

DOE/OR/20717--4-Vol. 7

DOE/OR/20717--4 Vol. 7

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The BRECKINRIDGE PROJECT

Initial Effort

REPORT IV

VOLUME 7

MASTER

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

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UNDER COOPERATIVE AGREEMENT
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REPORT IV
VOLUME 7

INTRODUCTION

Report IV, Volume 7 provides descriptions, data, and drawings pertaining to the Oxygen Plant (Plant 15) and Naphtha Hydrotreating and Reforming (Plant 18).

The Oxygen Plant (Plant 15) utilizes low-pressure air separation to manufacture the oxygen required in Gasification and Purification (Plant 12). The Oxygen Plant also supplies nitrogen as needed by the H-Coal[®] process.

Naphtha Hydrotreating and Reforming (Plant 18) upgrades the raw H-Coal[®] naphtha.

The following information is provided for both plants described in this volume:

- A description of the plant's process design, including the utility balance, catalysts and chemicals usage, and process flow diagrams.
- An equipment list including item numbers and descriptions.
- Data sheets and sketches for major plant components (Oxygen Plant only).
- 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.

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 7

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PLANT 15 OXYGEN PLANT

1.0 INTRODUCTION

In the Breckinridge H-Coal[®] plant, coal is hydrogenated with hydrogen. Most of this hydrogen is manufactured by gasifying a vacuum tower residue in Gasification and Purification (Plant 12). In the gasification reaction, the main reactants are the hydrocarbon residue, steam, and oxygen. The oxygen is manufactured in Plant 15 using classical low-pressure air separation plants.

Since the oxygen requirements exceed the largest commercially available plant, three air separation plants in parallel, each nominally rated at 1,670 TPD of oxygen are supplied. Liquid oxygen storage and vaporization are provided in the event the oxygen demand exceeds the manufacturing capability at any point in time.

In addition to oxygen gas, facilities to supply nitrogen gas are provided in Plant 15. Many parts of the H-Coal[®] plant will utilize nitrogen for purging, blanketing, or inerting purposes. This nitrogen is supplied on demand from Plant 15.

PLANT 15 OXYGEN PLANT

2.0 PROCESS DESIGN

2.1 Design Basis

2.1.1 Product Requirements

Product requirements are supplied by three parallel air separation units, each with a design capacity of 1,670 short tons per stream day of oxygen. Each unit has product oxygen compression capabilities at 1,570 ST/D. A nitrogen liquefaction system is supplied to increase the refrigeration capacity of the plants during the liquid mode of production. Plant 15 is capable of operating in the following two modes.

o Mode 1

Oxygen gas:	5,010 TPD
Gas liquid:	0
Nitrogen liquid:	0
Nitrogen gas:	1,200 scfm (pipeline)
Nitrogen gas (internal uses):	7,000 scfm (plant 8 and 15**)
Nitrogen gas:	4,600 scfm
Liquid argon:	150 TPD (nominal)

o Mode 2

Oxygen gas:	4,710 TPD
Oxygen liquid:	*
Nitrogen liquid:	*
Nitrogen gas:	1,200 scfm (pipeline)
Nitrogen gas (internal uses):	7,000 scfm (plants 8 and 15**)
Nitrogen gas:	4,600 scfm
Liquid argon:	150 TPD nominal

* Liquefaction capability is such that the plant is capable of liquefying 450 TPD of oxygen. Total gaseous plus liquid oxygen does not exceed 5,010 TPD. The balance of the liquid product available is liquid nitrogen and/or liquid argon.

** Pure low-pressure nitrogen is expected to be available for H-Coal® plant usage and for plant export.

2.1.2 Product Purity Specification

- o Oxygen gas: 99.5% O₂
- o Oxygen liquid: 99.5% O₂
- o Nitrogen pipeline gas: 99.999% N₂ and Ar
- o Nitrogen liquid: 99.999% N₂ and Ar
- o Liquid argon: 99.999% Ar

2.1.3 Pipeline Requirements

Oxygen Gas. The H-Coal[®] reactor system 4,710 TPD is supplied at 925 psig and a minimum temperature of 200°F. Three centrifugal compressors in parallel are employed for this service. A high-pressure liquid oxygen pump and vaporizer rated at 1,600 TPD are provided as a backup for the pipeline.

Nitrogen Gas (Low-Pressure). Nitrogen gas at 1,200 scfm is supplied at 100 psig and ambient temperature as a general low-pressure distribution system for startup and shutdown purging, tank blanketing and miscellaneous use. Since the service is intermittent, the supply is from an intermediate stage of the cycle nitrogen compressor. A liquid nitrogen pump and vaporizer rated at 1,200 scfm and provided for backup. Excess high purity nitrogen and waste nitrogen from 15E-21-1 A, B, C through 15E-21-16 A, B, C vented to atmosphere are available for use in Plant 38.

2.1.4 Storage Area

- o Oxygen Liquid - Storage capacity for 6,000 tons of oxygen liquid is available. Oxygen liquid inventory is maintained above 4,500 tons except during periods of equipment failure or high liquid oxygen consumption in the H-Coal[®] facility.
- o Nitrogen liquid - Storage capacity for 3,000 tons of nitrogen liquid is available. Nitrogen liquid inventory is maintained above 500 tons.

Feed Air Conditions. Design ambient conditions are 96°F dry bulb and 78°F wet bulb. Elevation is 420 feet above sea level. Minimum winter ambient is -10°F.

Design Details. Instrument air to Plant 15 is supplied at 100 psig and ambient temperature. The three air separation units are supplied with connections to allow for the easy addition of krypton, xenon, and neon.

Two main air compressors and two product oxygen compressors are equipped with steam turbine drives. All other services are electric motor driven.

Nominal 900 psig, 750°F superheated steam is provided at battery limits for the large steam drives.

Nominal 50 psig, 150 psig, and 600 psig saturated steam is provided at battery limits for nitrogen and oxygen vaporizers and other miscellaneous heating use. The lowest level steam is used consistent with process requirements.

Exhaust steam from turbine drives is condensed at 3.5 inch Hg. All steam condensate is returned to battery limits at 100 psig.

Any condensate from 150 psig process heaters is flashed into the 50 psig system and then sent to battery limits.

Electric power is supplied from a substation making the following services available to the oxygen plant as required:

o Motors:

0 to 3/4 hp	115 V 1-Phase	60 Hz (continuous)
	460 V 3-Phase	60 Hz (on/off)
1 to 200 hp	460 V 3-Phase	60 Hz
201 to 5000 hp	4160 V 3-Phase	60 Hz
Large	13,800 V 3-Phase	60 Hz

o Instruments: 120 V 1-Phase 60 Hz

o Lighting: 480-120/240 V 3-Phase 60 Hz

2.2 Process Description - Air Separation Unit (ASU)

Please refer to Flowsheets 0-251-4Y-2 and 0-251-4Y-3.

The ASU consists of three parallel trains. Process air is brought in through a filter and compressed to approximately 103 psia by a Four-stage Centrifugal Compressor (15K-11). The air leaving the compressor is cooled to 90°F in the Direct Contact Coolers (15E-13 A, B and C). The air is then cooled to liquid air temperatures in Reversing Heat Exchangers (15E-21-1 A, B, C through 16 A, B, C and 15E-22-1 A, B, C through 16 A, B, C) by the outgoing streams. During this process, contained water and carbon dioxide are frozen and deposited as solids inside the exchangers.

At regular intervals, the air and the waste nitrogen stream, which is the largest effluent stream, switch flow passages. Both continue to flow in the same direction - across the same temperature gradient - but the passages through which they flow are interchanged. As a result, the water and carbon dioxide deposited by the air before reversal are evaporated completely and removed from the plant by waste nitrogen. Switching is accomplished by an automatic system of timers, valves and check valves.

Air as a saturated vapor leaves the reversing exchangers, enters the high-pressure column, and is separated into oxygen-rich liquid (termed rich liquid) at the bottom and into pure liquid and vapor nitrogen at the top.

Pure nitrogen from the top of the high-pressure column is condensed in the Reboilers (15E-31 A, B, C) by boiling pure liquid oxygen in the low-pressure column. The returning liquid serves as reflux for the high-pressure column.

The pure liquid nitrogen withdrawn from the top of the column is flashed and enters the Separators (15Y-32 A, B and C) where liquid nitrogen is removed and sent to storage. The nitrogen gas from 15Y-32 A, B and C joins with nitrogen gas from the top of the low-pressure column to form the waste nitrogen stream.

Rich liquid is taken from the base of the high-pressure column, subcooled in the Rich Liquid Subcoolers (15E-26-1 A, B, C and 2 A, B, C), purified in the Rich Liquid Adsorbers (15Y-27-1 A, B, C and 2 A, B, C) and passed to the feed entry tray of the low-pressure column. Before reaching the low-pressure column, part of the rich liquid passes through the crude argon condenser and vaporizes.

Final separation of oxygen takes place in the low-pressure column. Liquid oxygen is taken from the base of the low-pressure column, subcooled in the Liquid Oxygen Product Subcoolers (15E-33 A, B, C), and then sent to storage.

A liquid nitrogen stream which is withdrawn partway down the high-pressure column is subcooled in Reflux Liquid Subcoolers (15E-36-1 A, B, C and 2 A, B, C), and provides reflux for the low-pressure column.

Additional protection against hydrocarbon accumulation in the ASU Reboilers (15E-31-1 A, B and C) is provided by the Oxygen Guard Adsorbers (15Y-37-1 A, B, C and 2 A, B, C). The Liquid Oxygen Recirculating Pumps (15G-37-1 A, B, C and 2 A, B, C) provide continuous recirculation of liquid, assuring the prevention of hydrocarbon buildup in the ASU reboiler.

Waste nitrogen vapor from the top of the low-pressure column provides refrigeration in 15E-36-1 A, B, C and 2 A, B, C and 15E-26-1 A, B, C and

2 A, B, C before leaving through Exchangers (15E-22-1 A, B, C and 2 A, B, C). After exiting Plant 15, part of this flow is compressed in Plant 38 before being used in airslides in Plant 1.

A side stream containing argon is taken from the low-pressure column and concentrated to approximately 96.5% in the crude argon column. Crude argon leaves as a liquid and is refined in the auxiliary argon purification unit.

2.2.1 Safety

The main operating hazard in an ASU comes from concentration of low-volatility insoluble combustibles in the liquid oxygen pool of the reboiler. Without control measures, distillation of oxygen solely in gaseous form for an extended time results in the concentration of ambient traces of acetylene and ethylene to levels reaching their low-solubility limits in reboiler liquid. At this point, a cumulative buildup of hydrocarbon rime on the surfaces of the reboiler begins, creating an explosion hazard.

The circulation of liquid oxygen creates an exit path by which hydrocarbons are purged without buildup to solubility limits.

Rich Liquid Adsorbers (15Y-27-1 A, B, C, 2 A, B, C, and 3 A, B, C). These protect against acetylene and ethylene hazards by intercepting and holding these substances from the rich liquid transfer stream feeding the low-pressure column.

Liquid Oxygen Guard Adsorbers (15Y-37-1 A, B, C and 2 A, B, C). Rich liquid adsorbers are efficient, but some quantity of hazardous material will pass through to the low-pressure column. Given sufficient time, this concentrates to dangerous limits, therefore final backup protection is required. This backup is provided by circulation of liquid oxygen from the low-pressure column through the guard adsorber and then returned to the low-pressure column.

2.2.2 Liquid Production

Liquid oxygen and nitrogen is produced in the ASU with refrigeration provided by the liquefier. The refrigeration required for heat leak, warm-end losses, and liquid argon production is provided by the ASU Expander Generators (15P-35-1 A, B, C and 2 A, B, C).

