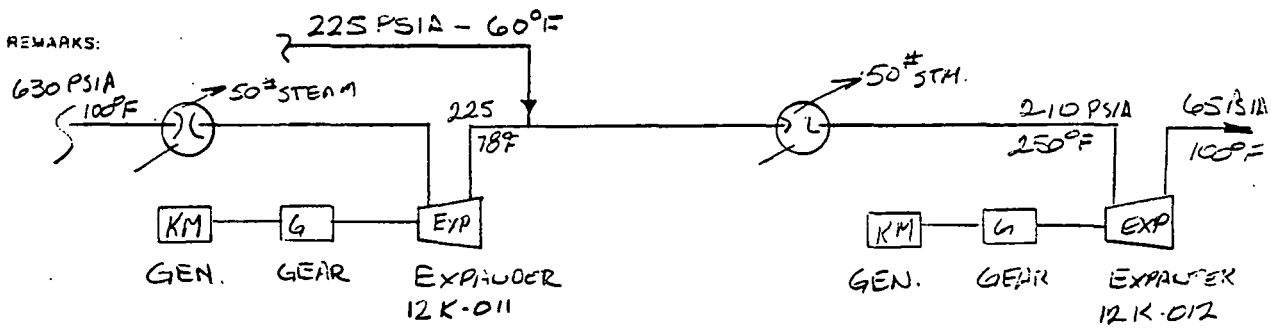
○ VENDOR'S REVIEW & COMMENTS ON PURCHASER'S PIPING & FOUNDATION

○ OPTICAL ALIGNMENT FLATS REQUIRED ON GEAR & DRIVE

○ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY _____

☒ TORSIONAL ANALYSIS REPORT REQUIRED

REMARKS:



TURBO EXPANDER 12K-012

UTILITIES

UTILITY CONDITIONS:

STEAM	DRIVERS		HEATING	
INLET MIN	____ PSIG	____ F	50 PSIG	SAT F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F
EXHAUST MIN	____ PSIG	____ F	____ PSIG	____ F
NORM	____ PSIG	____ F	____ PSIG	____ F
MAX	____ PSIG	____ F	____ PSIG	____ F

ELECTRICITY:

	DRIVE S	HEATING	CONTROL	SHUTDOWN
VOLTAGE 4160	460V	____	120	120
HERTZ 60	60	____	60	60
PHASE 3	3	____	1	1

COOLING WATER:

TEMP INLET 85 F — MAX RETURN 115 F

PRESS NORM 50 PSIG — DESIGN 75 PSIG

MIN RETURN 35 PSIG — MAX ALLOW ΔP 15 PSI

WATER SOURCE ____

INSTRUMENT AIR:

MAX PRESS 115 PSIG — MIN PRESS ____ PSIG

☐ **TOTAL UTILITY CONSUMPTION:**

COOLING WATER	____ GPM
STEAM, NORMAL	____ #/HR
STEAM, MAX	____ #/HR
INSTRUMENT AIR	____ SCFM
HP (DRIVE-)	____ HP
HP (AUXILIARIES)	____ HP

REMARKS:

GENERATOR

4000 HP, 3600 RPM

4000 V/3Φ/60 HZ

TEWAC IND. GENERATOR

R&C Form 187 (5/80) Sheet 6 of 6

Data Sheet NO. 12-DS-K-12 REV. 0 SHEET 6 OF 6

APPLICABLE TO. ● PROPOSALS ○ PURCHASE ○ AS BUILT EQUIPMENT NO.

FOR [illegible] PURIFICATION) PLANT 12 PURCH/MR NO.

SITE [illegible] UNIT 12K114, 12K214-12K314-12K414-12K514

SERVICE HYDROGEN COMPRESSOR NO. REQD. (5) FIVE

NOTE: ● INDICATES INFORMATION TO BE COMPLETED BY PURCHASER ■ BY MANUFACTURER

■ GENERAL

MANUFACTURER WORTHINGTON SERIAL NO.

TYPE RPM: MAX. 300

COMPRESSOR THROWS: NO. FURNISHED 5 MAX. NO. POSSIBLE 10 MAX. FRAME HP: — @ MAX. RPM — @ RATED RPM

DRIVER TYPE DRIVER RATED HP 15,000 RPM 300 DRIVER FURN. BY ● COMPR. MFR. ○

SERVICE/ITEM NO.	A	B				
STAGE	1	2				
GAS COMPRESSED	H_2	H_2				
CORROSIVE DUE TO	—	—				
RELATIVE HUMIDITY						
MOL. WGT., AT INTAKE	3.03	3.03				
C_p/C_v VALUE AT SUCTION	1.4	1.4				
C_p/C_v VALVES AT DISCHARGE						
INLET TEMP. °F.	28	105				
INLET PRESSURE, PSIA	550	1275				
MIN. ΔP BETWEEN STGS. PSI	350	2010				
ACTUAL DISCH. TEMP. °F. △	227	△ 300				
DISCHARGE PRESS. PSIA	500	3480				
Z @ SUCTION	1.02	1.06				
Z @ DISCHARGE	1.06	1.12				
EXPECTED (CAPACITY TOLERANCE ±3%, BHP TOLERANCE ±3%)						
LBS/HR. WET	45508	45508				
INLET CFM (CORRECTED)	2440	1065				
SCFM (14.7 & 60)	91,995	91,915				
BRAKE HORSEPOWER/STAGE	8058	7887				
TOTAL BHP	←	15946	→			
** RATED PER API (CAPACITY TOLERANCE -0%; BHP TOLERANCE +0%)						
LBS/HR. WET						
INLET CFM (CORRECTED)						
MMSCFD/SDFM (14.7 & 60)						
BRAKE HORSEPOWER / STAGE						
TOTAL BHP (W/GEAR LOSS INCLUDED)						
TOTAL HP REQUIRED BY DRIVER (W/GEAR LOSS INCLUDED)						

API RECIP. COMPR. SPEC. 618

○
○
○

ACCESSORIES

COMP. MFR. SHALL FURNISH

● PULSATION (DAMPERS) (VOLUME BOTTLES) FOR EACH CYLINDER
● INTERSTAGE PIPING & RELIEF VALVES
● INTER COOLERS
● SEPARATE MOISTURE SEPARATORS W/TRAPS ○ AFTER COOLERS
● COOLING WATER PIPING, SINGLE INLET - OUTLET MANIFOLD ○ W/ VALVES
● INSTRUMENT PANEL
● VENDOR ANALOG STUDY REQUIRED

■ WEIGHTS AND DIMENSIONS

MAX. ERECTION WEIGHT, LBS. 210,000 ±
MAX. MAINTENANCE WEIGHT, LBS. [illegible] ±
TOTAL WT., LESS DRIVER & GEAR, LBS. 210,000 ±
APPROX. FLOOR SPACE L 45' W 35' H 12'
ROD REMOVAL DISTANCE 6
INTER-COOLER BUNDLE REMOVAL - [illegible]

REMARKS: MOTOR WT. - APPROX. - 120,000#

ESTIMATED PRICE COMPLETE WITH 18000 HP MOTOR
PULSATION DAMPERS, GAS INTERCOOLERS, INTERSTAGE, GAS PIPING.

*S = SUCTION VALVE UNLOADERS H = HEAD END C = CRANK END F = FIXED POCKET OPEN V = VARIABLE POCKET OPEN
**SEE A.P.I. PAR. 55 (NO NEGATIVE TOLERANCE, ETC.)

NO.	DATE	REVISIONS	CHK'D.	DESIGN SUPV.	PROJ. ENGR.	BY	APPR
△							
△							
1	1-23-81	REVISED FOR PHASE ZERO			JBC		HNH
0	11-13-80	ISSUED FOR PHASE ZERO			JBC		

BECHTEL

RECIPROCATING COMPRESSOR DATA SHEET

JOB NO. 14222
DATA SHEET NO. 12-DS-K-14
REV. 1

B&C FORM 268 (10/80) SHEET 1 OF 8

RECIPROCATING COMPRESSOR DATA SHEET

CAPACITY CONTROL

TO PERMIT OPERATION					
AT AN INLET CFM OF					
POCKETS/VALVES OPEN*					
INLET PRESSURE PSIA					
DISCHARGE PRES. PSIA					
ACTUAL DISCH. TEMP. °F					
BRAKE HORSEPOWER/STAGE					
TOTAL BRAKE HORSEPOWER					
TO PERMIT OPERATION					
AT AN INLET CFM OF					
POCKETS/VALVES OPEN*					
INLET PRESSURE PSIA					
DISCHARGE PRES. PSIA					
ACTUAL DISCH. TEMP. °F					
BRAKE HORSEPOWER/STAGE					
TOTAL BRAKE HORSEPOWER					

CAPACITY CONTROL SHALL BE BY:
- ○ VARIABLE SPEED TO _____ % RATED
- ○ PURCHASERS BY-PASS
- ● MFR. STANDARD AUTOMATIC CONTROL
  - ● START/STOP ○ (2)(3)(4) STEP
  - ○ PILOTED BY REC. PRESS.
  - ○ PILOTED BY PURCH. INSTR. W/ _____ PSIG AIR SIGNAL
- ○ CLEARANCE POCKETS, _____ CYL.
  - ○ FIXED ○ VARIABLE
  - ○ MANUAL ○ MANUAL PNEU. ○ AUTO.
- ● SUCT. VALVE UNLOADERS, 54 CYL.
  - TYPE: ● PLUG ○ FINGER ○ _____
  - ○ MANUAL ○ MANUAL PNEU. ● AUTO.
- ON AIR/POWER FAILURE COMPRESSOR SHALL ● UNLOAD ○ LOAD

GAS ANALYSIS ○ MOL % ● VOL %	M.W.	RATED OPERATING CONDITIONS						REMARKS
AIR + AR	28.966	0.4						
OXYGEN	32.000							
NITROGEN	28.016	1.1						
WATER VAPOR	18.016							
CARBON MONOXIDE	28.010	1.7						
CARBON DIOXIDE	44.010	0.1						
HYDROGEN SULFIDE	34.076							
HYDROGEN	2.016	96.1						
METHANE	16.042	0.6						
ETHYLENE	28.052							
ETHANE	30.068							
PROPYLENE	42.078							
PROPANE	44.094							
i-BUTANE	58.120							
n-BUTANE	58.120							
i-PENTANE	72.146							
n-PENTANE	72.146							
HEXANE PLUS								
TOTAL		100						
AVG. MOL. WT.		3.03						

SKETCH: PRESENT DESIGN FOR FOUR (4) OPERATING + ONE (1) SPARE TRAINS - TOTAL GAS VOLUME IS 60077 LB MOL/HR

DATA SHEET NO. 12-DS-K-14 REV. 1 SHEET 2 OF 6

RECIPROCATING COMPRESSOR DATA SHEET

○ SITE DATA

ALTITUDE 420 FT. FT. BAROMETER _____ PSIA
DESIGN TEMP. °F 96°F DB / 78°F WB SUMMER -10°F WINTER MIN.
DESIGN WET BULB TEMP. °F 78° F
◉ WINTERIZATION REQD. ○ TROPICALIZATION REQD.
UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER _____

EQUIPMENT SHALL BE SUITABLE FOR:
○ INDOORS ○ HEATED ● UNHEATED
● OUTDOORS ● UNDER ROOF ○ WITHOUT ROOF
ELECTRICAL EQUIPMENT HAZARD CLASS ___ GR. ___ DIV. _____

COOLING WATER FOR COMP. CYLINDERS:
TYPE WATER CWT
PRESS., PSIG 50 SUPPLY 35 RETURN MIN.
TEMP., °F 35 SUPPLY 115 RETURN MAX.

COOLING WATER FOR (OIL COOLER)(INTERCOOLERS)(ROD PKG):
TYPE WATER CWT
PRESS., PSIG 50 SUPPLY 35 RETURN MIN.
TEMP., °F 85 SUPPLY 115 RETURN MAX.

ELECTRIC POWER FOR HEATERS:
_____ VOLTS _____ PHASE _____ HERTZ

STEAM FOR HEATERS:
NORMAL: _____ PSIG _____ °FTT
MAX.: _____ PSIG _____ °FTT

INSTRUMENT AIR SUPPLY:
PRESS., PSIG _____ MAX. _____ NORMAL _____ MIN.

UTILITY CONSUMPTION

ELECTRIC	H.P.	LOCKED ROTOR AMPS	FULL LOAD AMPS
MAIN DRIVER			
MAIN LUBE OIL PUMP			
AUX. LUBE OIL PUMP			
PKG. COOLANT OIL PUMP			
MECH. LUBRICATOR			

FRAME OIL HEATER	___ WATTS	___ VOLTS	___ HZ
LUBRICATOR HEATER	___ WATTS	___ VOLTS	___ HZ
SPACE HEATER	___ WATTS	___ VOLTS	___ HZ
	___ WATTS	___ VOLTS	___ HZ

STEAM

MAIN DRIVER	___ #/HR.	___ PSIG	___ °FTT TO	___ PSIG
LUBR. HEATER	___ #/HR.	___ PSIG	___ °FTT TO	___ PSIG
FRAME HEATER	___ #/HR.	___ PSIG	___ °FTT TO	___ PSIG
	___ #/HR.	___ PSIG	___ °FTT TO	___ PSIG

COOLING WATER

	COMP. CYL. JKTS.	ROD PKG.	L.O. COOLER	INTER COOLERS	OTHER
QUANTITY, GPM	752	70	250		
INLET TEMP., °F	35	35	35		
OUTLET TEMP., °F	100	90	90		
INLET PRESS., PSIG	50	50	50		
OUTLET PRESS., PSIG	45	45	45		
MAX. PRESS., PSIG	75	75	75		
TOTAL C.W., GPM		1072			

INSPECTION AND SHOP TESTS

	REQUIRED	WITNESSED
SHOP INSPECTION	⊗	⊗
MFR. STANDARD SHOP TESTS	⊗	○
VALVE LEAK TEST	⊗	○
CYL. HYDRO. TEST	⊗	⊗
HYDRO. CYL. WATER JKTS. ___ PSIG	○	○
CYL. HELIUM LEAK TEST MWP	⊗	⊗
BAR OVER TO CHECK RUNOUT, ETC.	⊗	⊗
MECH. RUN TEST W/SHOP DRIVER	○	○
MECH. RUN TEST W/JOB DRIVER	○	○
AUX. EQUIP. OPER. TEST	○	○
DISMANTLE-REASSEMBLE INSPECTION	○	○
_____	○	○
_____	○	○

PAINTING

● MANUFACTURER'S STANDARD SUBJECT TO OWNER'S REVIEW
○ OTHER _____

SHIPMENT

● DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD.
● OUTDOOR STORAGE OVER 6 MONTHS

ALARMS AND SHUTDOWNS

COMP. MFR. SHALL FURNISH ELEC. SEPARATE CONTRACTS FOR:

	PRE-ALARM	SHUTDOWN
LOW LUBE OIL PRESSURE	●	●
LOW MECH. LUBR. OIL LEVEL	●	○
HIGH COMP. J.W. TEMP. _____	●	○
HIGH LEVEL IN EACH MOIST. SEP.	●	○
HIGH GAS DISCH. TEMP. _____	●	●
LOW GAS SUCT. PRESS. _____	●	○
HIGH VIBRATION	●	●
COMP. MAIN BEARINGS HIGH TEMP.	●	●
_____		

REMOTE SHUTDOWN: ● ELEC. ○ PNEUMATIC ○ HYDR.
PRE-ALARM CONTACTS SHALL: ○ OPEN ○ CLS. TO SOUND ALARM
SHUTDOWN CONTACTS SHALL: ○ OPEN ○ CLOSE TO SHUTDOWN
○ CONTROL CURRENT: 120 VOLTS 1 PHASE 60 HERTZ
SWITCH ENCLOSURE: ● EXP. PROOF ○ WEATHERPROOF
○ NEMA TYPE _____

REMARKS: _____

R&C: FORM 268 (5/80) SHEET 3 OF 8

DATA SHEET NO. 12-DS-K-14 REV. 1 SHEET 3 OF 6

RECIPROCATING COMPRESSOR DATA SHEET

CYLINDER DATA

ITEM NO./SERVICE	EST. ONLY			
STAGE	1		2	
NO. OF CYL. PER STAGE	2		2	
TYPE CYL. COOLING REQD.	FORCED COOLING			
TYPE CYL. (STEP)(TANDEM)	HORIZONTAL			
SINGLE/DOUBLE ACTING	D		D	
CYLINDER LINER YES/NO	YES		YES	
CYLINDER LINER WET/DRY	DRY		DRY	
OUTSIDE DIAM. LINER, INCHES	12.36		7 1/4	
BORE, INCHES	11 3/4		3 1/2	
STROKE, INCHES	18		18	
PISTON DISPLACEMENT, CFM	2233		635	
CLEARANCE, %	15		15	
VOLUMETRIC EFFICIENCY, %	73.6		32.32	
API VALVE GAS VELOCITY, FT/MIN.				
NO. INLET/DISCH. VALVES/CYL.				
TYPE OF VALVES	PLATE		PLATE	
INLET/DISCH. VALVE LIFT, MILS				
MAX. ALLOW PISTON SPEED, FPM	900		900	
NORMAL PISTON SPEED, FPM	900		900	
ROD DIAMETER, INCHES	5 1/4		5 1/4	
MAX. ALLOW. ROD LOADING T	210,000		210,000	
MAX. ALLOW. ROD LOADING C	210,000		210,000	
ACTUAL ROD LOAD, T (GAS LOAD)	99,337		139,019	
ACTUAL ROD LOAD, C (GAS LOAD)	52,086		58,043	
ACTUAL ROD LOAD, T (GAS & INERTIA)				
ACTUAL ROD LOAD, C (GAS & INERTIA)				
DEGREES ROD REVERSAL	ABOVE 50			
MAX. ALLOW. CYL. WKG. PRESS., PSIG	2000		3500	
MAX. ALLOW. CYL. TEMP. °F	300		300	
RECOM. RELIEF VALVE, PSIG	1925		3608	
HYDROSTATIC TEST, PSIG	4000		7000	
SUCTION SIZE/RATING				
FACING				
DISCH. SIZE/RATING				
FACING				
POSITION FROM DRIVER END*				

COMPRESSOR MATERIALS

CYLINDERS	SS		FS	
CYLINDER LINERS	CI		CI	
PISTONS	CI		CI	
PISTON RINGS TEFLON	FILLED TEFLON			
RIDER RINGS	CI			
PISTON RODS	4140 OR 8320			
PISTON ROD HARD, (ROCKWELL "C")	50 IN PACKING AREA			
VALVE SEATS	NI		NI	
VALVE STOPS	NI		NI	
VALVE PLATES	SS		SS	
VALVE SPRINGS	CHROME VANADIUM CADMIUM			
ROD PACKING	FILLED TEFLON (METALIC)			

COMPRESSOR PACKING

- (3) FULL FLOATING VENTED PACKING
  - W/STAINLESS STEEL SPRINGS
- (3) FORCED FEED LUBRICATED
- ( ) NON-LUBRICATED (3) TEFLON ( ) CARBON
- (3) WATER COOLED
- ( ) PROVISIONS FOR FUTURE (WATER) (OIL) COOLING
- (3) VENTED TO SUCT. COMP.

DISTANCE PIECE

- ( ) STANDARD
- ( ) EXTRA LONG SINGLE COMPARTMENT
- (3) TWO COMPARTMENT
- (3) SOLID COVER (3)
- (3) VENTED TO SUCT. (3) DESIGN PRESS., PSIG 10

LUBRICATION

FRAME

- ( ) SPLASH SYSTEM
- (3) PRESSURE SYSTEM (INCLUDE THE FOLLOWING)
  - (3) MAIN OIL PUMP DRIVEN BY (COMP. SHAFT) (ELEC. MOTOR) (3)
  - (3) AUX. OIL PUMP DRIVEN BY ELECTRIC MOTOR
  - (3) HAND OPERATED PUMP FOR STARTING
- (3) SYSTEM OIL CAPACITY _____ GALS.
- (3) TYPE OIL _____ GRADE _____
- (3) ELEC. HTR. W/THERMOSTAT ( ) STEAM COIL

TYPE BEARINGS (3) SLEEVE (3) BALL (3) _____

BRG. MATL. (3) ALUM. (3) BABBIT (3) _____

(3) OUTBOARD BEARING INCLUDED (3) TYPE _____

CYLINDERS

LUBRICATOR TO BE DRIVEN BY:

(3) COMPRESSOR SHAFT (3) ELECTRIC MOTOR (3) BOTH

LUBRICATOR CAPACITY (3) 24 HR. ( ) _____

(3) TYPE OIL _____ GRADE _____

(3) LUBRICATOR MAKE _____ MODEL _____

(3) STEAM COIL _____ (3) NO. OF COMP. _____

(3) ELECTRIC HEATER W/THERMOSTAT

BARRING DEVICE ( ) MANUAL (3) PNEU.

(3) COUPLING - LOW SPEED

MFR. _____ MODEL _____

TYPE _____

☐ COUPLING - HIGH SPEED

MFR. _____ MODEL _____

TYPE _____

(3) COUPLING - (MAIN)(AUX) OIL PUMP

MFR. _____ MODEL _____

TYPE _____

TYPE GUARDS ( ) CODE ( ) STANDARD ( ) NON-SPARK

( ) STATIC COND. V-BELTS ( ) TOT. ENCL. V-BELT DRO.

AIR INTAKE FILTER BY: ( ) COMP. MFR. ( ) PURCH.

☐ MFR. _____ MODEL _____

☐ TYPE _____ ( ) FLANGED OUTLET CONNECTION

REMARKS: _____

* OR FLYWHEEL RH = RIGHT HAND LH = LEFT HAND OB = OUTBOARD IB = INBOARD

DATA SHEET NO. _____ REV. 1 SHEET 1 OF 6

ELECTRIC MOTOR DATA SHEET

APPLICABLE TO: (P) PROPOSAL ( ) PURCHASE ( ) AS BUILT

FOR THE BRECKINRIDGE PROJECT — UNIT

SITE BRECKINRIDGE, KY — DRIVEN EQUIP. RECIP. COMP.

SERVICE HYDROGEN — NO. REQUIRED FIVE (5)

MANUFACTURER — MODEL — SERIAL NO.

NOTE: (P) INDICATES INFORMATION TO BE COMPLETED BY PURCHASER; (M) BY MANUFACTURER

MOTOR DESIGN DATA

APPLICABLE SPECIFICATIONS:
( ) NEMA
( )
( )

SITE DATA:
AREA: (P) C.L. 1 GR. D DIV. 2 ( ) NON-HAZARDOUS
(P) ALTITUDE 100 FT. (P) AMBIENT TEMPS: MAX. 95 °F, MIN. -10 °F
UNUSUAL CONDITIONS: ( ) DUST ( ) FUMES
( ) OTHER

DRIVE SYSTEM: (P) DIRECT CONNECTED ( ) GEAR ( ) OTHER

TYPE MOTOR:
( ) SQUIRREL CAGE INDUCTION ( ) NEMA DESIGN
(P) SYNCHRONOUS WP-II
(P) POWER FACTOR REQD. UNITY
EXCITATION: (P) BRUSHLESS ( ) SLIP RING
( ) FIELD DISCHARGE RESISTOR BY MOTOR MFR.
( ) WOUND ROTOR INDUCTION
( )

ENCLOSURE:
( ) CLASS 1, GROUP D, EXP. PROOF
( ) TEFC
( ) TEWAC ( ) TEXF, USING ____ GAS
( ) DOUBLE WALL CARBON STEEL TUBES
( ) WATER SUPPLY: PRESS. ___ PSIG TEMP. ___ °F
( ) WATER ALLOW. ΔP ___ PSI & TEMP. RISE ___ °F
( ) WATER SIDE MIN. CORR. ALLOW. ___ IN. AND FOUL FACTOR
( ) (AIR) (GAS) SUPPLY PRESS. ___ PSIG
( )
(P) WEATHER PROTECTED, TYPE I
( ) FORCED VENTILATED
( ) OPEN-DRIPPROOF
( ) OPEN
( )
( )

BASIC DATA:
(P) 13200 VOLTS 3 PHASE 60 HERTZ
(M) NAMEPLATE HP 18000 SERVICE FACTOR 1.0
(P) SYNCHRONOUS RPM 300
(P) INSULATION: CLASS ___ TYPE ___
(P) TEMP. RISE: ___ °C ABOVE ___ °C BY ___

STARTING:
(P) FULL VOLTAGE ( ) REDUCED VOLTAGE ___ %
( ) LOADED ( ) UNLOADED
( ) VOLTAGE DIP ___ %

VIBRATION:
(P) NEMA STANDARD ( )

NOISE:
(P) NEMA STANDARD ( )

ACCESSORY EQUIPMENT

( ) BASEPLATE (P) SOLEPLATE (P) STATOR SHIFT
( ) MFR. STD. FANS ( ) NON-SPARKING FANS
(P) D.C. EXCITATION:
☐ KW REQD ___ VOLTS ___
BY: ( ) PURCHASER ( ) MANUFACTURER
DESCRIPTION ___
( ) ENCLOSED COLLECTOR RINGS:
( ) PURGED: MEDIUM ___ PRESS. ___ PSIG.
( ) EXPLOSION-RESISTANT NONPURGED
( ) FORCED VENTILATION
☐ CFM ___ PRESS. DROP ___ IN. H_2O
( ) BEARING TEMP. DEVICES:
(M) LOCATION ___
(M) DESCRIPTION ___
(M) SET @ ___ °C FOR ALARM ___ °C FOR SHUTDOWN
(P) SPACE HEATERS:
☐ ___ KW ( ) ___ VOLTS ___ PHASE ___ HERTZ
( ) MAX. SHEATH TEMP. ___ °C
WINDING TEMPERATURE DETECTORS:
( ) THERMISTORS: NO./PHASE ___
TYPE: ( ) POS. TEMP. COEFF. ( ) NEG. TEMP. COEFF.
TEMPERATURE SWITCH: ( ) YES ( ) NO
(P) RESISTANCE TEMPERATURE DETECTORS: NO./PHASE ___
☐ RESISTANCE MATL. ___ ☐ ___ OHMS
SELECTOR SWITCH & INDICATOR BY: ( ) PURCHR. ( ) MFR.
(M) MAX. STATOR WINDING TEMPS:
___ °C FOR ALARM ___ °C FOR SHUTDOWN
WINDING TEMP. DETECTOR & SPACE HEATER LEADS:
(P) IN SAME CONDUIT BOX
( ) IN SEPARATE CONDUIT BOXES
( ) MOTOR ARRANGED FOR DIFFERENTIAL PROTECTION:
( ) SELF-BALANCE PRIMARY-CURRENT METHOD
( ) C.T. DESCRIPTION ___
( ) EXTENDED LEADS ☐ LENGTH ___ FT.
( ) SURGE CAPACITORS
( ) LIGHTNING ARRESTERS
( ) C.T. FOR AMMETER
( ) DESCRIPTION ___
MAIN CONDUIT BOX SIZED FOR:
( ) MAIN MOTOR LEADS ( ) TYPE: ___
( ) INSULATED ( ) NON-INSULATED
( ) C.T.'S FOR DIFF. PROTECTION (MOUNTED BY ___)
( ) SURGE CAPACITORS (MOUNTED BY ___)
( ) LIGHTNING ARRESTERS (MOUNTED BY ___)
( ) C.T. FOR AMMETER (MOUNTED BY ___)
( ) SPACE FOR STRESS CONES
( ) AIR FILTERS:
☐ MFR ___ ☐ TYPE ___
REMARKS: ___

R&C FORM 268 (5/80) SHEET 5 OF 8

ELECTRIC MOTOR DATA SHEET

MANUFACTURER'S DATA

MANUFACTURER _____

FRAME NO. _____ FULL LOAD RPM (IND.) _____

EFFICIENCY: F.L. ____ 3/4L _____ 1/2L _____

PWR. FACTOR (IND.): F.L. ____ 3/4L _____ 1/2L _____

CURRENT (RATED VOLT.): FULL LOAD ____ LOCKED ROTOR ____

LOCKED ROTOR POWER FACTOR _____

LOCKED ROTOR WITHSTAND TIME (COLD START) _____

TORQUES (FT-LBS): FULL LOAD _____

LOCKED ROTOR _____ STARTING (SYN.) _____

PULL-UP (IND.) _____ PULL-IN (SYN.) _____

BREAKDOWN (IND.) _____ PULL-OUT (SYN.) _____

OPEN CIRCUIT TIME CONSTANT (SEC.) _____

SYMMETRICAL CONTRIBUTION TO 3Ø TERMINAL FAULT:

AT 1/2 CYCLES _____ AT 5 CYCLES _____

REACTANCES: SUB-TRANSIENT (X"d) _____

TRANSIENT (X'd) _____ SYNCHRONOUS (Xd) _____

A.C. STATOR RESISTANCE _____ OHMS @ _____ °C

RATED KVA _____

KVA INRUSH @ FULL VOLT. & LOCKED ROTOR (SYN.) _____ %

KVA @ FULL VOLTAGE & 95% SPEED _____ %

MAX. LINE CURR. IN STATOR ON 1ST SLIP CYC. @ PULL-OUT (SYN) _____ _____

ACCELERATION TIME (MOTOR ONLY @ RATED VOLT ____ SEC.

ACCEL. TIME (MOTOR & LOAD @ 85% RATED VOLT.) _____ SEC.

ROTOR/FIELD WK^2 @ MOTOR SHAFT (LB-FT^2) _____

ROTATION FACING COUPLING END _____

NO. OF STARTS PER HOUR _____

FIELD DISCHARGE RESISTOR _____ OHMS

RATED EXCITATION FIELD VOLTAGE _____ D.C.

RESISTANCE OF EXCITATION FIELD @ 25°C _____ OHMS

EXCITATION FIELD AMPS @ FULL LOAD & RATED P.F. _____

EXCITATION FIELD AMPS: MAX. _____ MIN. _____

EXCITATION FIELD ☐ RHEOSTAT ☐ FIXED RESISTOR RECO.

SUPPLIED BY _____

BEARING: TYPE _____ LUBR. _____

LUBE OIL REQUIRED: _____ GPM @ _____ PSIG

TOTAL SHAFT END FLOAT _____

LIMIT END FLOAT TO _____

MOTOR ROTOR: ☐ SOLID ☐ SPLIT

MOTOR HUB: ☐ SOLID ☐ SPLIT

FOR TEWAC & TEIGF MOTORS:

COOLING WATER RECD. _____ GPM

C.W. TEMP. RISE ____ °F PRESS. DROP _____ PSI

(AIR) (GAS) RECD. ____ SCFM PRESS. MAINT. _____ IN.H_2O

CURVES REQD. BASED ON MOTOR SATURATION @ RATED VOLTAGE:

○ SPEED vs TORQUE (ALSO @ ____ % RATED VOLTAGE)

○ SPEED vs POWER FACTOR

○ SPEED vs CURRENT

WEIGHTS (LBS):

NET WEIGHT _____ SHIPPING WEIGHT _____

ROTOR WEIGHT _____ MAX. ERECTION WT. _____

MAX. MAINT. WT. (IDENTIFY) _____

DIMENSIONS (FEET & INCHES):

L _____ W _____ H _____

SHOP INSPECTION AND TESTS

	REQUIRED	WITNESS
SHOP INSPECTION	●	○
TESTING PER NEMA	●	○
MFR. STD. SHOP TESTS	●	○
IMMERSION TEST	○	○
SPECIAL TESTS (LIST BELOW):		
_____	○	○
_____	○	○
_____	○	○
_____	○	○

COUPLING:

○ SUPPLIED BY DSV TYPE

○ MFR. _____ ☐ MODEL _____

○ MOTOR MFR. ○ COMPR. MFR. ○ PURCH. TO MOUNT MTR. HALF

PAINTING:

● MANUFACTURER'S STANDARD

○ _____

SHIPMENT

● DOMESTIC ○ EXPORT ○ EXPORT BOXING REQUIRED

○ OUTDOOR STORAGE OVER 3 MONTHS

○ _____

REMARKS: ELECTRIC MOTOR 4000 V, 3Ø, 60V

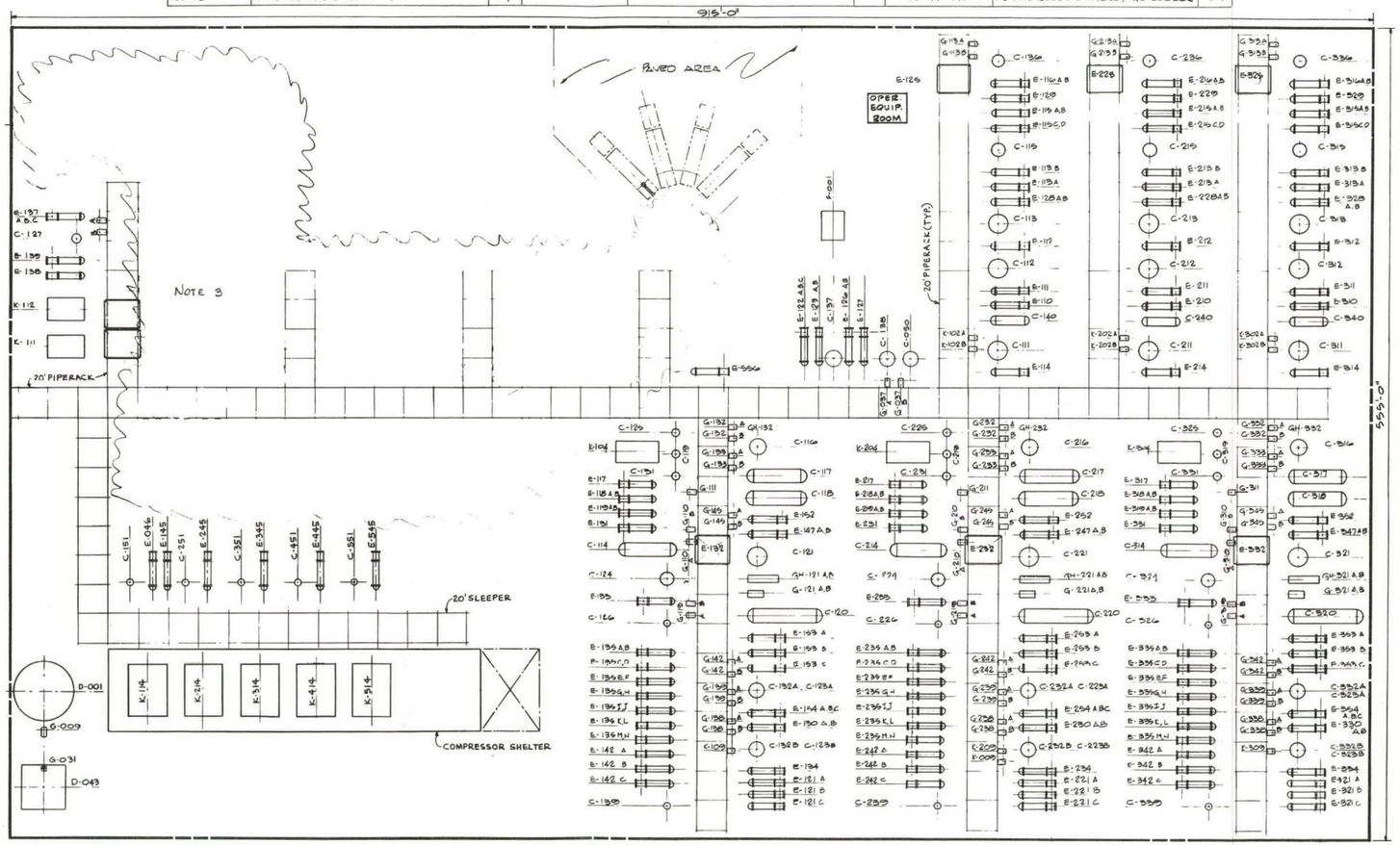
120, 1Ø, 60V

R&C FORM 268 (5/80) SHEET 6 OF 8

DATA SHEET NO. 12-DS-K-14 REV. 1 SHEET 6 OF 6

EQUIPMENT LIST

ITEM	DESCRIPTION	LOCATION	ITEM	DESCRIPTION	LOCATION	ITEM	DESCRIPTION	LOCATION
		D-7	12C-309-330	SOLVENT FILTER	B-3&5	12E-116A&C - 356&C	DEAERATOR FEED PREHEATER	F-3&4
		D-7	12C-140-340	FIRST STAGE H.P. STEAM DRUM	E-3&4	12E-116A&B - 356&B	SHIFTED GAS COOLER	F-3&4
		E-5&7	12C-050	QUENCH WATER SURGE DRUM	E-5&7	12E-117 - 317	RECYCLE VAPOR 1ST STAGE COOLER	D-3&5
		E-5&7	12C-151-551	H_2 COMPRESSOR K.O. DRUM	E-4	12E-118A&B - 318A&B	RECYCLE VAPOR 2ND STAGE COOLER	D-3&5
12C-111-311	FIRST STAGE SHIFT CONVERTER	E-7	12C-151-551	H_2 COMPRESSOR K.O. DRUM	D-7&8	12E-119A&B - 319A&B	RECYCLE VAPOR AFTER COOLER	D-3&5
12C-112-312	SECOND STAGE SHIFT CONVERTER	E-2&4	12C-052	50 PSIG CONDENSATE PDT	D-6	12E-121A&C-321A&C	LEAN SOLVENT COOLER	B-3&5
12C-113-313	THIRD STAGE SHIFT CONVERTER				E-7	12E-122A&C	UNSHIFTED GAS STEAM GENERATOR	E-5
12C-114-314	LEAN SOLVENT PRESATURATOR				E-5&7	12E-123A&B	UNSHIFTED GAS L.P. STEAM BOILER	E-4
12C-115-315	HOT SHIFTED GAS K.O. DRUM				D-8	12E-126-326	HOT SHIFTED GAS AIR COOLER	F-3&4
12C-116-316	H_2S ABSORBER	D-3&5			F-7	12E-126A&B&C	STRIPPED WATER PREHEATER	E-4
12C-117-317	H_2S ABSORBER RICH SOLVENT 1ST FLASH DRUM	D-3&5				12E-127	HOT FUEL GAS COOLER	B-4
12C-118-318	H_2S ABSORBER RICH SOLVENT 2ND FLASH DRUM	D-3&5				12E-128A&B-328A&B	GASIFIER QUENCH WATER PREHEATER	F-3&4
12C-119-319	2ND STAGE K.O. DRUM	D-3&5				12E-129 - 329	GASIFIER QUENCH WATER PREHEATER	F-3&4
12C-120-320	H_2 FLASH DRUM	C-2&5	12D-001	SOLVENT MAKE UP TANK		12E-130A&B-330A&B	CO_2 STRIPPING AIR COOLER	C-3&5
12C-121-321	CO_2 ABSORBER				B-8	12E-131-331	SURFACE CONDENSER	D-3&5
12C-123&6-323&6	CO_2 STRIPPER				E-7	12E-132-332	H_2S STRIPPER OVERHEAD CONDENSER	D-3&5
12C-124-324	H_2S STRIPPER	D-3&6	12D-043	SELEXOL SUMP	Note 1	12E-133-333	H_2S STRIPPER REBOILER	C-3&5
12C-125-325	HP STAGE K.O. DRUM	D-3&5			B-7	12E-134-334	ACID GAS HEATER	B-3&5
12C-126-326	H_2S STRIPPER OVERHEAD K.O. DRUM	C-3&5				12E-135A-M - 335A-M	LEAN RICH SOLVENT EXCHANGER	C-3&5
12C-127	FUEL GAS H_2S ABSORBER	E-8				12E-137A,B,C	LEAN SOLVENT COOLER	E-8
12C-131-331	3RD STAGE K.O. DRUM	D-3&5	12E-110-310	FIRST STAGE H.P. STEAM GENERATOR		12E-138	EXPANDER FEED HEATER	E-8
12C-132&5-332&5	LOW PRESSURE FLASH DRUM	C-3&5	12E-111-311	FIRST STAGE SHIFT B.F.W. PREHEATER	E-3&4	12E-139	EXPANDER INTERSTAGE HEATER	E-8
12C-134-336	COLD SHIFTED GAS K.O. DRUM	F-3&4	12E-112-312	SECOND STAGE WASTE HEAT BOILER	E-3&4	12E-142A,B -342A,B	H_2S STRIPPER FEED PRE-HEATER	C-3&5
12C-137	HOT FUEL GAS K.O. DRUM	E-4	12E-113A&B - 313A&B	THIRD STAGE WASTE HEAT BOILER	F-3&4			
12C-138	COLD FUEL GAS K.O. DRUM	E-4	12E-114-314	FIRST STAGE SHIFT FEED HEATER	E-3&4	12E-145-345	H_2 COMPRESSOR INTERSTAGE COOLER	D-7



EQUIPMENT LIST

ITEM	DESCRIPTION	LOCATION	ITEM	DESCRIPTION	LOCATION	ITEM	DESCRIPTION	LOCATION	ITEM	DESCRIPTION	LOCATION
12E-046	H_2 COMPRESSOR SPILLBACK COOLER	D-7	12G-008	SELEXOL SOLVENT MAKE-UP PUMP	D-8				12T-101A-H	SCREENED SLAG BELT CONVEYOR	E-5&7
12E-147A&B - 347A&B	CO_2 ABSORBER PRECOOLER	D-3&5	12G-110A&B - 310A&B	H_2S ABSORBER PRESAT. SOLVENT CHARGE PUMP	D-3&5	12G-044 A&B	FLUSHING OIL PUMP	D-8			
12E-152-352	CO_2 ABSORBER FEED GAS CHILLER	D-3&5	12G-111-311	FLASH GAS K.O. DRUM	D-3&5	12G-149 A&B - 349A&B	CONDENSATE PUMP	D-3&5			
12E-153A,B,C - 353A&C	LEAN SOLUTION CHILLER	C-3&5	12G-113A&B - 313A&B	COLD CONDENSATE PUMP	F-3,4			E-7			NOTE 1
12E-154A,B,C - 354A,B,C	SOLVENT EXCHANGER	C-3&5	12G-119A&B - 319A&B	H_2S STRIPPER REFLUX PUMP	D-3&5	12G-047 A&B	50 PSIG CONDENSATE PUMP	D-6	12Y-103-503	QUENCH EFFLUENT SCREENS	NOTE 1
			12G-121A&B - 321 A&B	CO_2 ABSORBER LEAN SOLVENT CHARGE PUMP	C-3&5						NOTE 1
12E-157-351	STEAM JET CONDENSER		12G-122A&B	F.G. H_2S ABSORBER LEAN SOLUTION CHARGE PUMP	E-7	12H-101-501	START UP VENTURI SCRUBBER	NOTE 1			
			12G-085 A,B,C,D	GASIFIER FEED BOOSTER PUMP	D-7	12H-102A&B-502A&B	GASIFIER VAPOR VENTURI SCRUBBER	NOTE 1		SOOT SLURRY CLARIFIER	F-7
12F-102-502	GASIFIER START UP BURNER	NOTE 1	12G-027 A&B	BURNER TIP WATER PUMP	E-7	12H-104-304	EXHAUST STEAM JET	NOTE 1		SOOT SLURRY CLARIFIER	F-6
12F-103A&C-353A&C	PROCESS BURNER	NOTE 1	12G-028 A&B	SOOT SLURRY PUMP	E-7			E-7			
12F-201	START-UP HEATER	E-4			E-7	12K-102A&B - 302A&B	RECYCLE SHIFT GAS BLOWER	E-3,4			
			12G-031	SELEXOL SUMP PUMP	D-7	12K-104-304	RECYCLE VAPOR COMPRESSOR TURBINE	D-3&5			
12H-112A&B - 312A&B	LEAN SOLVENT HYDRAULIC TURBINE	D-3&5	12G-132 A&B - 332A&B	H_2S ABSORBER LEAN SOLVENT CHARGE PUMP	D-3&5	12K-009	CO_2 STRIPPER AIR COMPRESSOR	C-4			
12H-132 - 332	RICH SOLVENT HYDRAULIC TURBINE	D-3&5	12G-153 A&B - 353 A&B	RICH SOLVENT TRANSFER PUMP	D-3&5	12K-109-309	CO_2 STRIPPER AIR COMPRESSOR	C-3&5			
12J-101-501	GASIFIER FEED PUMP	D-7	12G-037 A&B	GASIFIER QUENCH WATER PUMP	E-4	12K-111	FIRST STAGE FUEL GAS TURBO EXPANDER	E-8			
12G-001 A,B,C	GASIFIER FEED PUMP	D-7	12G-138A&B - 338A&B	CO_2 STRIPPER SOLVENT WATER PURGE PUMP	C-3&5	12K-112	SECOND STAGE FUEL GAS TURBO EXPANDER	E-8			
			12G-139A&B - 339A&B	LEAN SOLVENT CROSS BLEED PUMP.	C-3&5	12K-114-514	HYDROGEN COMPRESSOR	C-7&8			
			12G-142A&B - 342A&B	LEAN SOLVENT BOOSTER PUMP	C-3&5						

NOTES

1. THIS EQUIPMENT IS LOCATED WITHIN THE GASIFIER STRUCTURE.
2. HIGH POINT OF FINISHED GRADE IS EL 100'-0"
3. EQUIPMENT NOT SHOWN - LIMITED DISTRIBUTION RIGHTS.

REFERENCE DRAWINGS

50E-A-1	OVERALL SITE PLAN
50E-A-4	PLOT PLAN INDEX

0 10 20 30 40 50 60

1"=30'-0"
GRAPHIC SCALE

NO.	DATE	REVISIONS	BY	CHK	SUPV	ENGR	BY APPR.	ASST. APPR.
1	10-8	ISSUED FOR PHASE ZERO	JK	JK	NS			
2	8/30/10	ISSUED FOR REVIEW AND APPROVAL	TR	JK	JK			

SCALE: 1"=30'-0" | DESIGNED TR/JK | DRAWN TR/EEP/SN

ASHLAND SYNTHETIC FUELS INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-88MC26717