Nitrogen gas from the top of the high-pressure column flows through the first section of the Reversing Exchangers (HE-22 A), and is divided into two streams. The major portion is split again with the larger portion flowing to the ASU Expander (15P-35), reentering the cold end of the RHEs, and finally leaving the warm end as low-pressure nitrogen. The smaller portion flows to the liquefier as medium-pressure "cold recycle." The balance of the nitrogen continues through the second part of the Reversing Exchanger (HE-21 A) and then to the liquefier as medium-pressure "warm recycle." This split flow affords close temperature control in the ASU. Supercritical nitrogen returns from the liquefier to the ASU where it enters the top of the high-pressure column.

2.3 Process Description - Nitrogen Liquefaction Unit

Please refer to Flowsheet O-251-4Y-4.

The refrigeration load for the liquefier is supplied by a combined compression/expansion system. Pure nitrogen from the top of the High Pressure Column (15C-25 A) is heated to ambient temperature in Heat Exchangers (15E-21-1 A through 16 A, 15E-22-1 A through 16 A, 15E-71, and 15E-72) before it is compressed in the Cycle Compressor (15K-55). The nitrogen is cooled in the Aftercooler (15E-56) and further compressed by Low-and High-Level Expander/Compressors (15K-77 and 15K-76). Each of these compressors is driven by a process expander. The high-pressure nitrogen is cooled in the Compressor Expander Aftercooler (15E-76), and a part of this flow is sent to the Freon Refrigeration Unit (15E-60) for

forecooling. The remainder of the nitrogen is sent through 15E-71 A through F. The nitrogen from 15E-60 joins the main nitrogen stream and is further cooled in 15E-72.

The majority of the nitrogen is then expanded in High-Level Expander/Compressor (15K-76), the remainder of nitrogen is cooled in 15E-73 A through F, 15E-74 A through F, and 15E-75 A through F, and then sent back to the high-pressure column as a supercritical stream.

The nitrogen expanded in 15K-76 is warmed in 15E-74 A through F and then expanded in Low-Level Compressor Expander (15K-77). Thus, a reheat effect is achieved in 15E-74 A through F since the nitrogen which is expanded traverses the exchangers twice. The expanded nitrogen is warmed through the Exchangers (15E-75 A through F to 15E-71 A through F) and sent back to the cycle compressor.

The nitrogen flow through 15K-76 and 15K-77 and the discharge pressures are controlled by variable inlet guide vanes.

2.4 Process Description - Argon Purification Unit

Please refer to Flowsheet O-251-4Y-6.

The argon purification system receives crude argon (approximately 96.5% Ar) from the ASU. Pure liquid argon is delivered to storage. When controlled, the system is able to start up and shut down without upsetting the ASU.

Crude argon from the Crude Argon Columns (15C-29 A, B, C) (96.5% argon, 1.5% nitrogen, and 2% oxygen) at -297°F , and approximately 20 psia is warmed up in the Argon Heat Exchanger (15E-40) to $+33^{\circ}\text{F}$, after being flashed and partly vaporized in the pure argon column condenser. The

countercurrent stream through 15E-40 is dried argon gas from the Deoxo system (oxygen content 1 ppm and -80°F dewpoint).

After leaving the Argon Heat Exchanger (15E-40) crude argon gas is compressed in the Argon Compressor (15K-41).

Hydrogen gas is added to the crude argon gas after compression. Hydrogen flow is determined by the oxygen percentage in the crude argon gas before it enters the Deoxo Reactor (15Y-43). This control is provided by the percent oxygen analyzer. Approximately 1.0% excess hydrogen is maintained to ensure complete oxygen removal. Saturated gas enters 15Y-43 where, under catalytic reaction, oxygen is combined with hydrogen to form water. Reaction temperature is controlled by limiting the oxygen concentration entering the Deoxo unit.

Either a high oxygen concentration to the Deoxo or a high discharge gas temperature from the Deoxo will sound an alarm and, if it is not corrected, shuts off the feed gas from the Deoxo system to the pure argon column. Since this is a closed system, the above action prevents more crude gas from entering the Deoxo unit, and then the system enters into a total recycle.

Subsequently, the gas is cooled in the Reactor Aftercooler (15E-45) and water is removed in the Separator (15Y-45). Additional cooling is accomplished in the Argon Chiller (15E-461). The gas then enters the Separator (15Y-462) where additional water is removed. This last stage of cooling provides an effective means of reducing the dryer load.

After passing through the Argon Dryers (15Y-47 A or B) and the dust entrainment filter, and before it enters 15E-40, the feed is analyzed for oxygen purity and dew point. In the unlikely event of a dryer failure

15E-40 is piped to allow quick derime without the necessity of warming the associated cold argon equipment.

After recovering refrigeration from the crude argon feed, the oxygen-free argon is further cooled and liquefied in the Pure Argon Column Reboiler (15E-493). From the reboiler, the feed is expanded through a Hydrogen Separator (15Y-48) to the Pure Argon Column (15C-49) where hydrogen is recovered and recycled back with crude argon. Crude liquid argon provides a condensing medium for the pure argon condenser.

Next, pure argon liquid leaves the bottom of the pure argon column and is sent to the liquid argon storage tank. Sample lines from the liquid argon lines are provided to the analyzers for purity check.

2.5 Derime Data for ASU

Except for losses due to power failure, products are available from this facility 360 days per year. The remaining time is allocated to plant derime and machine maintenance. After the initial startup, design time for derime starting from operating temperatures is 30 hours.

2.6 Startup Data

2.6.1 Warm Starts - ASU

Normal startup time for the ASU is 72 hours following completion of the derime without liquid assist.

2.6.2 Cold Starts - ASU

Power failure can cause loss of the entire producing system. The time required to regain full production after such an outage is partially dependent upon the duration of the shutdown. It can be as short as 30 minutes or as long as 24 hours without liquid assist.

2.7 Operating Personnel

The ASU is instrumented such that three operators per shift can monitor it. All valves which require modulation in any mode of operation or changing from one mode to another, have air operators with control at a centralized control location.

2.8 Catalysts, Chemicals, and Raw Materials

The 3 air separation units designed for Plant 15 do not require a continuous replenishment of catalysts, chemicals, and raw materials.

Catalysts. Only one catalyst is used in the air separation process. This use consists of a catalyst bed installed within the DE-OXO REACTOR located in the warm argon purification system. Experience has shown that the initial catalyst charge remains active for many years (at least 5-10 years).

Chemicals. 79,650 pounds of silica gel is required for initial charge in the Liquid Oxygen Guard Adsorbers and the Rich Liquid Adsorbers. This silica gel will require replacement every three years.

Raw Materials. No raw materials are required for the operation of the air separation units. The feed gas to the units consists of air withdrawn from the atmosphere.

2.9 Utility Balance

Electricity, kW

<u>Condition</u>	<u>Consumed</u>	<u>Generated</u>
Operating	34,742	1,278

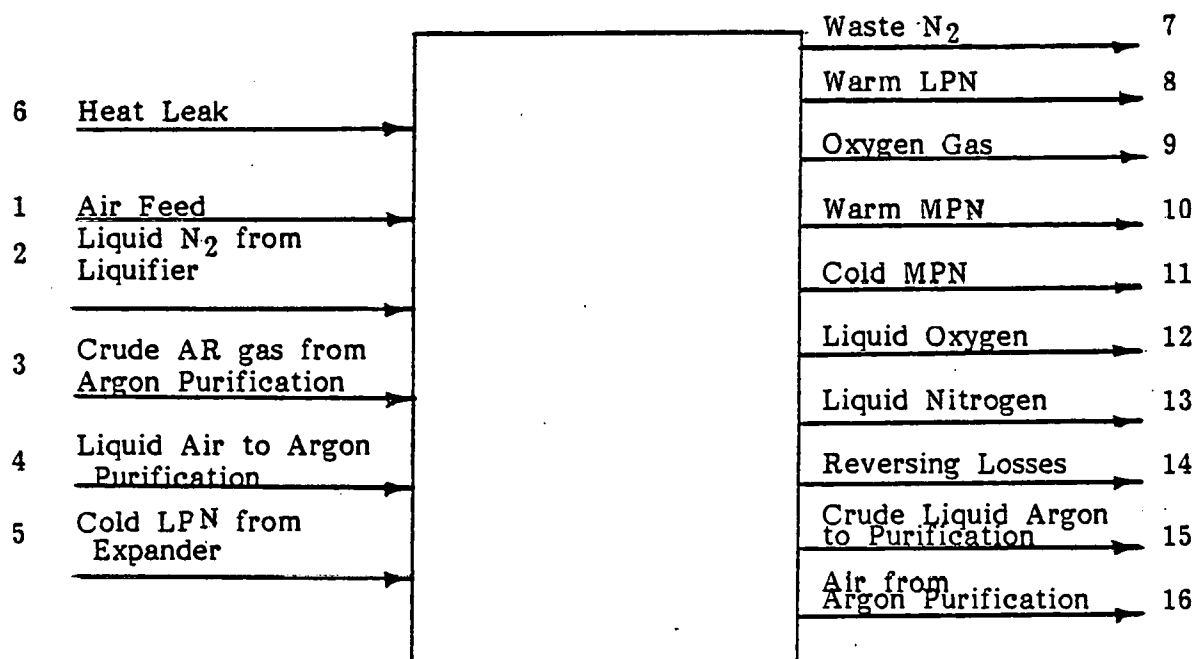
Steam, lb/hr

<u>Level</u>	<u>Consumed</u>	<u>Imported</u>
900 psig	560,560	560,560
150 psig	40,000	40,000