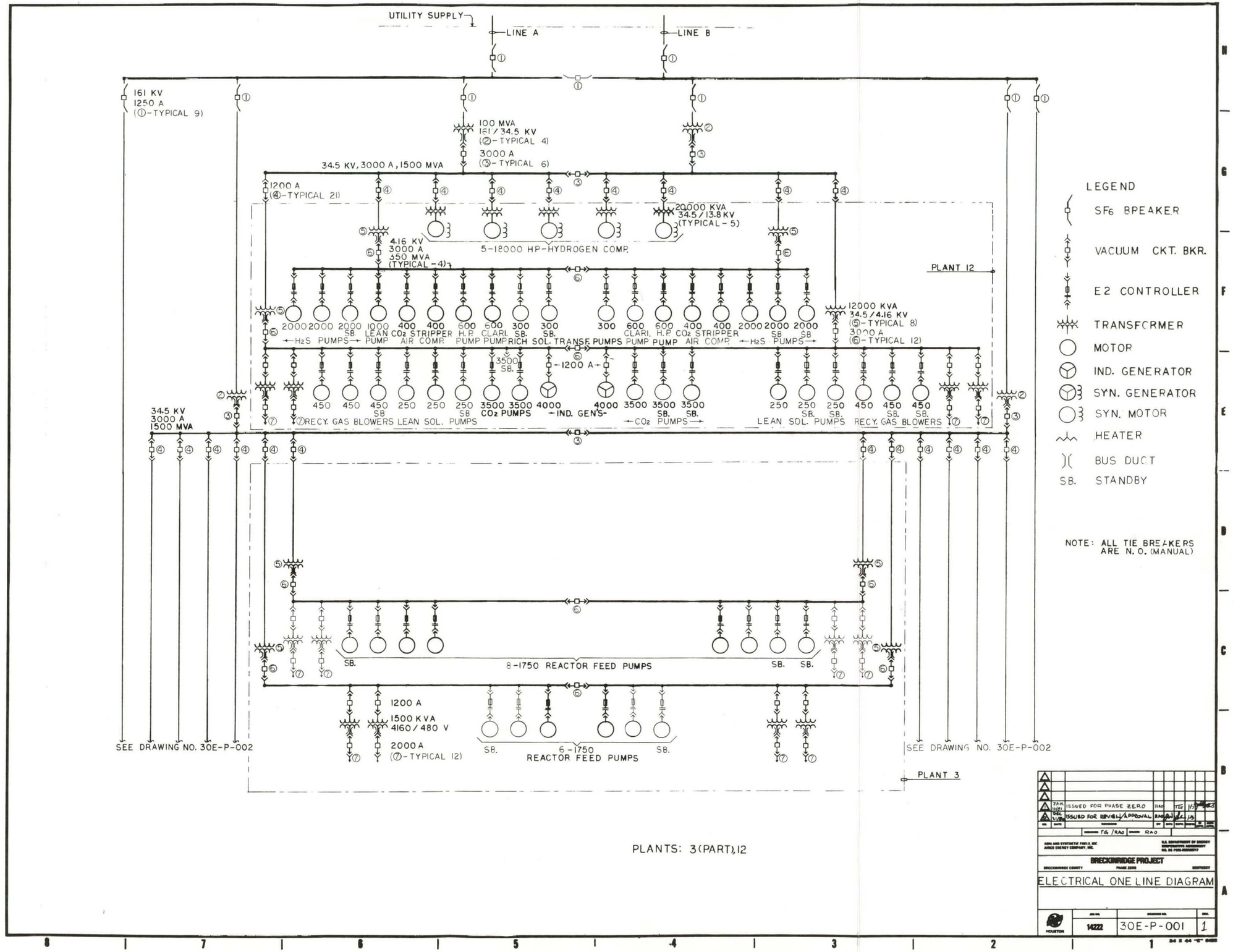
BRECKINRIDGE PROJECT

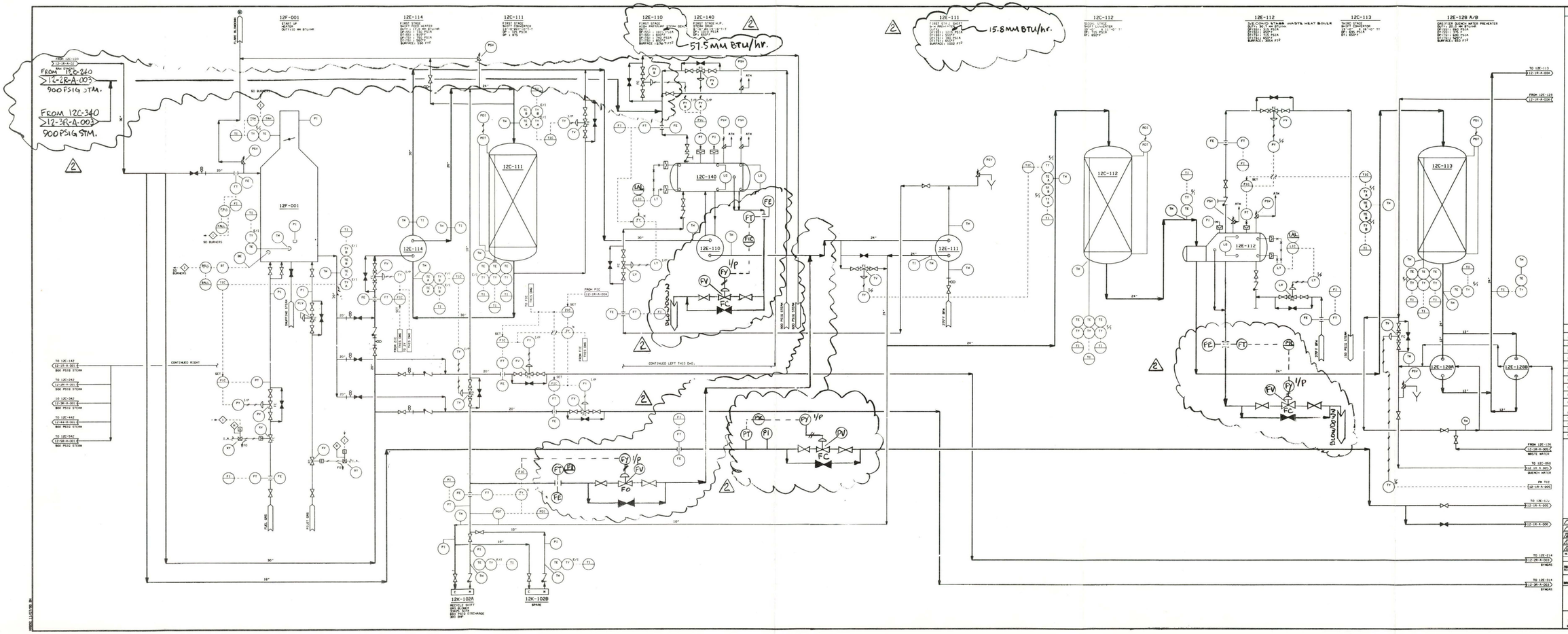
BRECKINRIDGE COUNTY | PHASE ZERO | KENTUCKY

PLOT PLAN PLANT 12
GASIFICATION & PURIFICATION PLANT
(UNLIMITED DISTRIBUTION VERSION)

HOUSTON | JOB NO. 14222 | DRAWING NO. 12E-A-2 | REV. 1

34 X 44 "E" SIZE


UTILITY SUPPLY
LINE A
LINE B
161 KV
1250 A
(①-TYPICAL 9)
100 MVA
161/34.5 KV
(②-TYPICAL 4)
3000 A
(③-TYPICAL 6)
34.5 KV, 3000 A, 1500 MVA
1200 A
(④-TYPICAL 21)
20,000 KVA
34.5/13.8 KV
(TYPICAL-5)
5-18000 HP-HYDROGEN COMP.
4.16 KV
3000 A
350 MVA
(TYPICAL-4)
PLANT 12
12000 KVA
34.5/4.16 KV
(⑤-TYPICAL 8)
3000 A
(⑥-TYPICAL 12)
2000 2000 2000 1000 400 400 600 600 300 300 300 600 600 400 400 2000 2000 2000
SB
←H2S PUMPS→ LEAN CO2 STRIPPER PUMP AIR COMP. H.P. PUMP CLARI. PUMP SB. RICH SOL. TRANSF PUMPS CLARI. PUMP H.P CO2 STRIPPER PUMP AIR COMP. ←H2S PUMPS→
SB SB
3500 SB.
1200 A
450 450 450 250 250 250 3500 3500 4000 4000 3500 3500 3500 250 250 250 450 450 450
SB
⑦RECY. GAS BLOWERS LEAN SOL. PUMPS
3500 CO2 PUMPS
-IND. GENS-
←CO2 PUMPS→
SB. SB.
LEAN SOL. PUMPS SB. SB. RECY. GAS BLOWERS ⑦
34.5 KV
3000 A
1500 MVA
SB.
8-1750 REACTOR FEED PUMPS
SB. SB.
1200 A
1500 KVA
4160/480 V
2000 A
(⑦-TYPICAL 12)
SB.
6-1750
REACTOR FEED PUMPS
SB.
SEE DRAWING NO. 30E-P-002
SEE DRAWING NO. 30E-P-002
PLANT 3
PLANTS: 3(PART), 12
LEGEND
SF6 BREAKER
VACUUM CKT. BKR.
E2 CONTROLLER
TRANSFORMER
MOTOR
IND. GENERATOR
SYN. GENERATOR
SYN. MOTOR
HEATER
BUS DUCT
SB. STANDBY
NOTE: ALL TIE BREAKERS ARE N. O. (MANUAL)
ISSUED FOR PHASE ZERO
ISSUED FOR REVIEW/APPROVAL
TG/RAO
RAO
BRECKINRIDGE PROJECT
ELECTRICAL ONE LINE DIAGRAM
14222
30E-P-001
1



NOTES

1. SEE SPEC. 14222-A-1-A-2 FOR PHASE ZERO SCOPE DEFINING P&ID CONTENT.
2. P&ID IS TYPICAL FOR ONE TRAIN OF TOTAL OF THREE TRAINS.
3. PIPING DETAILS, LINE BLINDS, SPACER FLANGES, ETC., ARE NOT SHOWN FOR THESE DRAWINGS.
4. ALL PANEL MOUNTED INSTRUMENTS ARE LOCATED IN THE MAIN CONTROL ROOM AND ARE ON A DISTRIBUTED DATA SYSTEM.
5. INSTRUMENTATION DOES NOT SHOW AUXILLIARY DEVICES SUCH AS ALARMS.

REFERENCE DRAWINGS

PROCESS PFD	SHIFT SECTION	12-0-B-02
PROCESS PFD	SHIFT SECTION	12-0-B-03
PROCESS P&ID	SHIFT SECTION, DESULFURIZATION SECT.	12-1R-A-001
PROCESS P&ID	SHIFT SECTION, DESULFURIZATION SECT.	12-1R-A-002
PROCESS P&ID	SHIFT SECTION	12-1R-A-004
PROCESS P&ID	FUEL GAS PURIFICATION	12-1R-A-005
PROCESS P&ID	SHIFT SECTION, DESULFURIZATION SECT.	12-2R-A-006
PROCESS P&ID	SHIFT SECTION, DESULFURIZATION SECT.	12-3R-A-001
PROCESS P&ID	SHIFT SECTION, DESULFURIZATION SECT.	12-4R-A-001
PROCESS P&ID	SHIFT SECTION, DESULFURIZATION SECT.	12-5R-A-001
PLOT PLAN		12E-A-1
SYMBOLS & LEGEND-PAGE		0E-A-1
SYMBOLS & LEGEND-PAGE		0E-A-2
SYMBOLS & LEGEND-PAGE		0E-A-3
SYMBOLS & LEGEND-PAGE		0E-A-4

REV.	DESCRIPTION	DRAWN	CHKD	APPD	DATE
2	REV. AS SHOWN				
1	ISSUE FOR PHASE ZERO				
0	ISSUE FOR REVIEW & APPROVAL	JA	JA	JA	5/97

KELLOGG BROWN & ROOT, INC. — KINCH BARNEY COMPANY Inc.

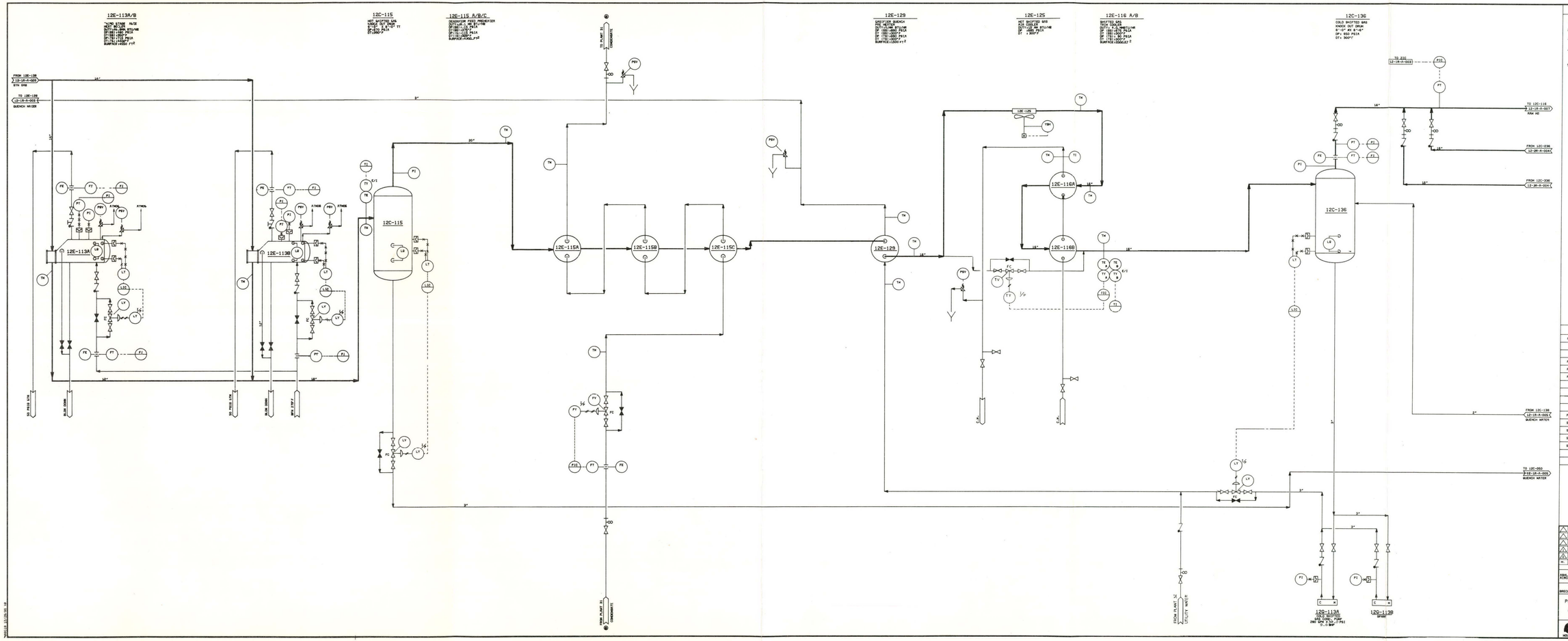
U.S. DEPARTMENT OF ENERGY — SOUTHERN COMPANY SERVICES

BRECKINRIDGE PROJECT
PHASE ZERO

BRECKINRIDGE COUNTY — KENTUCKY

PROCESS PIPING AND INSTRUMENT DIAGRAM
SHIFT CONVERSION SHT. 1 OF 2
GASIFICATION AND PURIFICATION PLANT

KBR/KBM	JOB NO.	DRAWING NO.	REV.
	14222	12-1R-A-003	2



NOTES

1. SEE SPEC. 14222-0-1-A-J FOR PHASE ZERO SCOPE DEFINING P&ID CONTENT.
2. P&ID IS TYPICAL FOR ONE TRAIN OF TOTAL OF THREE TRAINS
3. VENTS, DRAINS, LINE BLINDS, BREAK FLANGES, ETC. MAY NOT SHOWN FOR PHASE ZERO.
4. ALL PANEL MOUNTED INSTRUMENTS SHOWN ON THIS P&ID ARE CONTROL ROOM AND ARE ON A DISTRIBUTED DATA SYSTEM.
5. INSTRUMENTATION DOES NOT SHOW AUXILLIARY DEVICES SUCH AS ALARMS.

REFERENCE DRAWINGS

PROCESS PFD SHIFT SECTION	12-0-R-03
PROCESS P&ID- SHIFT CONVERSION SECTION	12-1R-A-003
PROCESS P&ID- SELEXOL, NITORGEN PURIFICATION	12-1R-A-007
PROCESS P&ID- FUEL GAS PURIFICATION	12-1R-A-005
PLOT PLAN	12E-A-1
SYMBOLS & LEGEND- P&ID'S	0E-A-1
SYMBOLS & LEGEND- P&ID'S	0E-A-2
SYMBOLS & LEGEND- P&ID'S	0E-A-3
SYMBOLS & LEGEND- P&ID'S	0E-A-4

REV	DESCRIPTION	DRAWN	CHK'D	APP'D	DATE
0	ISSUE FOR PHASE ZERO	HDC	LDL	MJF	PK
1	ISSUE FOR REVIEW/APPROVAL	CHAP ABOT		LDL	

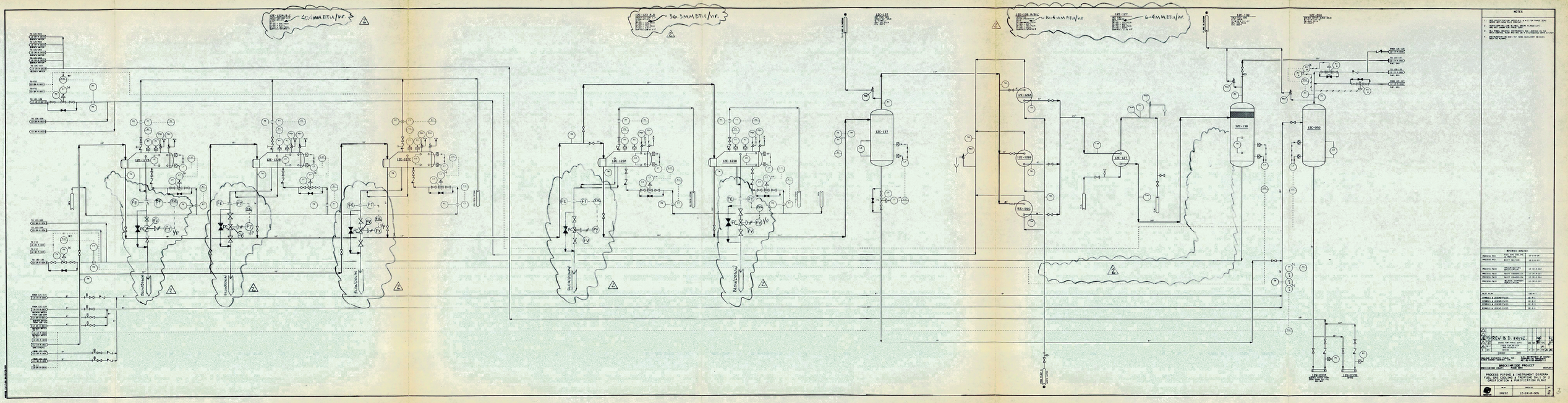
KELLOGG BROWN & ROOT, INC. / RENAISSANCE ENERGY COMPANY, INC.

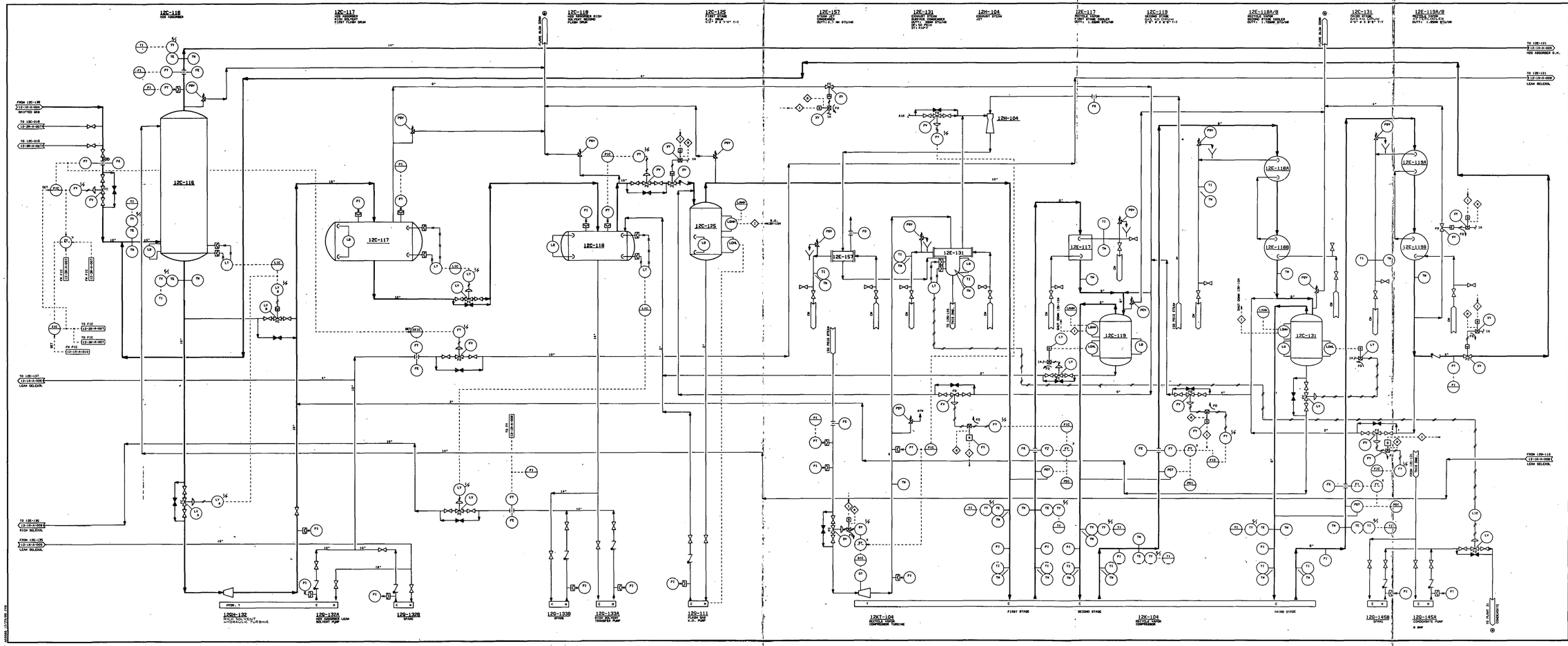
U.S. DEPARTMENT OF ENERGY
CLEAN COAL TECHNOLOGY DEMONSTRATION
NO. DE-FC26-00NT40717

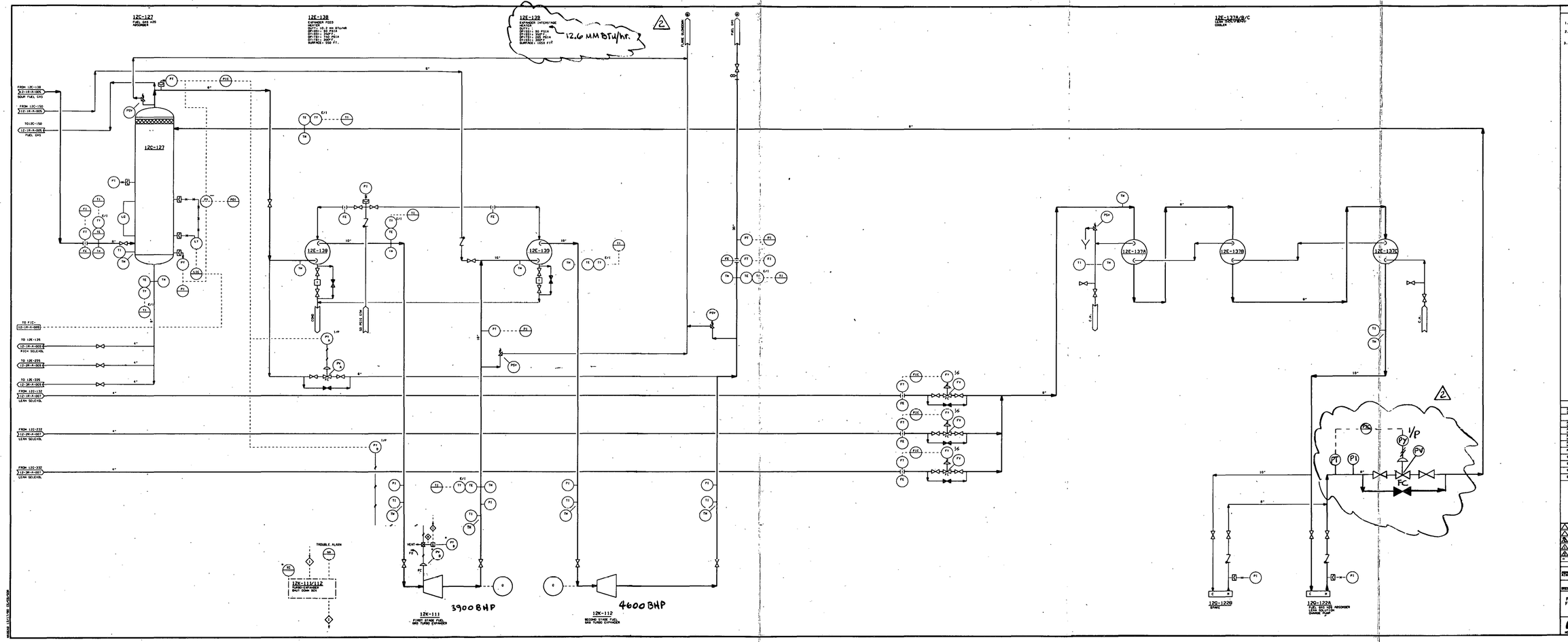
BRECKINRIDGE PROJECT
PHASE ZERO
BRECKINRIDGE COUNTY, KENTUCKY

PROCESS PIPING AND INSTRUMENT DIAGRAM
SHIFT CONVERSION SHEET 2 OF 2
GASIFICATION AND PURIFICATION PLANT

HOUSTON	JOB NO.	DRAWING NO.	REV.
	14222	12-1R-A-004	1


40.4MMBTU/hr
36.3MMBTU/hr
16.4 MMBTU/hr
6.4MMBTU/hr
12C-137
12C-138
12C-060
12C-127
12C-126A
12C-126B
12C-126C
12C-128A
12C-128B
12C-128C
12C-126D
12C-126E
12C-126F
12C-126G
12C-126H
12C-126J
12C-126K
12C-126L
12C-126M
12C-126N
12C-126P
12C-126Q
12C-126R
12C-126S
12C-126T
12C-126U
12C-126V
12C-126W
12C-126X
12C-126Y
12C-126Z
12C-127A
12C-127B
12C-127C
12C-127D
12C-127E
12C-127F
12C-127G
12C-127H
12C-127J
12C-127K
12C-127L
12C-127M
12C-127N
12C-127P
12C-127Q
12C-127R
12C-127S
12C-127T
12C-127U
12C-127V
12C-127W
12C-127X
12C-127Y
12C-127Z
BLOWDOWN
NOTES
1. SEE SPECIFICATION 12-SP-E-0011 & W.O FOR PHASE ZERO AND PHASE ONE SCOPE DEFINITION.
2. SEE SPECIFICATION 12E-SP-E-0004 FOR PLANOUT REQUIREMENTS.
3. ALL PIPING SHALL BE SUPPLIED AS PER SPECIFICATION 12E-SP-E-0001 UNLESS OTHERWISE NOTED.
4. INSTRUMENTATION SHALL NOT BE SHOWN ALTHOUGH SERVICES MAY BE SHOWN.
REFERENCE DRAWINGS
PROCESS PFD — 12-SP-M-001
PROCESS PFD — 12-SP-M-002
PROCESS PFD — 12-SP-M-003
PROCESS PFD — 12-SP-M-004
PROCESS PFD — 12-SP-M-005
PROCESS PFD — 12-SP-M-006
MAJOR EQUIPMENT LIST — 12E-SP-E-0001
BUNDLE 1 (GENERIC PACK) — 12-M-1
BUNDLE 2 (GENERIC PACK) — 12-M-2
BUNDLE 3 (GENERIC PACK) — 12-M-3
BUNDLE 4 (GENERIC PACK) — 12-M-4
REV B.D. ENGR.
ISSUE FOR PHASE ZERO
ISSUE FOR APPROVAL
ISSUE FOR APPROVAL
BRECKENRIDGE PROJECT
PROCESS PIPING & INSTRUMENT DIAGRAM FUEL GAS COOLING & TREATING (PH.1) OF E GASIFICATION & PURIFICATION PLANT
14222
12-1R-M-005
2
3


12C-116
HOT ABSORBER
12C-117
HOT REGENERATED RICH SOLVENT SURGE DRUM
12C-118
HOT REGENERATED RICH SOLVENT SURGE DRUM
12C-125
FLASH DRUM
12E-157
FLASH GAS CONDENSER
12E-131
FLASH GAS CONDENSER
12H-104
EXHAUST STACK
12E-117
LEAN SOLVENT COOLER
12E-118A/B
RECYCLE STEAM CONDENSER
12E-131
FLASH GAS CONDENSER
12E-119A/B
REFLUX CONDENSER
NOTES
REFERENCE DRAWINGS
PROCESS PIPING AND INSTRUMENT DIAGRAM SELEXOL HYDROGEN PURIFICATION SH. 1 OF 4 GASIFICATION AND PURIFICATION PLANT
BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY
PHASE ZERO
KENTUCKY
14222
12-1R-A-007
1



NOTES

1. SEE SPECIFICATION 14222-A-1 & A-2 FOR PHASE ZERO AND PHASE ONE SCOPE OF WORK.
2. ALL PHASE ONE/TWO INSTRUMENTS ARE LOCATED IN THE MAIN CONTROL ROOM AND ARE ON A DISTRIBUTED DATA SYSTEM.
3. INSTRUMENTATION DOES NOT SHOW AUXILIARY DEVICES SUCH AS FLANGES.

VENTS, DRAINS, LINE BLINDS, BREAK FLANGES, ETC., ARE NOT SHOWN FOR PHASE ZERO.

REFERENCE DRAWINGS

PROCESS PFD FUEL GAS COOLING & TREATING	12-0-A-04
PROCESS PFD FUEL GAS	12-1R-A-005
PROCESS & UTILITIES	
HYDROGEN PURIFICATION	12-1R-A-007
PROCESS PFD SELEXOL	12-1R-A-008
PROCESS & UTILITIES	
HYDROGEN PURIFICATION	
PROCESS PFD SELEXOL	12-1R-A-005
HYDROGEN PURIFICATION	
PILOT PLAN	12C-A-1
SYMBOLS & LEGEND-P&ID'S	0C-A-1
SYMBOLS & LEGEND-P&ID'S	0C-A-2
SYMBOLS & LEGEND-P&ID'S	0C-A-3
SYMBOLS & LEGEND-P&ID'S	0C-A-4

REV	ISSUE	BY	DATE
2	REV 12.6-139 DWG		
1	ISSUE FOR PHASE 0		05
0	ISSUE FOR REVIEW & APPROVAL		05

DESIGNED BY: KELLOGG BROWN & ROOT, INC.
DRAWN BY: KELLOGG BROWN & ROOT, INC.
CHECKED BY: KELLOGG BROWN & ROOT, INC.
APPROVED BY: KELLOGG BROWN & ROOT, INC.
DESIGN CHIEF | DRAFT CHIEF

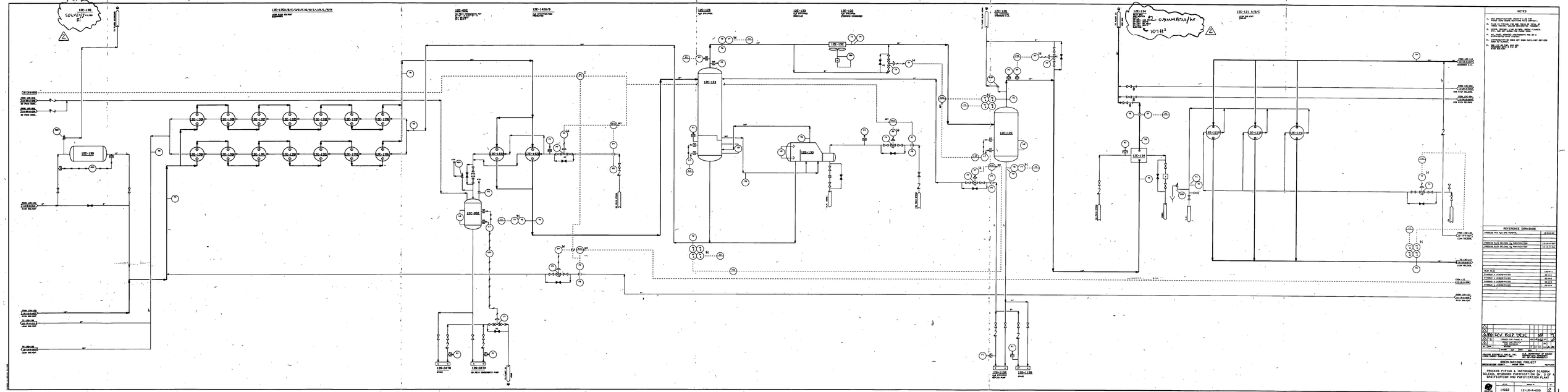
U.S. DEPARTMENT OF ENERGY
NETL - MORGANTOWN, WV
NO. DE-FC26-98FT40321

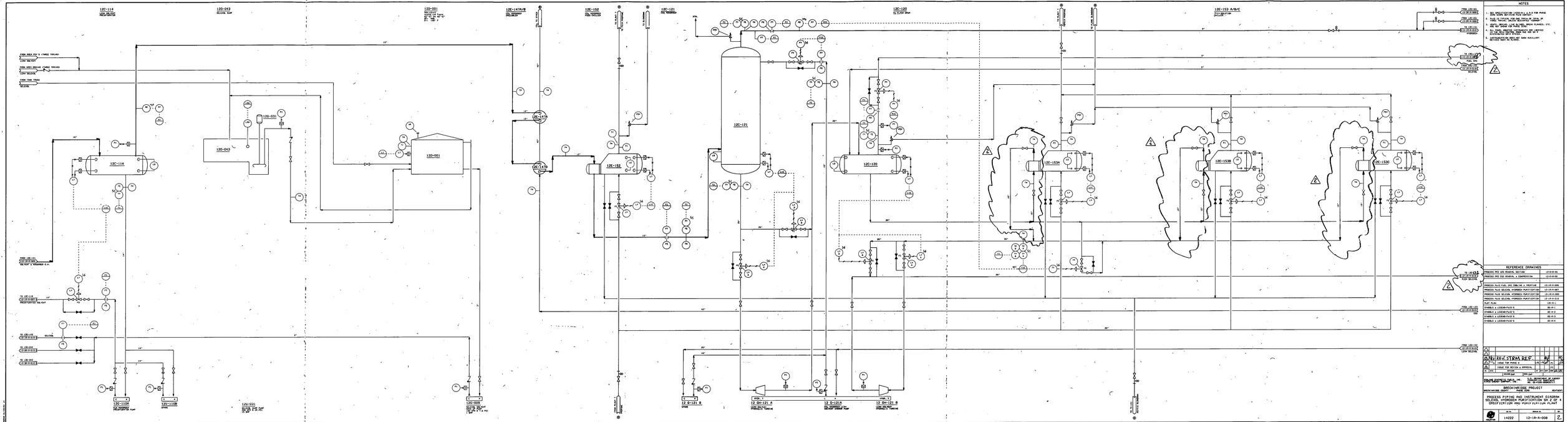
BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY | PHASE ZERO | KENTUCKY

PROCESS PIPING AND INSTRUMENT DIAGRAM FUEL GAS COOLING & TREATING SH. 2 OF 2 GASIFICATION AND PURIFICATION PLANT

JOB NO.	DRAWING NO.	REV.
14222	12-1R-A-006	2

SHEET 1 OF 1


12C-130
SOLVENT FILLING
12C-1301
12C-1302
12C-1303
12C-1304
12C-1305
12C-1306
12C-1307
12C-1308
12C-1309
12C-1310
12C-1311
12C-1312
12C-1313
12C-1314
12C-952
12C-1428
12C-1429
12C-124
12C-125
12C-126
12C-133
12C-134
12C-135
12C-136
12C-137
12C-138
12C-139
12C-121 A/B/C
12D-0478
12D-0479
12C-1330
12C-1331
0.9MMBTU/hr
107Lit²
TO 12C-121 A/B/C
FROM 12C-121
TO 12C-124
FROM 12C-124
TO 12C-125
FROM 12C-125
TO 12C-126
FROM 12C-126
TO 12C-133
FROM 12C-133
TO 12C-134
FROM 12C-134
TO 12C-135
FROM 12C-135
TO 12C-136
FROM 12C-136
TO 12C-137
FROM 12C-137
TO 12C-138
FROM 12C-138
TO 12C-139
FROM 12C-139
TO 12C-130
FROM 12C-130
TO 12C-952
FROM 12C-952
TO 12C-1428
FROM 12C-1428
TO 12C-1429
FROM 12C-1429
TO 12C-1330
FROM 12C-1330
TO 12C-1331
FROM 12C-1331
TO 12D-0478
TO 12D-0479
FROM 12D-0479
NOTES
REFERENCE DRAWINGS
REV. ISSUED FOR CLIENT REVIEW
BRECKNRIDGE PROJECT
PROCESS PIPING & INSTRUMENT DIAGRAM
SILICON HYDROGEN PURIFICATION SKID 'C' OF 'C'
GRIT(ATION AND PURIFICATION PLANT
14220
12-19-A-005



NOTES

1. ALL VESSELS/COLUMNS (120-043,A,B,C) FOR PHASE I ARE TO BE SUPPLIED WITH SPARE NOZZLES.
2. FOR CLARITY, ONLY ONE TRAIN OF SELEXOL IS SHOWN. ALL EQUIPMENT AND PIPING IS DUPLICATED.
3. ALL VALVES, LINE SIZES, BREAK FLANGES, ETC. TO BE SPECIFIED BY PIPING GROUP.
4. ALL TANK VENTS AND RELIEF VALVES ARE ROUTED TO THE FLARE SYSTEM. FLARE GAS LINE NOT SHOWN FOR CLARITY.
5. INSTRUMENTATION NOT SHOWN FOR CLARITY.
6. SELEXOL DATA PER PLANT.