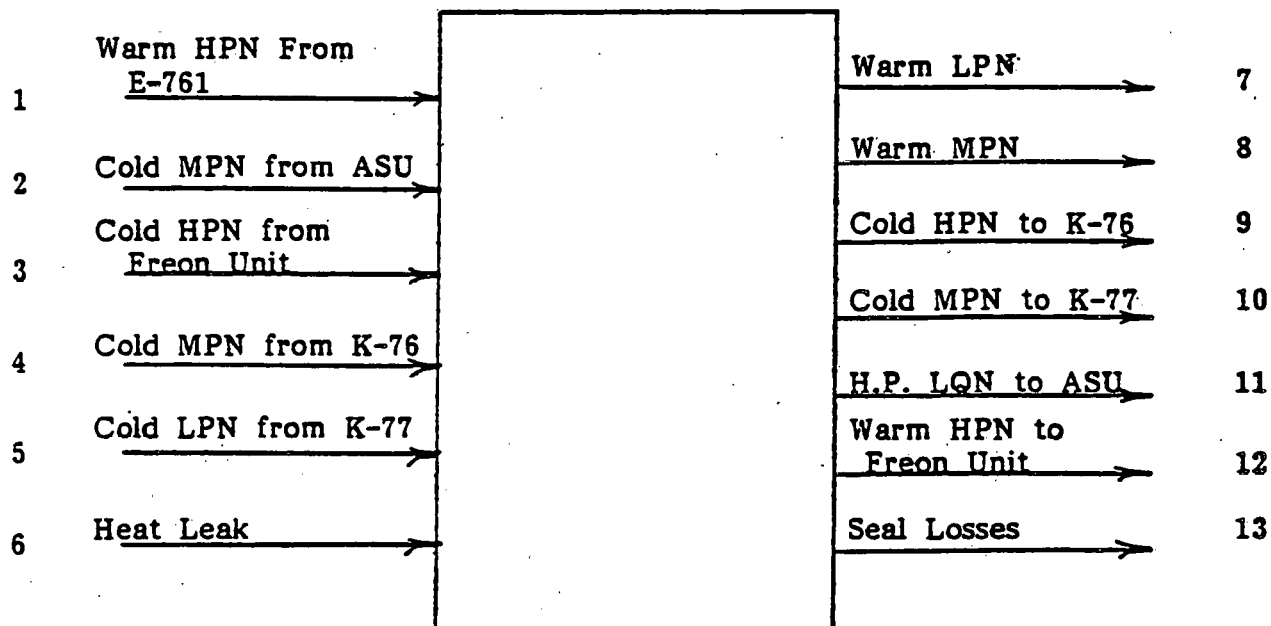
Condensate Returned: 560,560

Water, GPM

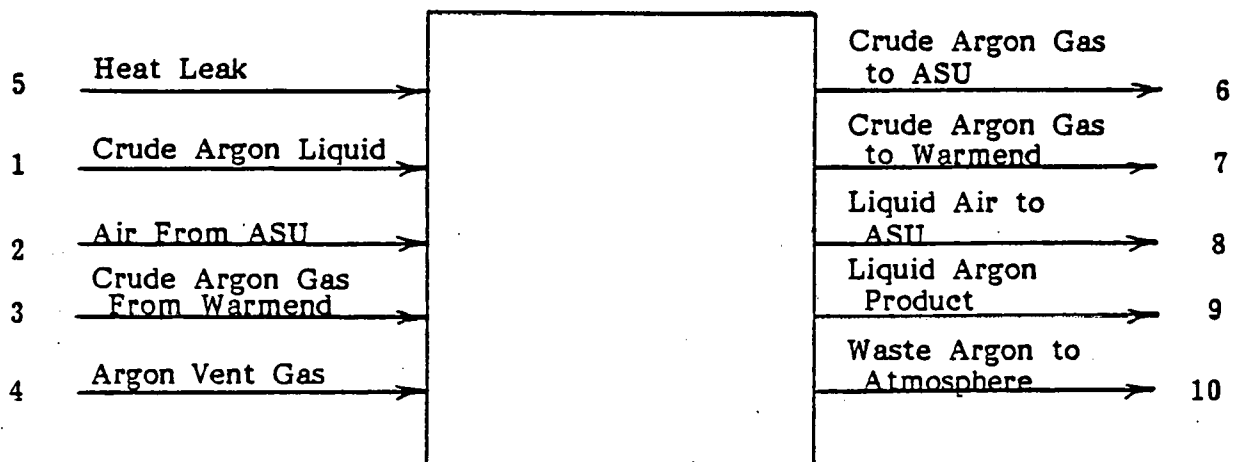
Cooling water circulation: 71,600

TITLE HEAT BALANCE — AIR SEPARATION UNIT

INLET
OUTLET

Str	Flow	(SCM/HR) X (BTU/SCM) = (MM BTU/HR)	Enthalpy	Str	Flow	(SCM/HR) X (BTU/SCM) = (MMBTU/HR)	Enthalpy
1	243,305	648.476	157.7775	7	161,285	632.006	101.9331
2	4,488	201.783	0.9056	8	29,623	631.418	18.7045
3	468	382.906	0.1792	9	44,122	703.955	31.0599
4	617	196.759	0.1214	10	3,118	630.276	1.9652
5	29,623	416.987	12.3524	11	31,215	475.592	14.8456
6	(Heat Leak)		0.5217	12	2,797	178.048	0.4980
				13	315	147.937	0.0466
				14	3,595	648.484	2.3313
				15	1,815	125.234	0.2273
				16	617	399.190	0.2463
TOTAL				TOTAL			
171.8578				171.8578			

TITLE HEAT BALANCE — NITROGEN LIQUIFIER

INLET
OUTLET

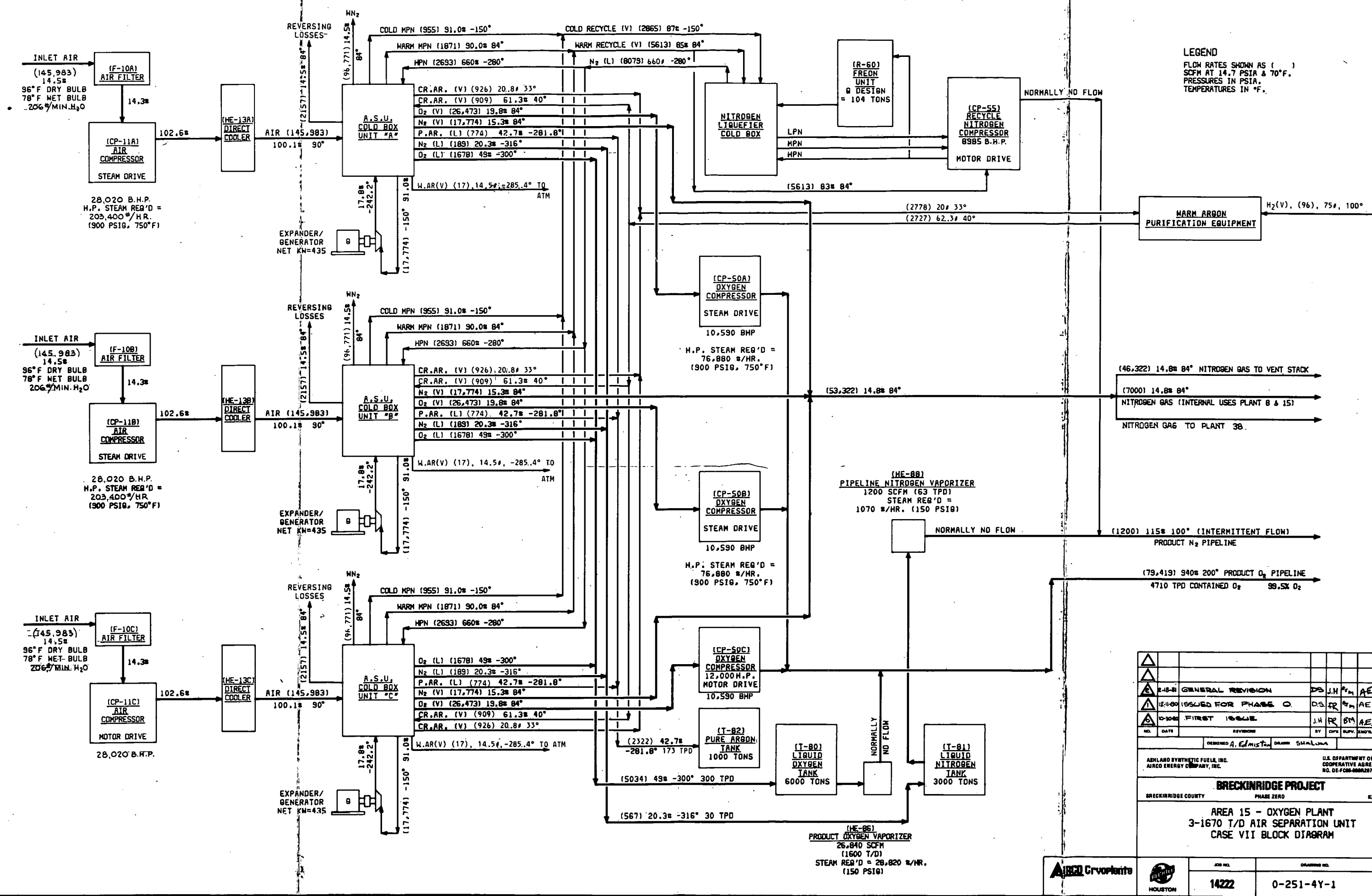
Str	(LB/HR) X (BTU/LB) = MM BTU/HR			Str	(LB/HR) X (BTU/LB) = MM BTU/HR		
1	154,435	200.117	30.905	7	117,574	202.3	23.785
2	12,456	140.013	1.744	8	12,456	201.991	2.516
3			4.665	9			15.204
4			13.210	10			13.882
5			12.468	11	35,126	33.793	1.187
6	(Heat Leak)		0.165	12	31,161	200.122	6.236
TOTAL		=	63.157	13	1,735	200.122	0.347
				TOTAL		=	63.157

TITLE HEAT BALANCE — COLD ARGON PURIFICATION

INLET

Str	Flow	Enthalpy	(SCM/HR) X (BTU/SCM) = (MM BTU/HR)
1	5445	125.253	0.682
2	1850	399.459	0.739
3			2.457
4	336	380.575	0.128
5	(Heat Leak)		0.030
TOTAL			= 4.036

OUTLET

Str	Flow	Enthalpy	(SCM/HR) X (BTU/SCM) = (MM BTU/HR)
6	1405	382.918	0.538
7			2.501
8	1850	196.757	0.364
9	4208	142.586	0.600
10			0.033
Total			= 4.036



LEGEND
FLOW RATES SHOWN AS ()
SCFM AT 14.7 PSIA & 70°F.
PRESSURES IN PSIA.
TEMPERATURES IN °F.

REVISION	DATE	BY	CHKD	APP'D	REASON
1-10-81		DS	JH	AE	GENERAL REVISION
2-10-81		DS	TR	AE	ISSUED FOR PHASE 0
3-10-81		JH	PR	AE	FIRST ISSUE

ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.		U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC02-80NA00117	
BRECKINRIDGE PROJECT BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY			
AREA 15 - OXYGEN PLANT 3-1670 T/D AIR SEPARATION UNIT CASE VII BLOCK DIAGRAM			
JOB NO.	DRAWING NO.	REV.	
14222	0-251-4Y-1	2	

2-27-81
ORIGINAL
DUPLICATE

32" WN₂ (V)
20" O₂ (V)
12" MPN
14" EXPANDED N₂
16" LPN (17774) 153° 84°
36" AIR (145,983)
100.1° 90°
12" COLD MPN
6" WARM MPN
30" O₂ (V)
10" (17774) 91° -150°
X-35-1A42A
NET KW=435
S-212-1A THRU 8A
WN₂ (98,928)
14.5° 84°
2157 SCFM REVERSING LOSSES

HE-22-1A THRU 16A
HE-21-1A THRU 16A
SP-32A
HE-33A
4" N₂ (V)
3" N₂ (L)
2" N₂ (L)
HE-36-2A
HE-36-1A
HE-26-1A
HE-24-1A
HE-23A
O₂ (V)
2" AIR (L)
24" AIR (V)
10" R.L.
12" N₂ (V)
6" N₂ (L)
10" R.L.
3" O₂ (L)
3" O₂ (L) (1678) 49° -300°
3" N₂ (L) (189) 20.3° -316°
4" COLD MPN (955) 91° -150°
6" WARM MPN (1871) 90° 84°
30" O₂ (V) (26,473) 19.8° 84°
C-30A
C-25A
RB-31A
14" O₂ (L)
RB-31A-A
D-27-1A & 2A
D-27-1A, 2A & 3A
C-29A
RB-28A
2" LIQUID N₂ FROM LIQUEFIER (2693), 660° -280°
2" AR. VENT GAS RETURN (281) 20.14, -297°
2" AR (L) (1089) 20.14, -297°
TO ATMOS
NO FLOW
12" R.L.
10" R.L.
6" AIR TO PURE ARGON REBOILER
3" O₂ (L) TO STORAGE TANK
3" N₂ (L) TO STORAGE TANK
4" COLD MPN TO LIQUEFIER
6" WARM MPN TO LIQUEFIER
30" O₂ (V) TO COMPRESSOR
O₂ TO PLANT 38
6" WARM MPN TO SEAL GAS
P-371-1A & 2A
P-291-1A, 2A & 3A
8" (L)

NOTES
FLOW RATES SHOWN AS ()
SCFM @ 14.7 PSIA @ 70°F.
PRESSURE IN LIA, TEMPERATURE
IN °F.