REFERENCE DRAWINGS

PROCESS PFD AIR SEPARATION SECTION	12-D-0-01
PROCESS PFD CO2 REMOVAL & COMPRESSION	12-D-0-02
PROCESS FLOW FUEL GAS COMBUSTOR & TURBINE	12-J-0-1006
PROCESS FLOW SELEXOL HYDROGEN PURIFICATION	12-J-0-1007
PROCESS FLOW SELEXOL HYDROGEN PURIFICATION	12-J-0-1009
PROCESS FLOW SELEXOL HYDROGEN PURIFICATION	12-J-0-1010
PLOT PLAN	12C-0-1
SYMBOLS & LEGEND-PLATE 1	00-A-1
SYMBOLS & LEGEND-PLATE 2	00-A-2
SYMBOLS & LEGEND-PLATE 3	00-A-3
SYMBOLS & LEGEND-PLATE 4	00-A-4

NO.	REVISION	BY	CHK'D	APP'D
2	REV. STRM REF.	RD		
1	ISSUE FOR PHASE I	RD		
0	ISSUE FOR REVIEW & APPROVAL			

DESIGNED	DRAWN	TRACED	CHECKED
RD	RD		

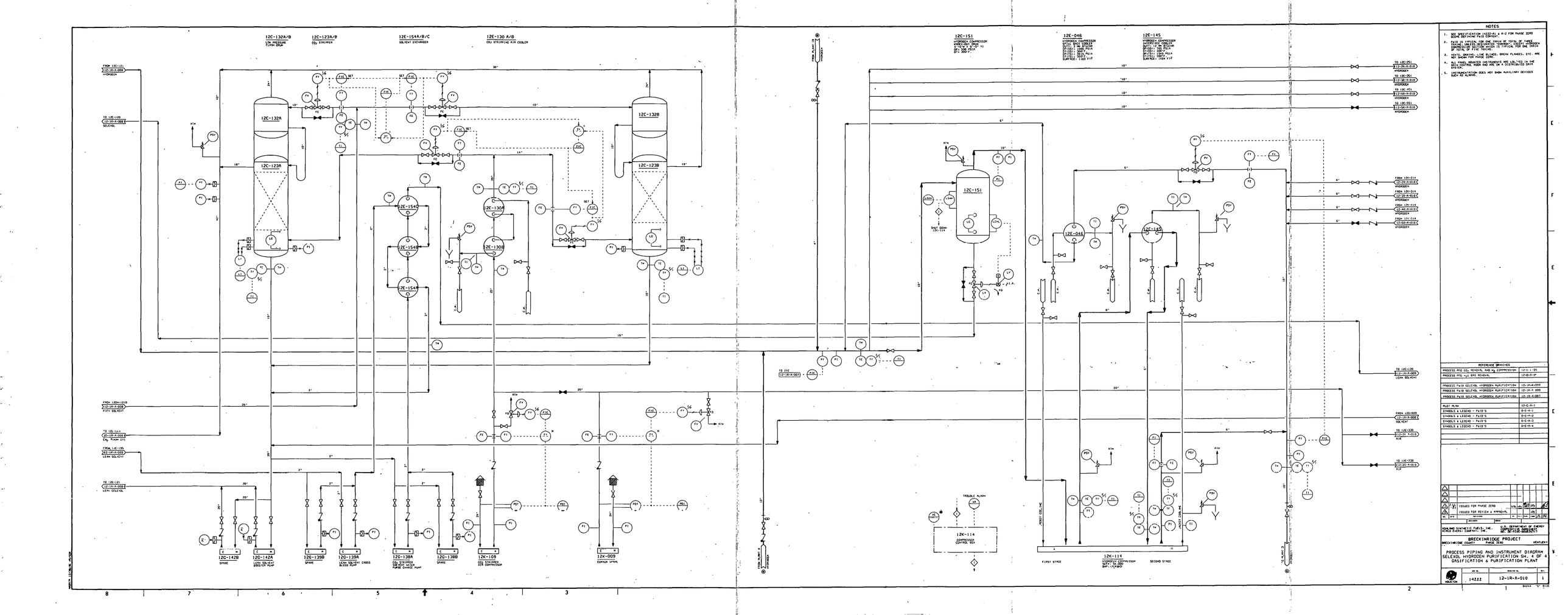
PROJECT MANAGER	U.S. DEPARTMENT OF ENERGY
CONTRACT NO.	DE-AC22-91ER20070

BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY, KENTUCKY

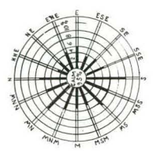
PROCESS PIPING AND INSTRUMENT DIAGRAM SELEXOL HYDROGEN PURIFICATION SH 2 OF 4 DESIGNATION PRE-PUMP PLANT

BECHTEL	14222	12-JR-A-008

2


12C-132A/B
LOW PRESSURE SELEXOL DRYER
12C-123A/B
CO2 STRIPPER
12E-154A/B/C
SOLVENT EXCHANGER
12E-130 A/B
CO2 STRIPPING AIR COOLER
12C-151
HYDROGEN COMPRESSOR
12E-046
HYDROGEN COMPRESSOR
12E-145
HYDROGEN COMPRESSOR
12C-132A
12C-123A
12C-132B
12C-123B
12E-154A
12E-154B
12E-154C
12E-130A
12E-130B
12C-151
12E-046
12E-145
12K-114
COMPRESSOR CONTROL SYSTEM
12C-142B
SPARE
12C-142A
LEAN SOLVENT BOOSTER PUMP
12C-139B
SPARE
12C-139A
LEAN SOLVENT CROSS FLOW PUMP
12C-138A
H2S STRIPPER FEED/WATER PURGE CHARGE PUMP
12C-138B
SPARE
12C-109
H2S STRIPPER AIR COMPRESSOR
12C-009
CONDEN SATE SPARE
FIRST STAGE
SECOND STAGE
FROM 12C-121 12-18-K-009 HYDROGEN
TO 12C-120 12-18-K-008 SELEXOL
FROM 12C-121A 12-18-K-008 RICH SOLVENT
TO 12E-154 12-18-K-008 CO2 FLASH GAS
FROM 12C-135 12-18-K-009 LEAN SOLVENT
TO 12C-121 12-18-K-008 LEAN SELEXOL
TO 12C-251 12-26-K-010 HYDROGEN
TO 12C-351 12-36-K-010 HYDROGEN
TO 12C-451 12-36-K-010 HYDROGEN
TO 12C-551 12-36-K-010 HYDROGEN
FROM 12K-211 12-26-K-010 HYDROGEN
FROM 12K-311 12-26-K-010 HYDROGEN
FROM 12K-411 12-26-K-010 HYDROGEN
FROM 12K-511 12-26-K-010 HYDROGEN
TO 12C-120 12-18-K-009 LEAN SOLVENT
FROM 12C-009 12-18-K-002 SOUR
TO 12E-220 12-24-K-010 AIR
TO 12E-220 12-12-K-010 AIR
FROM PLANT HYDROGEN
TO DISC 12-18-K-001
TO PLANT HYDROGEN
TROUBLE ALARM
SHUT DOWN 12K-114
ATm
PDI
PDT
PDSL
FE
FT
FIC
TE
TT
TI
TA
LE
LT
LIC
LSL
LSH
LSHH
PI
PSV
FBM
ANTI SURGE
SURGE LOOP
12 INCH
NOTES
1. SEE SPECIFICATION 14222-61, A-12 FOR PHASE ZERO SCOPE DEFINING P&ID CONTENT.
2. PAGE 26 SYMBOLOGY IS ONE SYMBOL OF TOTAL OF THREE (TRACING UNLESS DESIGNATED "ECONOMIC") FROM HYDROGEN PURIFICATION. HYDROGEN PURIFICATION IS TYPICAL FOR ONE SYSTEM OF TOTAL OF FIVE TRAINS.
3. VENTS, DRAINS, LINE BLINDS, BREAK FLANGES, ETC. ARE NOT SHOWN FOR PHASE ZERO.
4. ALL PANEL MOUNTED INSTRUMENTS ARE LOCATED IN THE CONTROL ROOM AND ARE ON A DISTRIBUTED DATA SYSTEM.
5. INSTRUMENTATION DOES NOT SHOW AUXILIARY DEVICES SUCH AS ALARMS.
REFERENCE GRAPHICS
PROCESS PFD CO2 REMOVAL AND H2 COMPRESSION 12-C-1-PS
PROCESS PFD H2S GAS REMOVAL 12-D-1-P
PROCCCC PAID SELEXOL HYDROGEN PURIFICATION 12-18-K-008
PROCESS PAID SELEXOL HYDROGEN PURIFICATION 12-18-K-009
PROCESS PAID SELEXOL HYDROGEN PURIFICATION 12-18-K-007
PILOT PLAN 12-C-A-1
SYMBOLS & LEGEND - PAID'S D-C-A-1
SYMBOLS & LEGEND - PAID'S D-C-A-2
SYMBOLS & LEGEND - PAID'S D-C-A-3
SYMBOLS & LEGEND - PAID'S D-C-A-4
ISSUED FOR PHASE ZERO
ISSUED FOR REVIEW & APPROVAL
KBR, MW SUSTAINABLE TECHNOLOGY, INC. A KELLOGG BROWN & ROOT COMPANY
U.S. DEPARTMENT OF ENERGY NATIONAL ENERGY TECHNOLOGY LABORATORY
BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY
PROCESS PIPING AND INSTRUMENT DIAGRAM SELEXOL HYDROGEN PURIFICATION SH. 4 OF 4 GASIFICATION & PURIFICATION PLANT
HOUSTON
JOB NO. 14222
DRAWING NO. 12-18-K-010
REV. 1
SCALE: 1/4" = 1'-0"

TRUE NORTH 5°0'
PLANT NORTH 0°0'



LEGEND

1. COAL DRYING AND PULVERIZING
2. COAL SLURRY PREPARATION
3. H-COAL PREHEATING AND REACTION
4. H-COAL PRIMARY SEPARATION
5. H-COAL RECYCLE SLURRY PREPARATION
6. H-COAL RECYCLE HYDROGEN CONCENTRATION AND COMPRESSION
7. GAS PLANT
8. CRYOGENIC HYDROGEN PURIFICATION
9. SOUR WATER TREATING
10. SULFUR PLANT
12. GASIFICATION AND PURIFICATION
15. OXYGEN PLANT
17. DISTILLATE SEPARATION
18. NAPHTHA TREATING AND REFORMING
20. TANKAGE
21. INTERCONNECTING PIPING (PIPERACKS)
22. RIVER LOADING FACILITIES
23. RAIL AND TRUCK LOADING
26. COAL RECIEVING AND STORAGE
27. COAL WASHING AND SECONDARY CRUSHING
31. STEAM GENERATION AND B.F.W. TREATING
32. WATER SYSTEM
33. FIRE SYSTEM
34. WASTE WATER TREATMENT PLANTS
35. STACK GAS SCRUBBING
36. INSTRUMENT AIR AND PLANT AIR SYSTEM
38. INERT GAS SYSTEM
39. PURGE AND FLUSH OIL SYSTEM
42. WASTE SLUDGE INCINERATOR.

A. WAREHOUSE
B-1 THRU B-6. MAINTENANCE BUILDINGS
C. COOLING TOWERS (PLT. 32)
D. DEAD COAL (PLT. 26)
E. LIQUID OXYGEN AND NITROGEN UNLOADING
F. WATER INTAKE
G. CHANGE HOUSE
H. FIRE STATION
J. FIRST AID STATION
K. CAFETERIA
L. PARKING
M. ADMINISTRATION
N. RAILROAD COAL UNLOADING (PLT. 26)
P. FULL BARGES, 24 BARGE TOW (PLT. 22)
Q. COAL UNLOADING DOCK (PLT. 22)
R. EMPTY BARGES, 24 BARGE TOW (PLT. 22)
S. LIQUID LOADING DOCK (PLT. 22)
T. SWITCHGEAR | ZZ SUBSTATION
U. RAW COAL (PLT. 26)
V. FLY ASH UNLOADING AREA (PLT. 31)
W. RAW WATER POND
X. CSP RUNOFF TREATING AREA (PLT. 34)
Y. COAL STORAGE PILES (CSP) RUNOFF POND (PLT. 34)
Z. CONTROL ROOM
AA. COOLING TOWER SOFTENING AND FILTRATION (PLT. 32)
BB. WASTE WATER CONCENTRATION AND EVAPORATION SYSTEM (PLT. 34)
CC. ASH HANDLING. (PLT. 31)
DD. TANK TRUCK LOADING (PLT. 23)
EE. FIRE WATER TANK (PLT. 33)
FF. SANITARY SEWAGE TREATMENT PLANT (PLT. 34)
GG. REFUSE BUNKER (PLT. 27)
HH. EMERGENCY POND (PLT. 27)
JJ. PLANT FEED BUNKER (PLT. 26)
KK. POST TREATMENT OF STRIPPED SOUR WATER (PLT. 34)
LL. OILY WATER SURGE POND (PLT. 34)
MM. OILY WATER TREATMENT (PLT. 34)
NN. CLEAN COAL STORAGE (PLT. 26)
PP. BOILER FUEL STORAGE (PLT. 26)
QQ. SUMP AND TANK FOR INCINERATOR (PLT. 42)
RR. GATE HOUSE
SS. GUARD/SECURITY HOUSE
TT. OPERATING EQUIPMENT ROOM
UU. RAIL LOADING (PLT. 23)
VV. OPERATOR SHELTER
WW. LABORATORY
XX. SPECIAL CLEANING
YY. GARAGE

NOTES

1. SITE COORDINATES N5000'-0" E5000'-0" ARE ESTABLISHED AT THE MOUTH OF TOWN CREEK AT THE INTERSECTION OF THE WATER LINE OF THE OHIO RIVER.
   II REFERENCE: COMMONWEALTH LAND TITLE INSURANCE COMPANY PHILADELPHIA, PENNSYLVANIA FILE No. L-055292.
2. HIGH POINT OF FINISHED GRADE ELEVATION 100'-0" EQUALS ELEVATION 415'-0" ABOVE M.S.L.
3. NORMAL WATER ELEVATION OF OHIO RIVER IS EL. 382.3 AT RIVER MILE 706.
4. MEAN HIGHWAY ELEVATION IS EL. 415'-0"
5. TOP OF RAILROAD BALLAST EL. IS 415'-0"