21881	GENERAL REVISION	BA	JH.						
10304	ISSUED FOR PHASE C	DB	TR	AE					
10304	FIRST ISSUE	JH	TR	BA	AE				
NO.	DATE	REVISION	BY	CHK	APPV.	ENGR.	ST.	ASST.	APPL.
		DESIGNED A. Edmiston	DRN B. ARORA						

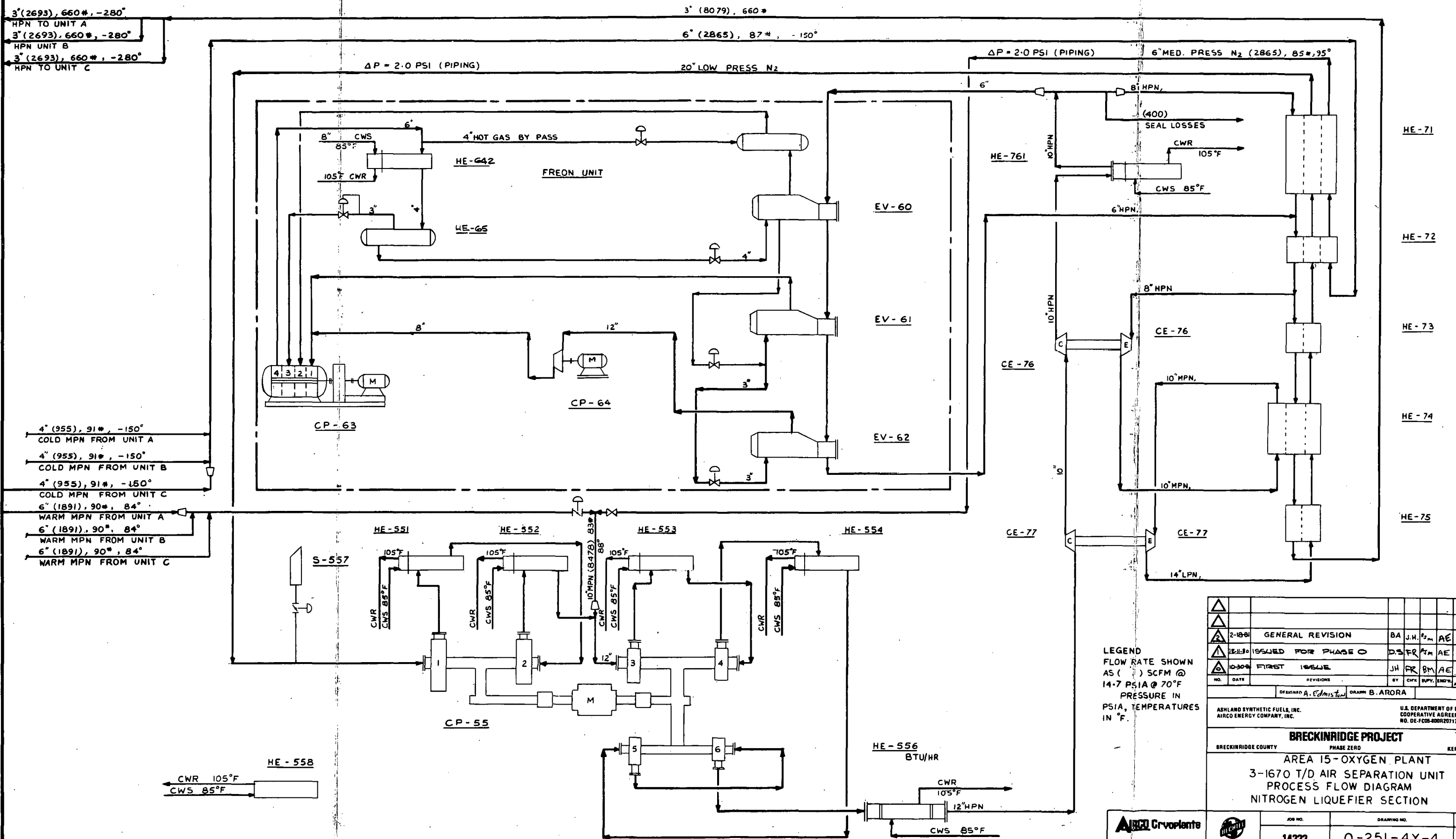
ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.
BRECKINRIDGE PROJECT
AREA -15
3-1670 T/D AIR SEPARATION UNITS
PROCESS FLOW DIAGRAM
HP/LP COLUMN & CRUDE ARGON SECTION

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80OR21717

P-291-1A, 2A & 3A

DUPLICATE ORIGINAL 2-27-81

- | | | | | | | | | | | | | |
|---|------------------------------------|---|--|--|--|---|--|--|-----------------------------------|--|-------------------------------------|--|
| 15-E-551 THRU 554
(HE-551 THRU 554)
INTERCOOLER | 15-E-558
(HE-558)
OIL COOLER | 15-E-642
(HE-642)
R-12
CONDENSER | 15-E-65
(HE-65)
R-12
RECEIVER | 15-K-63
(CP-63)
HIGH LEVEL
COMPRESSOR | 15-Y-557
(S-557)
CP-55
VENT
SILENCER | 15-K-64
(CP-64)
LOW LEVEL
COMPRESSOR | 15-K-55
(CP-55)
CYCLE N ₂
COMPRESSOR | 15-E-60 THRU 62
(EV-60 THRU 62)
EVAPORATOR | 15-E-556
HE-556
AFTERCOOLER | 15-K-76/77
CE-76/77
EXPANDER
COMPRESSOR | 15-E-761
(HE-761)
AFTERCOOLER | 15-E-71 THRU 75
(HE-71 THRU 75)
N ₂ LIQUEFIER
EXCHANGERS |
|---|------------------------------------|---|--|--|--|---|--|--|-----------------------------------|--|-------------------------------------|--|



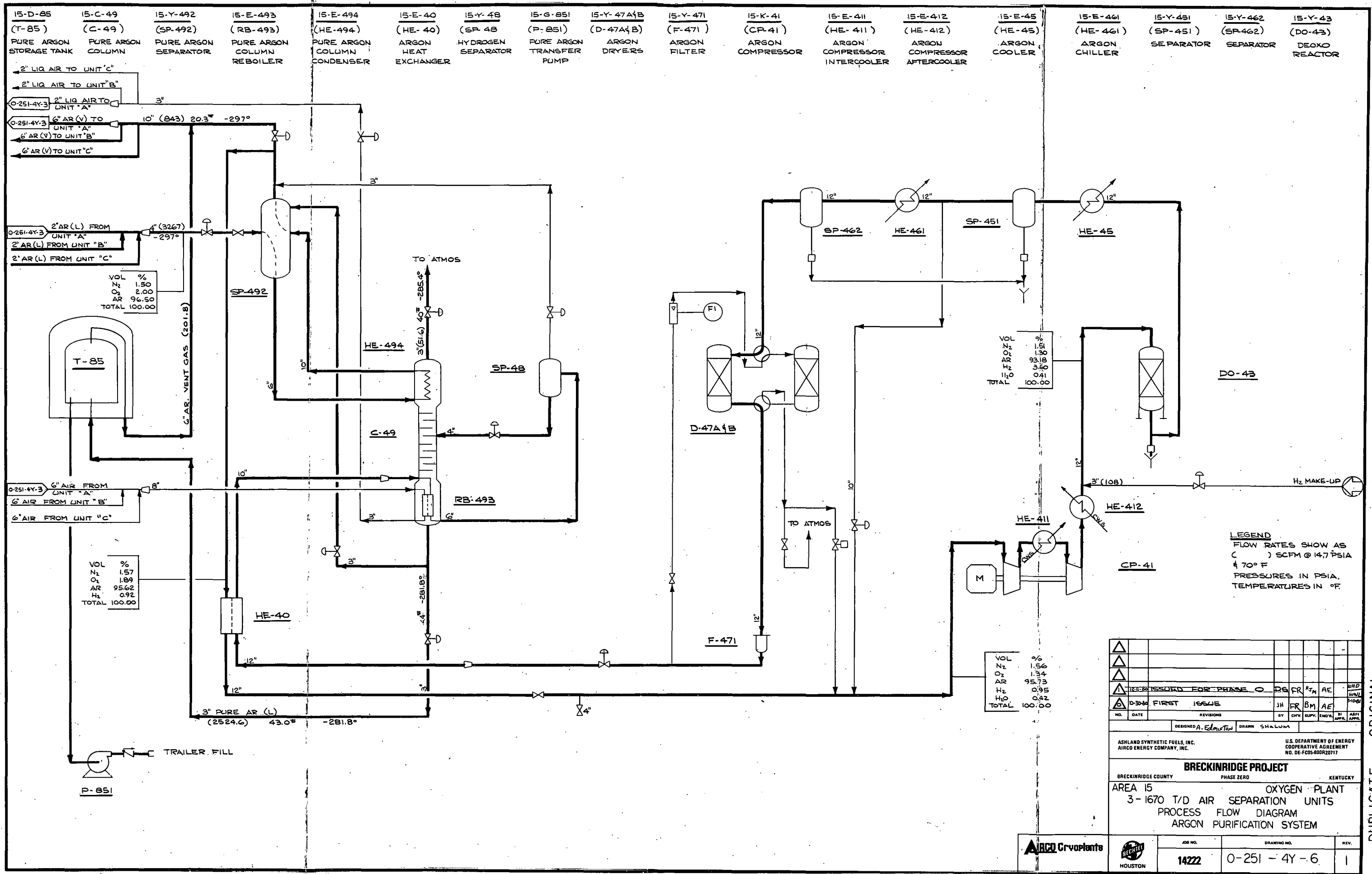
LEGEND
FLOW RATE SHOWN
AS () SCFM @
14.7 PSIA @ 70°F
PRESSURE IN
PSIA, TEMPERATURES
IN °F.

2-18-81	GENERAL REVISION	BA	J.H.	AE	VHD
10-11-81	ISSUED FOR PHASE 0	D.S.	FR	AE	
10-30-81	FIRST ISSUE	JH	FR	BM	AE
NO.	DATE	REVISIONS	BY	CHK	APP
		DESIGNED A. Edmiston	DRAWN B. ARORA		
ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.					
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC02-80OR20717					
BRECKINRIDGE PROJECT					
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY					
AREA 15-OXYGEN PLANT					
3-1670 T/D AIR SEPARATION UNIT					
PROCESS FLOW DIAGRAM					
NITROGEN LIQUEFIER SECTION					
JOB NO.		DRAWING NO.		REV.	
14222		O-251-4Y-4		2	

AIRCO Cryoplants



2-27-81
ORIGINAL
DUPLICATE



NO.	DATE	REVISIONS	BY	CHKD	SLP'D	ENG'D	APPL	ASST
1		ISSUED FOR PHASE 0	JH	FR	BM	AE		
2		FIRST ISSUE						

DESIGNED A. Edmiston DRAWN SHALOM

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

AREA 15 OXYGEN PLANT

3-1670 T/D AIR SEPARATION UNITS

PROCESS FLOW DIAGRAM

ARGON PURIFICATION SYSTEM

JOB NO.	DRAWING NO.	REV.
14222	0-251-4Y-6	1

DUPLICATE ORIGINAL 2-27-81



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 1 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
Three (3)	air separation	on oxygen plants are included	in this	equipment list.	The plants	are designated	A,B,C.	
Only one	liquefier unit	is included.						
F-10A	15-Y-10A	Inlet Filter	0-251-4Y-11	1Z-2	9/25/80	10/2/80		
F-10B	15-Y-10B	Inlet Filter	0-251-4Y-11	1Z-2	9/25/80	10/2/80		
F-10C	15-Y-10C	Inlet Filter	0-251-4Y-11	1Z-2	9/25/80	10/2/80		
CP-11A	15-K-11A	Air Compressor	0-251-4Y-11	1Z-3	9/23/80	10/2/80		
K-1A	15-K-1A	Steam Turbine		"				
CP-11B	15-K-11B	Air Compressor	0-251-4Y-11	1Z-3	9/23/80	10/2/80		
K-1B	15-K-1B	Steam Turbine		"				
CP-11C	15-K-11C	Air Compressor	0-251-4Y-11	1Z-3	9/23/80	10/2/80		
M-1C	15-M-1C	Motor Drive		"				
HE-111A	15-E-111A	Air Compressor	0-251-4Y-11	1Z-3				
HE-111B	15-E-111B	1st Stage	0-251-4Y-11	"				
HE-111C	15-E-111C	Intercooler	0-251-4Y-11	"				

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 2 of 26

[illegible]



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 3 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-112A	15-E-112A	Air Compressor	0-251-4Y-11	1Z-3				
HE-112B	15-E-112B	2nd Stage	0-251-4Y-11	"				
HE-112C	15-E-112C	Intercooler	"	"				
S-116A	15-Y-116A	Air Compressor	"	1Z-4	9/25/80	10/2/80		
S-116B	15-Y-116B	Blow off	"	"	"	"		
S-116C	15-Y-116C	Silencer	"	"	"	"		
HE-13A	15-E-13A	Direct	"	1Z-5	10/21/80			
HE-13B	15-E-13B	Cooler	"	"	"			
HE-13C	15-E-13C		"	"	"			
P-131-1A	15-G-131-1A	Direct Cooler	"	1Z-6	10/17/80	10/22/80		
P-131-1B	15-G-131-1B	Water	"	"	"	"		
P-131-1C	15-G-131-1C	Pump	"	"	"	"		
P-131-2A	15-G-131-2A	Direct Cooler	"	1Z-6	10/17/80	10/22/80		
P-131-2B	15-G-131-2B	Water	"	"	"	"		
P-131-2C	15-G-131-2C	Pump	"	"	"	"		

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 4 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-21-1A	15-E-21-1A	Warm	0-251-4Y-12	1Z-1	9/31/80	10/7/80		
HE-21-1B	15-E-21-1B	Reversing	"	"	"	"		
HE-21-1C	15-E-21-1C	Exchanger	"	"	"	"		
HE-21-2A	15-E-21-2A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-2B	15-E-21-2B	Reversing	"	"	"	"		
HE-21-2C	15-E-21-2C	Exchanger	"	"	"	"		
HE-21-3A	15-E-21-3A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-3B	15-E-21-3B	Reversing	"	"	"	"		
HE-21-3C	15-E-21-3C	Exchanger	"	"	"	"		
HE-21-4A	15-E-21-4A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-4B	15-E-21-4B	Reversing	"	"	"	"		
HE-21-4C	15-E-21-4C	Exchanger	"	"	"	"		
HE-21-5A	15-E-21-5A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-5B	15-E-21-5B	Reversing	"	"	"	"		
HE-21-5C	15-E-21-5C	Exchanger	"	"	"	"		



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10-10-80 PLANT NO. 15 JOB NO. 251 SHEET NO. 5 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-21-6A	15-E-21-6A	Warm	0-251-4Y-12	1Z-1	9/31/80	10/7/80		
HE-21-6B	15-E-21-6B	Reversing	"	"	"	"		
HE-21-6C	15-E-21-6C	Exchanger	"	"	"	"		
HE-21-7A	15-E-21-7A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-7B	15-E-21-7B	Reversing	"	"	"	"		
HE-21-7C	15-E-21-7C	Exchanger	"	"	"	"		
HE-21-8A	15-E-21-8A	Warm	"	1Z-1	9/31-80	10/7/80		
HE-21-8B	15-E-21-8B	Reversing	"	"	"	"		
HE-21-8C	15-E-21-8C	Exchanger	"	"	"	"		
HE-21-9A	15-E-21-9A	Warm	0-251-4Y-13	1Z-1	9/31-80	10/7/80		
HE-21-9B	15-E-21-9B	Reversing	"	"	"	"		
HE-21-9C	15-E-21-9C	Exchanger	"	"	"	"		
HE-21-10A	15-E-21-10A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-10B	15-E-21-10B	Reversing	"	"	"	"		
HE-21-10C	15-E-21-10C	Exchanger	"	"	"	"		

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 6 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-21-11A	15-E-21-11A	Warm	0-251-4Y-13	1Z-1	9/31/80	10/7/80		
HE-21-11B	15-E-21-11B	Reversing	"	"	"	"		
HE-21-11C	15-E-21-11C	Exchanger	"	"	"	"		
HE-21-12A	15-E-21-12A	Warm	"	1Z-1	9/31-80	10/7/80		
HE-21-12B	15-E-21-12B	Reversing	"	"	"	"		
HE-21-12C	15-E-21-12C	Exchanger	"	"	"	"		
HE-21-13A	15-E-21-13A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-13B	15-E-21-13B	Reversing	"	"	"	"		
HE-21-13C	15-E-21-13C	Exchanger	"	"	"	"		
HE-21-14A	15-E-21-14A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-14B	14-E-21-14B	Reversing	"	"	"	"		
HE-21-14C	15-E-21-14C	Exchanger	"	"	"	"		
HE-21-15A	15-E-21-15A	Warm	"	1Z-1	9/31/80	10/7/80		
HE-21-15B	15-E-21-15B	Reversing	"	"	"	"		
HE-21-15C	15-E-21-15C	Exchanger	"	"	"	"		

EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 7 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-21-16A	15-E-21-16A	Warm	0-251-4Y-13	1Z-1	9/31/80	10/7/80		
HE-21-16B	15-E-21-16B	Reversing	"	"	"	"		
HE-21-16C	15-E-21-16C	Exchanger	"	"	"	"		
HE-22-1A	15-E-22-1A	Cold	0-251-4Y-12	1Z-1	9/31/80	10/7/80		
HE-22-1B	15-E-22-1B	Reversing	"	"	"	"		
HE-22-1C	15-E-22-1C	Exchanger	"	"	"	"		
HE-22-2A	15-E-22-2A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-2B	15-E-22-2B	Reversing	"	"	"	"		
HE-22-2C	15-E-22-2C	Exchanger	"	"	"	"		
HE-22-3A	15-E-22-3A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-3B	15-E-22-3B	Reversing	"	"	"	"		
HE-22-3C	15-E-22-3C	Exchanger	"	"	"	"		
HE-22-4A	15-E-22-4A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-4B	15-E-22-4B	Reversing	"	"	"	"		
HE-22-4C	15-E-22-4C	Exchanger	"	"	"	"		

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 8 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-22-5A	15-E-22-5A	Cold	0-251-4Y-12	1Z-1	9/31/80	10/7/80		
HE-22-5B	15-E-22-5B	Reversing	"	"	"	"		
HE-22-5C	15-E-22-5C	Exchanger	"	"	"	"		
HE-22-6A	15-E-22-6A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-6B	15-E-22-6B	Reversing	"	"	"	"		
HE-22-6C	15-E-22-6C	Exchanger	"	"	"	"		
HE-22-7A	15-E-22-7A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-7B	15-E-22-7B	Reversing	"	"	"	"		
HE-22-7C	15-E-22-7C	Exchanger	"	"	"	"		
HE-22-8A	15-E-22-8A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-8B	15-E-22-8B	Reversing	"	"	"	"		
HE-22-8C	15-E-22-8C	Exchanger	"	"	"	"		
HE-22-9A	15-E-22-9A	Cold	0-251-4Y-13	1Z-1	9/31/80	10/7/80		
HE-22-9B	15-E-22-9B	Reversing	"	"	"	"		
HE-22-9C	15-E-22-9C	Exchanger	"	"	"	"		



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 9 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-22-10A	15-E-22-10A	Cold	0-251-4Y-13	1Z-1	9/31/80	10/7/80		
HE-22-10B	15-E-22-10B	Reversing	"	"	"	"		
HE-22-10C	15-E-22-10C	Exchanger	"	"	"	"		
HE-22-11A	15-E-22-11A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-11B	15-E-22-11B	Reversing	"	"	"	"		
HE-22-11C	15-E-22-11C	Exchangers	"	"	"	"		
HE-22-12A	15-E-22-12A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-12B	15-E-22-12B	Reversing	"	"	"	"		
HE-22-12C	15-E-22-12C	Exchanger	"	"	"	"		
HE-22-13A	15-E-22-13A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-13B	15-E-22-13B	Reversing	"	"	"	"		
HE-22-13C	15-E-22-13C	Exchanger	"	"	"	"		
HE-22-14A	15-E-22-14A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-14B	15-E-22-14B	Reversing	"	"	"	"		
HE-22-14C	15-E-22-14C	Exchanger	"	"	"	"		

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 10 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-22-15A	15-E-22-15A	Cold	0-251-4Y-13	1Z-1	9/31/80	10/7/80		
HE-22-15B	15-E-22-15B	Reversing	"	"	"	"		
HE-22-15C	15-E-22-15C	Exchangers	"	"	"	"		
HE-22-16A	15-E-22-16A	Cold	"	1Z-1	9/31/80	10/7/80		
HE-22-16B	15-E-22-16B	Reversing	"	"	"	"		
HE-22-16C	15-E-22-16C	Exchangers	"	"	"	"		
S-212-1A	15-Y-212-1A	Waste	0-251-4Y-12	1Z-7				
S-212-1B	15-Y-212-1B	Nitrogen	"	"				
S-212-1C	15-Y-212-1C	Silencer	"	"				
S-212-2A	15-Y-212-2A	Waste	"	1Z-7				
S-212-2B	15-Y-212-2B	Nitrogen	"	"				
S-212-2C	15-Y-212-2C	Silencer	"	"				
S-212-3A	15-Y-212-3A	Waste	"	1Z-7				
S-212-3B	15-Y-212-3B	Nitrogen	"	"				
S-212-3C	15-Y-212-3C	Silencer	"	"				



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 11 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
S-212-4A	15-Y-212-4A	Waste	0-251-4Y-12	12-7				
S-212-4B	15-Y-212-4B	Nitrogen	"	"				
S-212-4C	15-Y-212-4C	Silencer	"	"				
S-212-5A	15-Y-212-5A	Waste	0-251-4Y-13					
S-212-5B	15-Y-212-5B	Nitrogen	"					
S-212-5C	15-Y-212-5C	Silencer	"					
S-212-6A	15-Y-212-6A	Waste	"					
S-212-6B	15-Y-212-6B	Nitrogen	"					
S-212-6C	15-Y-212-6C	Silencer	"					
S-212-7A	15-Y-212-7A	Waste	"					
S-212-7B	15-Y-212-7B	Nitrogen	"					
S-212-7C	15-Y-212-7C	Silencer	"					
S-212-8A	15-Y-212-8A	Waste	"					
S-212-8B	15-Y-212-8B	Nitrogen	"					
S-212-8C	15-Y-212-8C	Silencer	"					

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 12 of 26

[illegible]