REFERENCE DRAWINGS

50E-A-4 INDEX DRAWING
50E-A-6 CONSTRUCTION REQUIREMENT STUDY

0 200 400 600 800 1000
1"=400'-0"
GRAPHIC SCALE

NO.	DATE	REVISIONS	BY	CHK'D	SUPV. ENG'R	BY APPR.	ASST APPR.
3	10/1/79	ISSUED FOR PHASE ZERO	P.P.	J.K.	J.K.	W.S.	
2	4/1/79	ISSUED FOR REVIEW AND APPROVAL	R.	J.K.	J.K.	W.S.	
1							

SCALE 1"=400' DESIGNED J. KUTLIK DRAWN T. BRISTOW

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-800R20111

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

OVERALL SITE PLAN

HOUSTON	JOB NO.	DRAWING NO.	REV.
	14222	50E-A-1	1

34 X 44 "E" SIZE

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

H G F E D C B A

P&ID LINE WORK STANDARDS

		LINE WIDTH
1.	INSTRUMENTATION	0.010 IN.
2.	GENERAL LINEWORK SYMBOLS & EQUIP	0.022 IN.
3.	PROCESS LINES	0.022 IN.
4.	MAIN PROCESS LINE	0.045 IN.
5.	DRAINS, VENTS & SAFTEY VALVES	0.022 IN.
6.	TEXT, 1/10" HIGH	0.010 IN.
7.	ARROWS FOR LINE WEIGHT 0: ◄ 1: ◄ 3: ◄	
A.	ELECTRICAL SIGNALS — 0.1" LINE, 0.1" SPACE	
B.	PNEUMATIC SIGNALS — 1/8",45° SLASHES AT 0.6" SPACING	
C.	CAPILLARY TUBE — 1/8", TEXT "X" AT 0.6" SPACING	
D.	HYDRAULIC SIGNAL — 1/8" TEXT "L" AT 0.6" SPACING	
E.	ELECTROMAGNETIC RADIATION OR SONIC SIGNAL — 01" DIA. ARCS AT 0.6" SPACING	
F.	OTHER SYSTEMS, BLDG. OUTLINES & EQUIPMENT — 0.5" (NOTE 1) 0.3" LINE, 0.1" SPACE	
G.	CENTER LINE — 0.5" (NOTE 1) 0.9",0.1" LINES, 0.1" SPACE	
H.	FURNISHED BY OTHERS — 0.6" (NOTE 1) 0.9",0.1" LINES, 0.1" SPACE	
I.	UNDERGROUND — 0.4" LINE,0.1" SPACE	
J.	UNDERGROUND (EXISTING) — 0.5",0.1" LINES,0.1" SPACE	
K.	EXISTING	

P&ID SYMBOL SIZES

1.	INSTRUMENT CIRCLE	0.6" DIA.
2.	MISCELLANEOUS EQUIPMENT	0.35" SIDES
3.	TIE-IN POINT BETWEEN NEW & EXISTING	0.40" SIDES
4.	LINE BREAK OR RESUMPTION POINT	0.25" X 1.4"
5.	INSTRUMENTATION TO/FROM	0.25" X 1.2"
6.	GRID NUMBER (A/2)	0.50" X 0.25"
7.	FURNISHED WITH EQUIPMENT	0.2" LINES

STATUS SYMBOLS - LINE VALVES

1. OPEN DURING NORMAL OPERATION (ALL VALVES EXCEPT BUTTERFLY)
2. CLOSED DURING NORMAL OPERATION
3. NO — OPEN DURING NORMAL OPERATION (BUTTERFLY ONLY)
4. NC — CLOSED DURING NORMAL OPERATION (BUTTERFLY ONLY)
5. LO — LO - LOCKED OPEN; LC - LOCKED CLOSED; CSO - CAR SEALED OPEN; CSC - CAR SEALED CLOSED

MABOOA 12/2/80 RH

PROCESS PIPING

1. MAIN PROCESS LINE
2. SECONDARY PROCESS LINE
3. CONCENTRIC REDUCER - INCREASER
4. ECCENTRIC REDUCER - INCREASER
5. WELDED CAP
6. SCREWED CAP
7. HOSE CONNECTION
8. QUICK DISCONNECT
9. REMOVABLE SPOOL
10. FLEXIBLE CONNECTION
11. BLIND FLANGE
12. INSULATING FLANGES (IF) OR DIELECTRIC UNION (DU) (SHOWN) — DU
13. BREATHER CAP
14. LOOP SEAL
15. (1/8) DOWNWARD SLOPE (1" PER 8' SHOWN)
16. (1/5) UPWARD SLOPE (1" PER 5' SHOWN)
17. ATM. OR — ATMOSPHERIC VENT
18. H — 0.2" WIDE, 0.8" LONG MAX. — HEAT CONSERVATION
19. B — 0.2" WIDE, 0.8" LONG MAX. — PROCESS CONTROL
20. C — 0.2" WIDE, 0.8" LONG MAX. — COLD INSULATION
21. T — 0.2" WIDE, 0.8" LONG MAX. — STEAM TRACING
22. E — 0.2" WIDE, 0.8" LONG MAX. — ELECTRIC TRACING
23. PP — 0.2" WIDE, OB" LONG MAX. — PERSONAL PROTECTION INSULATION
24. 0.2" WIDE, 0.8" LONG MAX. — JACKETED
25. SR — STRESS RELIEVE

LINE VALVES AND CONTROL VALVE BODIES

1. GATE
2. GATE WITH CAVITY VENT ON HIGH PRESSURE SIDE
3. GLOBE
4. ANGLE
5. THREE-WAY
6. FOUR-WAY
7. NEEDLE
8. PLUG (2-WAY)
9. PLUG (3-WAY)
10. PLUG (4-WAY)
11. BALL (2-WAY)
12. BALL (3-WAY)
13. DIAPHRAGM
14. BUTTERFLY
15. ECCENTRIC DISK
16. CHECK (FLOW DIRECTION ——► SHOWN)
17. CHECK WITH 1/8 DIA. HOLE DRILLED IN DISC
18. CHECK WITH FUSIBLE LINK
19. FCV — FLOW LIMITING (OR EXCESS FLOW CHECK)
20. STOP CHECK
21. QUICK OPENING
22. BLOWDOWN
23. VALVE PLUGGED
24. VALVE WITH BLIND FLANGE
25. HAND ACTUATOR
26. A — ACTUATOR: G - GEAR (SHOWN); A - AIR WRENCH; CH - CHAIN; E - EXTENSION STEM; S - SPECIAL TYPE

MISCELLANEOUS

1. SPECTACLE BLIND
2. CIRCULAR OR HAMER BLIND
3. BS — SIMPLEX BASKET STRAINER
4. BS — DUPLEX BASKET STRAINER
5. YS — Y-TYPE STRAINER (SHOWN WITHOUT BLOWOFF VALVE)
6. SU — TEMPORARY STARTUP STRAINER
7. SC — SCREEN TYPE STRAINER
8. F — FILTER
9. XJ — EXPANSION JOINT
10. NSE — FLAME ARRESTER
11. ST — TRAP: ST - STEAM TRAP (SHOWN); AT - AIR TRAP; DT - DRAIN TRAP
12. C125 ——► S325 — PIPE SPEC. CHANGE
13. EJECTOR OR EDUCTOR
14. EXHAUST HEAD
15. SPRAY NOZZLE OR SPARGER (SHOWN WITH UPWARD FLOW)
16. DESUPERHEATER
17. S/2 — SAMPLING CONNECTION (NO. INDICATES TYPE)
18. SC/2 — SAMPLE COOLER (NO. INDICATES TYPE)
19. SO — STEAM OUT
20. W A S — UTILITY STATION (WATER, AIR, STEAM SHOWN)
21. DF — DRINKING FOUNTAIN
22. HEATING COIL

MISCELLANEOUS (CONTINUED)

22. IN-LINE MIXER
23. COLD BOX
24. MODULATING-TYPE BY-PASS RECIRCULATING VALVE (YARWAY)
25. C — ASME BOILER PRESSURE VESSEL CODE LIMITS
26. DWS — DRAIN TO SEWER: DWS - OILY WATER SEWER (SHOWN); SWS - SANITARY WATER SEWER; CS - CHEMICAL SEWER; WS - WATER SEWER (STORM DRAIN)
27. AIR FILTER

CONTROL VALVE FAILURE MODES

1. FO — TWO-WAY (TYPICAL, GLOBE SHOWN): FO - INDICATES FAIL OPEN; FC - INDICATES FAIL CLOSED; FL - INDICATES FAIL LOCKED (POSITION DOES NOT CHANGE); FI - INDICATES FAIL INDETERMINATE
2. FO — 3-WAY
3. FO — 4-WAY

FIRE PROTECTION

1. FIRE HYDRANT
2. FIRE HYDRANT WITH PUMPER CONNECTION
3. FIRE HYDRANT WITH MONITOR (PUMP CONNECTION SHOWN)
4. M — ELEVATED MONITOR
5. 14 — HOSE AND STAND PIPE SYSTEM PER NFPA-14
6. 15 — FIXED SPRAY SYSTEM PER NFPA-15
7. 13 — SPRINKLER SYSTEM PER NFPA-13
8. A — HALON 1301 SYSTEM PER NFPA-12A
9. 12 — CO_2 SYSTEM PER NFPA-12
10. H — HOSE HOUSE
11. DELUGE VALVE — DELUGE VALVE
12. HR — HOSE REEL
13. POST INDICATOR VALVE

NOTES:
(1) MINIMUM LENGTH AND FORMAT FOR LINES.
(2) ALL LINE PATTERNS BASED ON 1.2" REPEAT PATTERN
(3) ALL LINES MUST MEET AT CORNERS. SYMBOLS & EQUIPMENT LINES MAY NOT START WITH A SPACE.

NO.	DATE	REVISIONS	BY	CH'K	SUPV.	ENGR.	PROJ. MGR.	DEPT. MGR.
1	2-26-81	ISSUED FOR PHASE 0	WAC	WAC	GD	WS	GD	
0		ISSUED FOR REVIEW / APPROVAL	WAC	WAC	GD	WS		

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-800R20717

BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY — PHASE ZERO — KENTUCKY

SYMBOLS & LEGEND
PIPING & INSTRUMENT DIAGRAMS

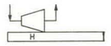
HOUSTON | JOB NO. 14222 | DRAWING NO. OE-A-1 | REV. 1

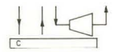
34X44 "E" SIZE

EQUIPMENT

1.  FILTER

2.  MOTOR DRIVEN PUMP, COMPRESSOR OR BLOWER (CENTRIFUGAL SHOWN)

3.  HYDRAULIC TURBINE DRIVEN PUMP

4.  TURBINE DRIVEN PUMP, COMPRESSOR OR BLOWER

5.  TURBOEXPANDER (ELECTRICAL GENERATOR SHOWN)

6.  RECIPROCATING AIR COMPRESSOR (INSTRUMENT & SERVICE)

7.  SCREEN

8.  VERTICAL CENTRIFUGAL OR SUMP PUMP (MOTOR DRIVEN SHOWN)

9.  BELT CONVEYOR

10.  MIXER

11.  EDUCTOR

12.  ROLL CRUSHER

HEAT EXCHANGERS

1.  FIN TUBE DOUBLE PIPE

2. AIR COOLER

3. AIR COOLER (PITCH CONTROL)

4. REBOILER & CHILLER KETTLE TYPE

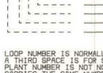
5. ELECTRIC HEATER

6. HEATER, COOLER OR CONDENSER

7. SURFACE CONDENSER

VESSELS, TANKS, ETC.

1.  PRESSURE VESSELS, VERTICAL (SHOWN) OR HORIZONTAL (TANKS, RECEIVERS, DRYERS, SEPARATORS, ETC.)

2.  CLARIFIER

3. CONE ROOF TANK

4. FLOATING TOP TANK

5.  FIRED HEATER

6. SUMP

7. GASIFIER

LEGEND FOR ROTATING EQUIPMENT

C - CENTRIFUGAL
P - PROPORTIONING
R - RECIPROCATION
RO - ROTARY
M - MOTOR DRIVEN
T - TURBINE DRIVEN
H - HYDRAULIC TURBINE DRIVEN

DESIGNATIONS
INSTRUMENT TAGGING

COMPLETE TAG NUMBER

PV 12 3 5B A

- PV — ISA FUNCTION
- 12 — PLANT NUMBER
- 3 — TRAIN NUMBER (SINGLE TRAIN IS 1)
- 5B — LOOP NUMBER
- A — MODIFIER, A, B, C ETC.

LOOP NUMBER IS NORMALLY TWO DIGITS, 10 THROUGH 99.
A THIRD SPACE IS FOR SPILLOVER.
PLANT NUMBER IS NOT NORMALLY SHOWN IF IT CARRIES THE SAME NUMBER AS THE DRAWING.

PV 348A FOR EXAMPLE

NO.	DATE	REVISIONS	BY	CH'K	SUPV.	ENGR.	AI SUPV.	JOINT APPR.
1	2-16-91	ISSUED FOR PHASE 0	JDC	AH	HS	HS		EP
0		ISSUED FOR REVIEW / APPROVAL	DWP	AH	AH	HS		

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

SYMBOLS & LEGEND
PIPING & INSTRUMENT DIAGRAMS

HOUSTON | JOB NO. 14222 | DRAWING NO. OE-A-2 | REV. 1

34X44 "E" SIZE

MRBGBA 12/02/90 BM

8 7 6 5 4 3 2 1

H G F E D C B A

GENERAL INSTRUMENTS

1. LOCAL MOUNTED
2. MAIN PANEL MOUNTED
3. BEHIND MAIN PANEL
4. LOCAL PANEL MOUNTED
5. BEHIND LOCAL PANEL
6. COMBINATION
   2 SERVICES (NOTE 1, DWG. O-EA-4)

SENSORS - FLOW

1. FE – ORIFICE PLATE
   FD – RESTRICTION ORIFICE
2. ORIFICE PLATE IN QUICK-CHANGE FITTING
3. VENTURI TUBE OR FLOW NOZZLE
4. PITOT OR PITOT-VENTURI TUBE
5. FORWARD-REVERSE PITOT TUBE
6. FLUME
7. WEIR
8. TURBINE OR PROPELLER TYPE
9. ROTAMETER
10. IN-LINE INSTRUMENT (NOTE 2, DWG. O-EA-4)
11. FLOW STRAIGHTENING VANES

SENSORS - LEVEL

1. GAGE GLASS OR FLOAT OR DISPLACEMENT TYPE LEVEL INSTRUMENT
2. DIFFERENTIAL PRESSURE TYPE (NOTE 3, DWG. O-EA-4)
3. (NOTE 3, DWG. O-EA-4)
   TANK-MOUNTED DIFFERENTIAL PRESSURE TYPE
4. [illegible] TYPE
5. GAGE BOARD TYPE

SENSORS - PRESSURE

1. DIRECT CONNECTED
2. WITH DIAPHRAGM SEAL, PIPED

SENSOR - ANALYSIS

1. THROUGH-FLOW TYPE
2. NON THROUGH-FLOW TYPE

SENSORS - TEMPERATURE

1. TI – BIMETALLIC THERMOMETER
   TW – THERMOWELL
   TE – SINGLE SENSOR
2. DUAL SENSOR (SHOWN WHEN BOTH ARE USED)
3. FILLED SENSOR

VALVE BODIES & FAILURE MODES

SEE DWG. O-EA-1
(NOTE 4, DWG. O-EA-4)

VALVES - ACTUATORS

1. PNEUMATIC DIAPHRAGM
2. DIAPHRAGM, PRESSURE BALANCED
3. ROTARY MOTOR (SHOWN TYPICALLY WITH ELECTRIC SIGNAL)
4. PNEUMATIC CYLINDER, SINGLE ACTING
5. HYDRAULIC CYLINDER, DOUBLE ACTING
6. PNEUMATIC CYLINDER, DOUBLE ACTING
7. PNEUMATIC CYLINDER, DOUBLE ACTING, WITH PILOT VALVE
8. SINGLE SOLENOID RESET AFTER LATCH
9. ELECTRO-HYDRAULIC (SHOWN) OR PNEUMATIC-HYDRAULIC (SYMBOL P/H)
10. UNCLASSIFIED (TYPE OF ACTUATOR TO BE WRITTEN ADJACENT TO THE SYMBOL)

VALVE BODY WITH ACTUATOR - TYPICAL

(NOTE 4, DWG. O-EA-4)