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 13 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
IE-24-1A	15-E-24-1A	Waste	0-251-4Y-14	1Z-8				
IE-24-1B	15-E-24-1B	Nitrogen	0-251-4Y-14	"				
IE-24-1C	15-E-24-1C	Heater	"	"				
IE-24-2A	15-E-24-2A	Waste	"	"				
IE-24-2B	15-E-24-2B	Nitrogen	"	"				
IE-24-2C	15-E-24-2C	Heater	"	"				
C-25A	15-C-25A	High	0-251-4Y-15	1Z-8				
C-25B	15-C-25B	Pressure	"	"				
C-25C	15-C-25C	Column	"	"				
C-30A	15-C-30A	Low	"	1Z-8				
C-30-B	15-C-30B	Pressure	"	"				
C-30-C	15-C-30C	COLUMN	"	"				
IE-26-1A	15-E-26-1A	Rich	"	1Z-8				
IE-26-1B	15-E-26-1B	Liquid	"	"				
IE-26-1C	15-E-26-1C	Subcooler	"	"				
IE-26-2A	15-E-26-2A	Rich	"	1Z-8				
IE-26-2B	15-E-26-2B	Liquid	"	"				
IE-26-2C	15-E-26-2C	Subcooler		"				

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 14 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
IE-36-1A	15-E-36-1A	Reflux	0-251-4Y-15	1Z-8				
IE-36-1B	15-E-36-1B	Liquid	0-251-4Y-15	"				
IE-36-1C	15-E-36-1C	Subcooler	0-251-4Y-15	"				
IE-36-2A	15-E-36-2A	Reflux	0-251-4Y-15	1Z-8				
IE-36-2B	15-E-36-2B	Liquid	"	"				
IE-36-2C	15-E-36-2C	Subcooler	"	"				
RB-31A	15-E-31A	ASU	"	1Z-8				
RB-31B	15-E-31B	Reboiler	"	"				
RB-31C	15-E-31C		"	"				
RB-31A-A	15-E-31A-A	ASU	"	1Z-8				
RB-31A-B	15-E-31A-B	AUX	"	"				
RB-31A-C	15-E-31A-C	Reboiler	"	"				
SP-32A	15-Y-32A	Nitrogen	"	1Z-8				
SP-32B	15-Y-32B	Flash	"	"				
SP-32C	15-Y-32C	Separator	"	"				
HE-33A	15-E-33A	Liquid Oxygen	"	1Z-8				
HE-33B	15-E-33B	Product	"	"				
HE-33C	15-E-33C	Subcooler	"	"				

EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 15 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
X-35-1A	15-P-35-1A	ASU Expander	0-251-4Y-14	1Z-9	10/9/80	10/13/80		
X-35-1B	15-P-35-1B	Gen.	0-251-4Y-14	"	"	"		
X-35-1C	15-P-35-1C	Loaded	"	"	"	"		
X-35-2A	15-P-35-2A	ASU Expander	4Y-14	1Z-9				
X-35-2B	15-P-35-2B	Gen.	"	"				
X-35-2C	15-P-35-2C	Loaded	"	"				
D- 27-1A	15-Y-27-1A	Rich	"	1Z-8				
D- 27-1B	15-Y-27-1B	Liquid	"	"				
D- 27-1C	15-Y-27-1C	Adsorber	"	"				
D- 27-2A	15-Y-27-2A	Rich	"	1Z-8				
D- 27-2B	15-Y-27-2B	Liquid	"	"				
D- 27-2C	15-Y-27-2C	Adsorber	"	"				
D- 27-3A	15-Y-27-3A	Rich	"	1Z-8				
D- 27-3B	15-Y-27-3B	Liquid	"	"				
D- 27-3C	15-Y-27-3C	Adsorber	"	"				

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EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 17 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
RB-28A	15-E-28A	Crude Argon	0-251-4Y-15	1Z-8				
RB-28B	15-E-28B	Column	"	"				
RB-28C	15-E-28C	Condenser	"	"				
C-29A	15-C-29A	Crude	"	1Z-8				
C-29B	15-C-29B	Argon	"	"				
C-29C	15-C-29C	Column	"	"				
P-291-1A	15-G-291-1A	Crude	"	1Z-50	10/21/80	10/22/80		
P-291-1B	15-G-291-1B	Argon	"	"	"	"		
P-291-1C	15-G-291-1C	Pump	"	"	"	"		
P-291-2A	15-G-291-2A	Crude	"	1Z-50	10/21/80	10/22/80		
P-291-2B	15-G-291-2B	Argon	"	"	"	"		
P-291-2C	15-G-291-2C	Pump	"	"	"	"		
P-291-3A	15-G-291-3A	Crude	"	1Z-50	10/21/80	10/22/80		
P-291-3B	15-G-291-3B	Argon	"	"	"	"		
P-291-3C	15-G-291-3C	Pump	"	"	"	"		

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 18 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
CP-50A	15-K-50A	Oxygen Compressor	0-251-4Y-18	1Z-10	10/9/80	10/13/80		
K-5A	15-K-5A	Steam Turbine	"	" "	"	"		
CP-50B	15-K-50B	Oxygen Compressor	"	" "	"	"		
K-5B	15-K-5B	Steam Turbine	"	" "	"	"		
CP-50C	15-K-50C	Oxygen Compressor	"	" "	"	"		
M-5C	15-K-5C	Motor Drive	"	" "	"	"		
HE-501A	15-E-501 A	1st Stage	"	1Z-10				
HE-501B	15-E-501 B	Intercooler	"	" "				
HE-501C	15-E-501 C		"	" "				
HE-502A	15-E-502 A	2nd	"	1Z-10				
HE-502B	15-E-502 B	Stage	"	" "				
HE-502C	15-E-502 C	Intercooler	"	" "				
HE-503A	15-E-503 A	3rd	"	1Z-10				
HE-503B	15-E-503 B	Stage	"	" "				
HE-503C	15-E-503 C	Intercooler	"	" "				
HE-504A	15-E-504 A	4th	"	1Z-10				
HE-504B	15-E-504 B	Stage	"	" "				
HE-504C	15-E-504 C	Intercooler	"	" "				



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 19 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-505A	15-E-505 A	5th	0-251-4Y-18	1Z-10				
HE-505B	15-E-505 B	Stage	"	" "				
HE-505C	15-E-505 C	Intercooler	"	" "				
HE-506A	15-E-506 A	6th	"	1Z-11				
HE-506B	15-E-506 B	Stage	"	" "				
HE-506C	15-E-506 C	Aftercooler	"	" "				
S-516A	15-Y-516 A	Oxygen	"	1Z-12				
S-516B	15-Y-516 B	Compr. Discharge	"	" "				
S-516C	15-Y-516 C	Silencer	"	" "				

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 20 of 26

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EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 415 JOB NO. 251 SHEET NO. 21 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
CP-55	15-K-55	Cycle N ₂ Compressor	0-251-4Y-17	1Z-13	9/30/80	10/3/80		
HE-551	15-E-551	CP-55 Intercooler	0-251-4Y-17	1Z-13	9/30/80			
HE-552	15-E-552	CP-55 Intercooler	"	" "	"			
HE-553	15-E-553	CP-55 Intercooler	"	" "	"			
HE-554	15-E-554	CP-55 Intercooler	"	" "	"			
HE-556	15-E-556	CP-55 Aftercooler	"	" "	"			
S-557	15-Y-557	CP-55 Vent Silencer	"	1Z-14	"			
HE-71 A-F	15-E-71A-F	Warm Exchanger	0-251-4Y-16	1Z-15	10/15/80	10/21/80		
HE-72 A-F	15-E-72A-F	Intermediate Exchanger	"	" "	"	"		
HE-73 A-F	15-E-73A-F	Intermediate Exchanger	"	" "	"	"		
HE-74 A-F	15-E-74A-F	Intermediate Exchanger	"	" "	"	"		
HE-75 A-F	15-E-75 A-F	Cold Exchanger	"	" "	"	"		

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 22 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
EV-60	15-E-60	Hi Level Evaporator	0-251-4Y-22	1Z-16	9/29/80	10/3/80		
EV-61	15-E-61	Med. Level Evaporator	"	" "	"	"		
EV-62	15-E-62	Lo Level Evaporator	"	1Z-16	"	"		
CP-63	15-K-63	Hi Stage Compressor	"	" "	"	"		
CP-64	15-K-64	Lo Stage Compressor	"	" "	"	"		
HE-642	15-E-642	Freon Condensor	"	" "	"	"		
HE-65	15-E-65	Receiver	"	" "	"	"		
CE-76	15-K-76	Hi Level Compr. Expand.	0-251-4Y-16	1Z-17	9/29/80	10/3/80		
CE-77	15-K-77	Lo Level Compr. Expand.	"	" "	9/29/80	10/3/80		
HE-761	15-E-761	Compr. Expand.	"	1Z-18	9/30/80	10/3/80		
		Aftercooler			"	"		
HE-671	15-E-671	Oil Condenser	0-251-4Y-22					
SP-672	15-Y-672	Oil Separator	"					
D-66A	15-Y-66A	Purge Drum	"					
D-66B	15-Y-66B	Purge Drum	"					
CP-67	15-K-67	Transfer Comp.	"					



EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/10/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 23 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
T-80	15-D-80	LQO Storage Tank	0-251-4Y-20	1Z-19				
P-801	15-G-801	Liquid O ₂ Transfer Pump	0-251-4Y-20	1Z-20	10/17/80			
P-861A	15-G-861A	Liquid Oxygen	"	1Z-21	10/17/80	10/22/80		
P-861B	15-G-861B	Vaporizer Pumps	"	" "	10/17/80	10/22/80		
HE-86	15-E-86	LIQ Oxygen Vaporizer	"	1Z-22				
T-81	15-D-81	LQN Storage Tank	0-251-4Y-21	1Z-25				
P-811	15-G-811	Liquid Nitrogen	"	1Z-27	10/17/80	10/22/80		
		Transfer Pump	"	" "	10/17/80	10/22/80		
			"					

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EQUIPMENT LIST

BRECKINRIDGE PROJECT

REV. NO. 0 DATE 10/29/80 PLANT NO. 15 JOB NO. 251 SHEET NO. 25 of 26

AIRCO ITEM NO.	BECHTEL ITEM NO.	DESCRIPTION	AIRCO FLOW DIAG. NO.	AIRCO SPEC NO.	DATES			
					FROM PROCESS	TO MECH	FROM MECH	TO BECHTEL
HE-40	15-E-40	Argon Heat Exchanger	0-251-4Y-23	1Z-36				
CP-41	15-K-41	Argon Compressor	0-251-4Y-24	1Z-37				
HE-411	15-E-411	Argon Comp. Intercooler	"					
HE-412	15-E-412	Argon Comp. Aftercooler	"	1Z-38				
DO-43	15-Y-43	DEOXO Reactor	"	1Z-39				
HE-45	15-E-45	Reactor Aftercooler	"	1Z-40				
SP-451	15-Y-451	Separator	"	1Z-41				
R-46	15-V-46	Refrigeration Unit	"	1Z-42				
HE-461	15-E-461	Argon Chiller	"	1Z-43				
SP-462	15-Y-462	Separator	"	1Z-44				
D-47A	15-Y-47A	Argon	"	1Z-45				
D-47B	15Y-47B	Dryers	"	1Z-45				
F-471	15-Y-471	Argon Filter	"	1Z-45				

[illegible]

4.0 DATA SHEETS AND SKETCHES

Equipment items conforming to Airco Specification No. 1Z-8 as shown on the Equipment List are proprietary and are not included in this section. These items are available for DOE review at the Houston offices of Bechtel Petroleum, Inc.