1. FV, FC

SELF-ACTUATED DEVICES - FLOW

1. FCV – FLOW REGULATOR (NOTE 5, DWG. O-EA-4)
2. FG – SIGHT FLOW GLASS

SELF-ACTUATED DEVICES - LEVEL

1. LCV – LEVEL REGULATOR WITH MECHANICAL LINKAGE

SELF-ACTUATED DEVICES - PRESSURE

1. PCV – PRESSURE REDUCING REGULATOR SELF-CONTAINED
2. PCV – PRESSURE REDUCING REGULATOR WITH EXTERNAL PRESSURE TAP
3. PDCV – DIFFERENTIAL PRESSURE REDUCING REGULATOR WITH INTERNAL AND EXTERNAL PRESSURE TAPS
4. PCV – BACKPRESSURE REGULATOR SELF-CONTAINED
5. PCV – BACKPRESSURE REGULATOR WITH EXTERNAL PRESSURE TAP
6. PSV – PRESSURE RELIEF OR SAFETY VALVE, ANGLE PATTERN SPRING OR WEIGHT LOADED, OR WITH INTEGRAL PILOT
7. PSV – VACUUM RELIEF VALVE, ANGLE PATTERN SPRING OR WEIGHT LOADED, OR WITH INTEGRAL PILOT
8. PSV – PRESSURE AND VACUUM RELIEF VALVE
9. PSE – RUPTURE DISK OR SAFETY HEAD, FOR PRESSURE RELIEF
10. PSE – RUPTURE DISK OR SAFETY HEAD, FOR VACUUM RELIEF

SELF-ACTUATED DEVICES - TEMPERATURE

1. TCV – TEMPERATURE REGULATOR, FILLED SYSTEM TYPE

HAND ACTUATED DEVICES

1. HCV – TWO-WAY HAND CONTROL VALVE IN PROCESS LINE (NOTE 6, DWG. O-EA-4)
2. HO – MANUALLY ADJUSTABLE RESTRICTION ORIFICE IN SIGNAL LINE
3. HS – TWO-WAY HAND ACTUATED SWITCHING VALVE IN PNEUMATIC SIGNAL LINE

MISCELLANEOUS DEVICES

(NOTE 7, DWG. O-EA-4)

TYPICAL SYMBOL

1. SIGNAL RELAY (NOTE 8, DWG. O-EA-4)

RELAY SIGNALS

2. √ – SQUARE ROOT EXTRACTOR
3. E/P – VOLTAGE TO PNEUMATIC CONVERTER
4. I/P – CURRENT TO PNEUMATIC CONVERTER
5. E/I – VOLTAGE TO CURRENT CONVERTER
6. Σ – ADD AND SUBTRACT
7. > – HIGH SELECT
8. < – LOW SELECT
9. ± – BIAS
10. × – MULTIPLY
11. ÷ – DIVIDE

FOR ADDITIONAL RELAY SYMBOLS, SEE ISA S5.1, TABLE 2

12. P – PURGE DEVICE (MEANS OF REGULATING PURGE MAY BE SHOWN IN PLACE OF THE SYMBOL). PURGE FLUID AND POWER SUPPLIES ARE:
    AIR SUPPLY
    ELECTRICAL SUPPLY
    GAS SUPPLY
    HYDRAULIC FLUID SUPPLY
    NITROGEN SUPPLY
    STEAM SUPPLY
    WATER SUPPLY
14. I – INTERLOCK
15. A – "AND" INTERLOCK – EFFECTIVE ONLY IF ALL INPUT EXIST
16. O – "OR" INTERLOCK – EFFECTIVE IF ONE OR MORE INPUT EXISTS
17. ACS – ANALOG CONTROL SIGNAL
18. BCS – BURNER CONTROL SIGNAL

NO.	DATE	REVISIONS	BY	CHK'D	SUPV.	ENGR.	PROJ. MGR.
1	2/21/81	ISSUED FOR PHASE 0	VBC	VBC	[illegible]	[illegible]	[illegible]
0		ISSUED FOR REVIEW / APPROVAL	[illegible]	[illegible]	[illegible]	[illegible]	

DESIGNED | DRAWN

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-800R20717

BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

SYMBOLS & LEGEND
PIPING & INSTRUMENT DIAGRAMS

HOUSTON | JOB NO. 14222 | DRAWING NO. OE-A-3 | REV. 1

34X44 "E" SIZE

MARSTON 12/22/80 RM

8 7 6 5 4 3 2 1

H G F E D C B A

FIRST LETTER (NOTE 9)		SUCCEEDING LETTER(S) (NOTE 9)																		
		SENSING DEVICE (NOTE 5)		DISPLAY DEVICE						CONTROL DEVICE (NOTE 5)						MISCELLANEOUS DEVICE				
							ALARM ANNUNCIATOR (NOTE 15)													
MEASURED OR INITIATING VARIABLE (NOTE 10)	SYMBOL	PRIMARY ELEMENT	TRANSMITTER	INDICATOR	RECORDER	INTEGRATING INDICATOR	LOW	HIGH	HIGH & LOW	CONTROL STATION MAN/AUTO	CONTROLLER	CONTROL VALVE	SELF-ACTUATED VALVE	OTHER FINAL CONTROL ELEMENT (NOTE 16)	SWITCH (NOTE 17)	LOCAL OBSERVATION GLASS	TEST POINT CONNECTION (NOTE 18)	RELAY, COMPUTER (NOTE 5)	USER'S CHOICE (NOTE 13)	UNCLASSIFIED (NOTE 14)
TYPICAL SYMBOL	( )	( )E	( )T	( )I	( )R	( )QI	( )AL	( )AH	( )AHL	( )K	( )C	( )V	( )CV	( )Z	( )G	( )O	( )P	( )Y	( )B ( )N	( )X
ANALYSIS (NOTE 11)	A	AE	AT	AI	AR		AAL	AAH	AAHL	AK	AC	AV		AZ	AS		AP	AY	AB AN	AX
BURNER FLAME	B	BE	BT	BI	BR		BAL				BC	BV			BS	BQ	BP	BY	BB BN	BX
CONDUCTIVITY	C	CE	CT	CI	CR		CAL	CAH	CAHL	CK		CV		CZ	CS		CP	CY	CB CN	CX
DENSITY (MASS) OR WEIGHT	D	DE	DT	DI	DR		DAL	DAH	DAHL	DK	DC	DV		DZ	DS		DP	DY	DB DN	DX
VOLTAGE (EMF)	E	EE	ET	EI	ER		EAL	EAH	EAHL	EK	EC			EZ	ES			EY	EB EN	EX
FLOW (NOTE 12)	F	FE	FT	FI	FR	FQI	FAL	FAH	FAHL	FK	FC	FV	FCV	FZ	FS	FQ	FP	FY	FB FN	FX
GAGING (DIMENSIONAL)	G	GE	GT	GI	GR		GAL	GAH	GAHL	GK	GC				GS			GY	GB GN	GX
HAND (MANUAL)	H										HC	HV	HCV	HZ	HS		HP	HY		
CURRENT	I	IE	IT	II	IR	IQI	IAL	IAH	IAHL	IK	IC			IZ	IS			IY	IB IN	IX
POWER	J	JE	JT	JI	JR	JQI	JAL	JAH	JAHL	JK	JC			JZ	JS			JY	JB JN	JX
TIME	K		KT	KI		KQI	KAL	KAH	KAHL		KC	KV		KZ	KS			KY	KB KN	KX
LEVEL	L	LE	LT	LI	LR		LAL	LAH	LAHL	LK	LC	LV	LCV	LZ	LS	LQ	LP	LY	LB LN	LX
MOISTURE	M	ME	MT	MI	MR		MAL	MAH	MAHL	MK	MC	MV		MZ	MS		MP	MY	MB MN	MX
USER'S CHOICE	O																			
PRESSURE	P	PE	PT	PI	PR		PAL	PAH	PAHL	PK	PC	PV	PCV	PZ	PS		PP	PY	PB PN	PX
PRESSURE DIFFERENTIAL	PD		PDT	PDI	PDR		PDAL	PDAH	PDAHL	PDK	PDC	PDV	PDCV	PDZ	PDS					
QUANTITY OR EVENT	Q		QT	QI	QR	QQI	QAL	QAH	QAHL	QK	QC	QV		QZ	QS			QY	QB QN	QX
SPEED OR FREQUENCY	S		ST	SI	SR	SQI	SAL	SAH	SAHL	SK	SC			SZ	SS			SY	SB SN	SX
TEMPERATURE	T	TE	TT	TI	TR		TAL	TAH	TAHL	TK	TC	TV	TCV	TZ	TS		TP	TY	TR TN	TX
MULTIVARIABLE	U			UI	UR		UAL	UAH	UAHL		UC	UV		UZ	US			UY	UB UN	UX
VISCOSITY	V		VT	VI	VR		VAL	VAH	VAHL	VK	VC	VV		VZ	VS		VP	VY	VB VN	VX
WEIGHT	W	WE	WT	WI	WR	WQI	WAL	WAH	WAHL	WK	WC	WV		WZ	WS			WY	WB WN	WX
UNCLASSIFIED (NOTE 14)	X																			
VIBRATION	Y	YE	YT	YI	YR			YAH							YS		YP	YY	YB YN	YX
POSITION	Z	ZE	ZT	ZI	ZR		ZAL	ZAH	ZAHL		ZC			ZZ	ZS			ZY	ZB ZN	ZX

GENERAL NOTES

1. EXAMPLES OF THE USE OF TANGENTIAL INSTRUMENT CIRCLES TO DENOTE A SINGLE INSTRUMENT WITH TWO VARIABLES AND/OR TWO FUNCTIONS.

   TWO VARIABLES: FR/PR, A 2 PEN RECORDER, ONE FOR FLOW ONE FOR PRESSURE.

   TWO FUNCTIONS: LIC/I, A DUAL-PILOT LEVEL INSTRUMENT, ONE TRANSMITTER AND ONE CONTROLLER.

   HCV/ZSH, MANUAL CONTROL VALVE WITH POSITION SWITCH.

2. THE TYPE OF FLOW INSTRUMENT MAY BE NAMED OUTSIDE THE INSTRUMENT CIRCLE, E.G. MAGNETIC FLOW METER, DISPLACEMENT METER, MASS FLOW METER, ETC.

3. THE UPPER INSTRUMENT LEAD LINE IS OMITTED IF LEVEL IS MEASURED BY PRESSURE INSTEAD OF DIFFERENTIAL PRESSURE.

4. VALVE BODY PORTS THAT ARE CLOSED IN NORMAL OPERATION ARE BLACKENED. THE OPERATING CONDITION SHOWN FOR ALL VALVE SYMBOLS (UNMISPOKEN TO FULL-LOAD OR NORMAL OPERATION REGARDLESS OF THE TYPE OF ACTUATOR OR WHETHER THE ACTUATOR IS ENERGIZED OR DE-ENERGIZED DURING THIS MODE OF OPERATION. FOR 3-WAY VALVES, PORT THAT CLOSES DURING UPSETS CONTAINS A DOT.

5. A CONTROL OR SENSING DEVICE OR RELAY HAVING A DISPLAY FUNCTION SHOULD HAVE THE APPROPRIATE DISPLAY LETTERS ADDED AFTER THE MEASURED VARIABLE DESIGNATION, E.G. CIC DESIGNATES ANALYSIS INDICATING CONTROL STATION.

6. A HAND CONTROL VALVE HCV IS A HAND-ACTUATED VALVE THAT EITHER MODULATED A PROCESS STREAM OR IS USED AS AN INSTRUMENT DEVICE.

7. FOR ROOT AND OTHER INSTRUMENT VALVES, SEE INSTRUMENT INSTALLATION DETAILS

8. THE DESCRIPTION DENOTING A RELAY FUNCTION SHOULD BE SHOWN ON THE P&ID EXCEPT WHEN USED WITH DISTINCTIVE SYMBOLS SUCH AS A SOLENOID VALVE.

   A DOUBLE SOLENOID VALVE IS DRAWN WITH TWO SINGLE SOLENOIDS.

9. THE INSTRUMENT LEGEND IS BASED ON ISA STANDARD S5.1-1973 FOR FURTHER DETAILS AND CLARIFICATION, REFER TO ISA STANDARD.

10. ANY FIRST LETTER MAY BE MODIFIED BY THE FOLLOWING LETTERS:

    D - DIFFERENTIAL (PD - PRESSURE DIFFERENTIAL)
    J - SCAN (AJ) - SCANNING ANALYZER INDICATOR)
    Q - INTEGRATE OR TOTALIZE (FQI - FLOW INTEGRATING INDICATOR)

11. THE LETTER A IS USED FOR ALL ANALYSIS VARIABLES. THE FOLLOWING TERMS MAY BE PLACED OUTSIDE THE INSTRUMENT CIRCLE OF A LOOP TO DENOTE THE SPECIFIC VARIABLES.

CHR	- CHROMATOGRAPH	NOX	- NITROGEN OXIDES
CL	- CHLORINE	O	- DISSOLVED OXYGEN
CO	- CARBON MONOXIDE	O2	- GASEOUS OXYGEN
COMB	- COMBUSTIBLE	ORP	- OXIDATION REDUCTION
COND	- CONDUCTIVITY	PH	- PH
H	- DISSOLVED HYDROGEN	SIO2	- SILICA
H2	- GASEOUS HYDROGEN	SO2	- SULPHUR DIOXIDE
H2S	- HYDROGEN SULFIDE	TRB	- TURBIDITY
M	- MOISTURE	VIS	- VISCOSITY
N	- NITROGEN		

12. FD - DESIGNATES FLOW RESTRICTION ORIFICE
    FF - DESIGNATES FLOW RATIO
    FFC - DESIGNATES FLOW RATIO CONTROLLER

13. A USER'S CHOICE LETTER B OR N FOR UNLISTED MEANINGS THAT WILL BE USED REPETITIVELY ON A PARTICULAR PROJECT. THE MEANINGS WILL BE DEFINED ONLY ONCE FOR THAT PROJECT AND HAVE ONE MEANING AS THE FIRST LETTER AND ANOTHER SINGLE MEANING AS THE SUCCEEDING LETTER.

14. THE LETTER X IS FOR UNLISTED MEANINGS THAT WILL BE USED ONLY ONCE OR TO A LIMITED EXTENT. IT MAY HAVE ANY NUMBER OF MEANINGS AS A FIRST LETTER AND ANY NUMBER OF MEANINGS AS A SUCCEEDING LETTER, EXCEPT FOR ITS USE WITH DISTINCTIVE SYMBOLS. THE MEANINGS WILL BE DEFINED OUTSIDE THE INSTRUMENT CIRCLE.

15. HIGH-HIGH ALARMS HAVE ( )HH; LOW-LOW ALARMS HAVE ( )LL, AND HIGH-LOW ALARMS HAVE ( )HAL IN INSTRUMENT CIRCLE, E.G.

    LAHH - DESIGNATES HIGH-HIGH LEVEL ALARM
    LALL - DESIGNATES LOW-LOW LEVEL ALARM
    LAHL - DESIGNATES HIGH-LOW LEVEL ALARM

16. THE LETTER Z WHICH FOLLOWS A MEASURED VARIABLE REPRESENTS FINAL DEVICES OTHER THAN CONTROL VALVES SUCH AS HYDRAULIC COUPLINGS, VARIABLE SPEED DRIVE, ACTUATOR, ETC.

17. THE LETTERS H, HH, L, LL AND HL ARE ADDED TO THE MEASURED VARIABLES FOR HIGH, HIGH-HIGH, LOW, LOW-LOW AND HIGH-LOW RESPECTIVELY, AS FOR ALARM.

18. A TEST POINT IS A PROCESS CONNECTION TO WHICH NO INSTRUMENT IS PERMANENTLY CONNECTED, BUT WHICH IS INTENDED FOR TEMPORARY, INTERMITTENT, OR FUTURE CONNECTION OF AN INSTRUMENT.

    PP - DESIGNATES PRESSURE POINT
    AP - DESIGNATES ANALYSIS POINT
    TP - DESIGNATES TEMPERATURE POINT
    TW - DESIGNATES THERMOWELL
    HP - DESIGNATES HAND TEST POINT

19. TEXT LOCATIONS AROUND INSTRUMENT "BALLOONS" SHALL BE STANDARDIZED AS SHOWN IN THE SKETCH BELOW.

J1 - ISA CODE (INSTRUMENT TYPE)
J2 - LOOP NUMBER
J3 - VENDOR IDENTIFIER (E.G. ♦)
J4 - FUNCTION (E.G. Y)

M4B11A 12/02/80 BH

NO.	DATE	REVISIONS	BY	CHK	SUPV.	ENGR.	PROJ. MGR.	OPER. MGR.
0	5-21	ISSUED FOR PHASE 0	JDC	JDC	JHD	JS	JS	
1		ISSUED FOR REVIEW / APPROVAL	DWP	JHD	JHD	JS		

DESIGNED | DRAWN | CHECKED

ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

SYMBOLS & LEGEND
PIPING & INSTRUMENT DIAGRAMS

HOUSTON | JOB NO. 14222 | DRAWING NO. 0E-A-4 | REV. 1

34X44 "E" SIZE