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4.1 Data Sheets for Tanks

0-251-1Z-25: Liquid Nitrogen Storage Tank (15D-81)

0-251-1Z-47: Liquid Argon Storage Tank (15D-85)

0-251-1Z-19: Liquid Oxygen Tank (15D-80)

Airco Cryopants				☐ STANDARDS ☐ INSTRUCTIONS ☒ SPECIFICATIONS ☐ DATA				NO. 0-251-IZ-25											
								WRITTEN BY				DATE							
								APPROVED BY <i>AE</i>				DATE <i>2/15/81</i>							
								APPROVED BY <i>HR</i>				DATE <i>3/11/81</i>							
								APPROVED BY <i>HNH</i>				DATE <i>3/11/81</i>							
REVISION																			
PAGE																			
DATE																			
WRITTEN BY																			
APPROVED BY																			

Liquid Nitrogen Storage

Tank

15-D-81

ISSUED FOR PHASE 0

TITLE LIQUID NITROGEN STORAGE 15-D-91

1. Scope

This specification covers the furnishing of all labor, materials, tools, equipment and insurance necessary design, fabricate, deliver and erect one cryogenic flat bottom storage vessel. Insulation, testing and cleaning and preparation for cooldown with the cryogenic liquid is also included.

2. Location

The site is located in Breckinridge County, Kentucky. The site will be located along the Ohio River in Breckinridge County, Kentucky. The nearest town is Addison.

3. Codes and Regulations

3.1 The inner and outer vessel will be built to API standards 620.

3.2 Piping - ANSI B31.5 or B31.3

3.3 Codes of any federal, state, municipal, or other legal political subdivision that may apply (OSHA).

4. Piping4.1 Inner Vessel

The following nozzles shall be provided for the inner vessel.

<u>Nozzle L. D.</u>	<u>Description</u>	<u>Size</u>
A	Bottom Discharge	6"
B	Bottom Fill	3"
C	Top Fill	4"
D	Top Vapor Outlet	6"
E	Full Trycock	2"
F	Level Connection (Liq)	2"
G	Level Connection (Vap)	2"
H	Two (2) Pressure Relief (top)	6"

ISSUED FOR PHASE 6

TITLE LIQUID NITROGEN STORAGE (S-D-8)

4. Piping**4.1 Inner Vessel (continued)**

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
I	Eighteen Inch Manway	18"
J	Float Gauge with Tap	—

Connections B, C,D,E,F & G are to be grouped together and penetrate through the lower shell of the outer vessel in a duct type connection.

4.2 Outer Vessel

The following nozzles or outlets shall be provided in the outer vessel.

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
M	Nitrogen Purge	2"
N	Pressure Vacuum Relief	Vendor to Size
O	Rupture Disk (protection inner vessel failure)	20"
P	Manway to Inner Tank	24"
Q	Root Manway (annular space relief)	20"

5. Safety Devices

The vendor shall design, supply all safety devices for the outer tank. Airco shall supply all safety devices for the inner tank. The vendor shall test and install all safety devices (inner and outer vessels).

6. Thermocouples

Six copper constantan thermocouples fastened to the inner vessel shall be provided. Thermocouples shall terminate in a NEMA 4 junction box mounted on the outer tank. Proper sealing for thermocouple penetration shall be provided.

- ☐ STANDARDS
☐ INSTRUCTIONS
☒ SPECIFICATIONS
☐ DATA

TITLE LIQUID NITROGEN STORAGE 15-0-81

7. Structural Requirements

Supports, Platforms, stairs, etc. shall conform to the minimum requirements of the AISC specification for design, fabrication and erection of structural steel. Platforms and stairways shall be open grating type with guard rails and toe plates in accordance with OSHA.

8. Cleaning

The vendor shall present a cleaning specification for the storage vessels. The inner vessel cleaning methods are most important and the vendor exercise extreme care when oxygen is to be stored.

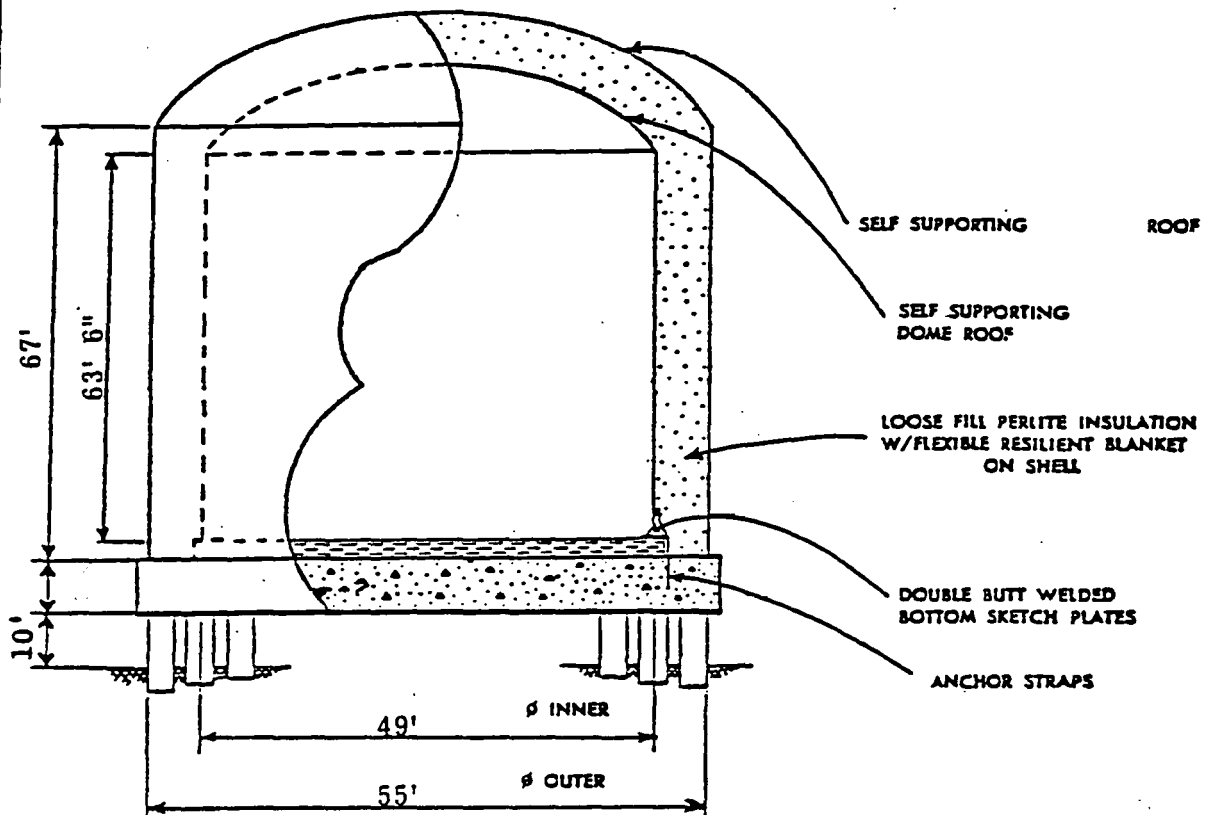
9. Painting

Painting of the outer tank will be the responsibility of Airco.

10. Testing

The inner vessel and the safety devices associated with this tank shall be hydrostatically tested by the vendor.

ISSUED FOR PHASE 0



Product Liquid Nitrogen Capacity 3000 Tons @ -320 °F

Design Loads:

Density <u>50.6</u> #/FT ³	Outer Roof Live Load _____ PSF
Internal Pressure <u>1</u> PSIG	Earthquake Zone # <u>2</u>
Design Vacuum <u>2</u> Inches H ₂ O	Annular Space Pressure <u>2</u> Inches H ₂ O
Wind <u>100</u> MPH	Plus Weight & Pressure of Insulation
Foundation <u>By Others</u>	

Guaranteed heat leak = .25% of full capacity

Design Data:

	Inner Tank -320°F	Outer Tank Ambient
Temperature	-320°F	Ambient
Code	API 620 APPN Q	
Material:		
Bottom	A553 & A353	A-283-C
Shell	A553	A-283-C
Roof	A553	A-283-C
Allowable Plate Stress	31700 PSI	15200 PSI
Joint Efficiency	85%	--

DOUBLE WALL STORAGE TANK

Airco Cryopants	☐ STANDARDS ☐ INSTRUCTIONS ☒ SPECIFICATIONS ☐ DATA	NO. 0-051-1Z-47															
		WRITTEN BY								DATE							
		APPROVED BY <i>AE</i>								DATE 2/15/81							
		APPROVED BY <i>HSH</i>								DATE 3/11/81							
REVISION																	
PAGE																	
DATE																	
WRITTEN BY																	
APPROVED BY																	

Liquid Argon Storage
Tank

15-D-85

ISSUED FOR PHASE 0

TITLE LIQUID ARGON STORAGE TANK 15-D-85

1. Scope

This specification covers the furnishing of all labor, materials, tools, equipment and insurance necessary design, fabricate, deliver and erect one cryogenic flat bottom storage vessel. Insulation, testing and cleaning and preparation for cooldown with the cryogenic liquid is also included.

2. Location

The site is located in Breckinridge County, Kentucky. The site will be located along the Ohio River in Breckinridge County, Kentucky. The nearest town is Addison.

3. Codes and Regulations

3.1 The inner and outer vessel will be built to API standards 620.

3.2 Piping - ANSI B31.5 or B31.3

3.3 Codes of any federal, state, municipal, or other legal political subdivision that may apply (OSHA).

4. Piping4.1 Inner Vessel

The following nozzles shall be provided for the inner vessel.

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
A	Bottom Discharge	4"
B	Bottom Fill	3"
C	Top Fill	3"
D	Top Vapor Outlet	6"
E	Full Trycock	2"
F	Level Connection (Liq)	2"
G	Level Connection (Vap)	2"
H	Two (2) Pressure Relief (top)	6"

TITLE LIQUID ARGON STORAGE TANK 15-D-85

4. Piping4.1 Inner Vessel (continued)

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
I	Eighteen Inch Manway	18"
J	Float Gauge with Tap	—

Connections B, C,D,E,F & G are to be grouped together and penetrate through the lower shell of the outer vessel in a duct type connection.

4.2 Outer Vessel

The following nozzles or outlets shall be provided in the outer vessel.

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
M	Nitrogen Purge	2"
N	Pressure Vacuum Relief	Vendor to Size
O	Rupture Disk (protection inner vessel failure)	20"
P	Manway to Inner Tank	24"
Q	Root Manway (annular space relief)	20"

5. Safety Devices

The vendor shall design, supply all safety devices for the outer tank. Airco shall supply all safety devices for the inner tank. The vendor shall test and install all safety devices (inner and outer vessels).

6. Thermocouples

Six copper constantan thermocouples fastened to the inner vessel shall be provided. Thermocouples shall terminate in a NEMA 4 junction box mounted on the outer tank. Proper sealing for thermocouple penetration shall be provided.

ISSUED FOR PHASE 6

TITLE LIQUID ARGON STORAGE TANK 15-D-85

7. Structural Requirements

Supports, Platforms, stairs, etc. shall conform to the minimum requirements of the AISC specification for design, fabrication and erection of structural steel. Platforms and stairways shall be open grating type with guard rails and toe plates in accordance with OSHA.

8. Cleaning

The vendor shall present a cleaning specification for the storage vessels. The inner vessel cleaning methods are most important and the vendor exercise extreme care when oxygen is to be stored.

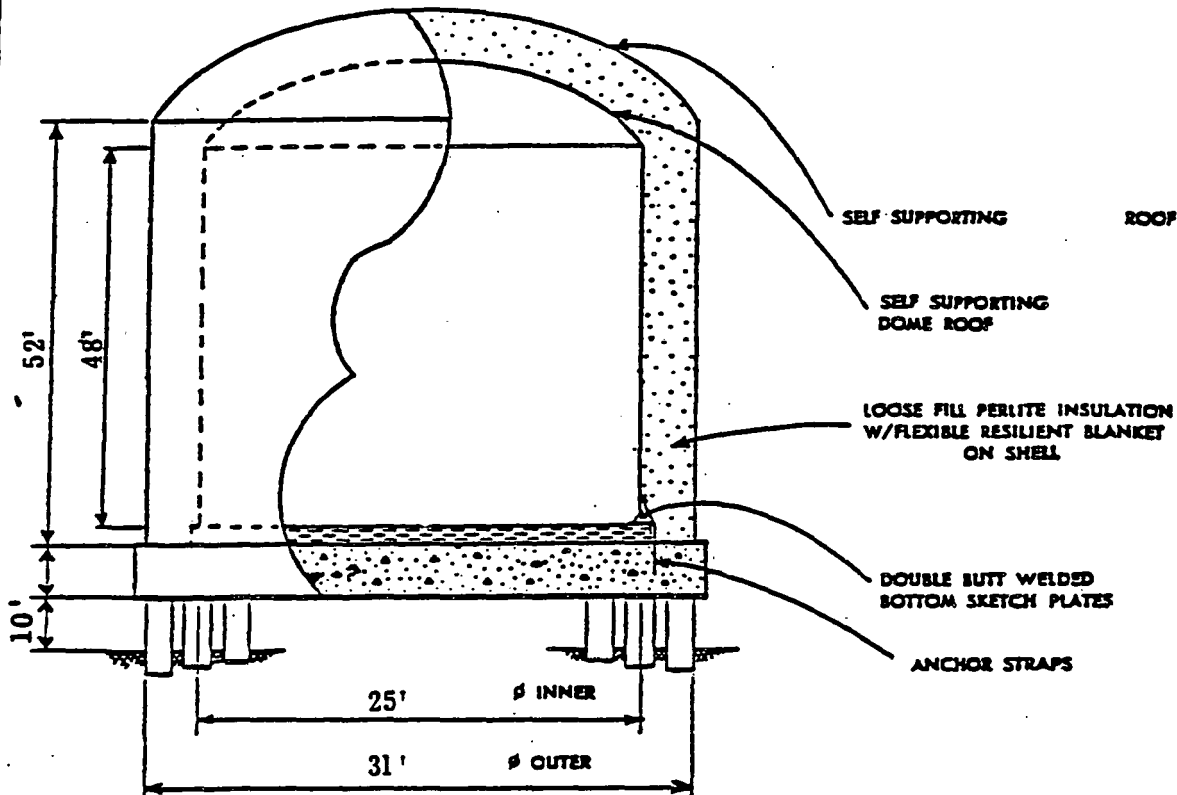
9. Painting

Painting of the outer tank will be the responsibility of Airco.

10. Testing

The inner vessel and the safety devices associated with this tank shall be hydrostatically tested by the vendor.

ISSUED FOR PHASE 0



Product Liquid Argon Capacity 1000 Tons @ -304 °F

Design Loads:

Density 87 #/FT³ Outer Roof Live Load _____ PSF
 Internal Pressure 1 PSIG Earthquake Zone # 2
 Design Vacuum 2 Inches H₂O Annular Space Pressure 2 Inches H₂O
 Wind 100 MPH Plus Weight & Pressure of Insulation
 Foundation By Others

Guaranteed heat leak = .25% of full capacity

Design Data:

	Inner Tank	Outer Tank
Temperature	<u>-320°F</u>	<u>Ambient</u>
Code	<u>API 620 APPN Q</u>	
Material:		
Bottom	<u>A553 & A353</u>	<u>A-283-C</u>
Shell	<u>A553</u>	<u>A-283-C</u>
Roof	<u>A553</u>	<u>A-283-C</u>
Allowable Plate Stress	<u>31700 PSI</u>	<u>15200 PSI</u>
Joint Efficiency	<u>85%</u>	<u>--</u>

DOUBLE WALL STORAGE TANK

CM 176A - 3/76 PRD. IN USA

Airco Cryopants				☐ STANDARDS ☐ INSTRUCTIONS ☐ SPECIFICATIONS ☐ DATA				NO. 0-251-1Z-19							
								WRITTEN BY				DATE			
								APPROVED BY <i>AE</i>				DATE <i>3/15/81</i>			
								APPROVED BY <i>VS</i>				DATE <i>3/11/81</i>			
APPROVED BY <i>HSH</i>				DATE <i>3/11/81</i>											
REVISION															
PAGE															
DATE															
WRITTEN BY															
APPROVED BY															
LIQUID OXYGEN STORAGE TANK 15-D-80															
ISSUED FOR PHASE 0															
Sheet No. <u>1</u> of <u>5</u>															

TITLE LIQUID OXYGEN STORAGE TANK 15-D-80

1. Scope

This specification covers the furnishing of all labor, materials, tools, equipment and insurance necessary design, fabricate, deliver and erect one cryogenic flat bottom storage vessel. Insulation, testing and cleaning and preparation for cooldown with the cryogenic liquid is also included.

2. Location

The site is located in Breckinridge County, Kentucky. The site will be located along the Ohio River in Breckinridge County, Kentucky. The nearest town is Addison.

3. Codes and Regulations

3.1 The inner and outer vessel will be built to API standards 620.

3.2 Piping - ANSI B31.5 or B31.3

3.3 Codes of any federal, state, municipal, or other legal political subdivision that may apply (OSHA).

4. Piping4.1 Inner Vessel

The following nozzles shall be provided for the inner vessel.

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
A	Bottom Discharge	8"
B	Bottom Fill	3"
C	Top Fill	4"
D	Top Vapor Outlet	6"
E	Full Trycock	2"
F	Level Connection (Liq)	2"
G	Level Connection (Vap)	2"
H	Two (2) Pressure Relief (top)	6"

ISSUED FOR PHASE 6

TITLE LIQUID OXYGEN STORAGE TANK 15-D-80

4. Piping4.1 Inner Vessel (continued)

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
I	Eighteen Inch Manway	18"
J	Float Gauge with Tap	—

Connections B, C,D,E,F & G are to be grouped together and penetrate through the lower shell of the outer vessel in a duct type connection.

4.2 Outer Vessel

The following nozzles or outlets shall be provided in the outer vessel.

<u>Nozzle I. D.</u>	<u>Description</u>	<u>Size</u>
M	Nitrogen Purge	2"
N	Pressure Vacuum Relief	Vendor to Size
O	Rupture Disk (protection inner vessel failure)	20"
P	Manway to Inner Tank	24"
Q	Root Manway (annular space relief)	20"

5. Safety Devices

The vendor shall design, supply all safety devices for the outer tank. Airco shall supply all safety devices for the inner tank. The vendor shall test and install all safety devices (inner and outer vessels).

6. Thermocouples

Six copper constantan thermocouples fastened to the inner vessel shall be provided. Thermocouples shall terminate in a NEMA 4 junction box mounted on the outer tank. Proper sealing for thermocouple penetration shall be provided.

ISSUED FOR PHASE 0

TITLE LIQUID OXYGEN STORAGE TANK 15-D-80

7. Structural Requirements

Supports, Platforms, stairs, etc. shall conform to the minimum requirements of the AISC specification for design, fabrication and erection of structural steel. Platforms and stairways shall be open grating type with guard rails and toe plates in accordance with OSHA.

8. Cleaning

The vendor shall present a cleaning specification for the storage vessels. The inner vessel cleaning methods are most important and the vendor exercise extreme care when oxygen is to be stored.

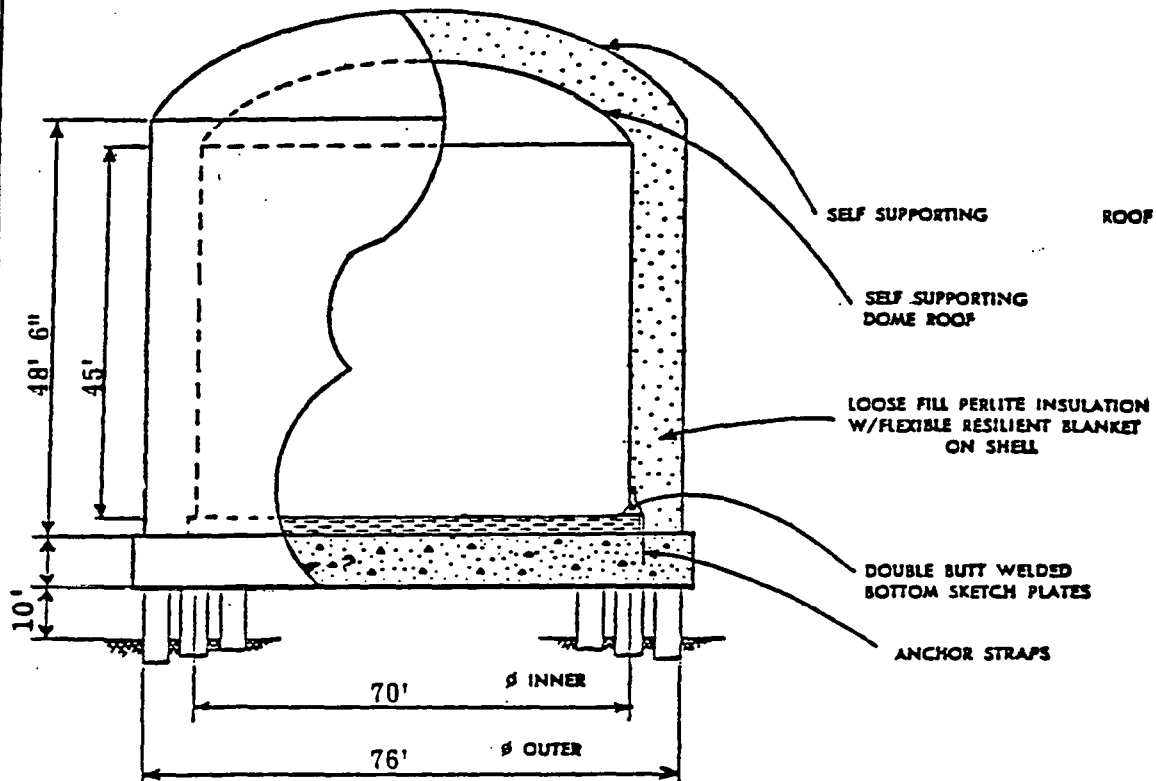
9. Painting

Painting of the outer tank will be the responsibility of Airco.

10. Testing

The inner vessel and the safety devices associated with this tank shall be hydrostatically tested by the vendor.

ISSUED FOR PHASE 0



Product Liquid Oxygen Capacity 6000 Tons @ -297 °F

Design Loads:

Density 72.6 #/FT³

Internal Pressure 1 PSIG

Design Vacuum 2 Inches H₂O

Wind 100 MPH

Foundation By Others

Outer Roof Live Load _____ PSF

Earthquake Zone # 2

Annular Space Pressure 2 Inches H₂O

Plus Weight & Pressure of Insulation

Guaranteed heat leak = .25% of full capacity

Design Data:

Temperature

Code

Material:

Bottom

Shell

Roof

Allowable Plate Stress

Joint Efficiency

Inner Tank

-320°F

API 620 APPN Q

A553 & A353

A553

A553

31700 PSI

85%

Outer Tank
Ambient

A-283-C

A-283-C

A-283-C

15200 PSI

--

DOUBLE WALL STORAGE TANK

4.2 Data Sheets for Vessels

0-251-1Z-31: Condensate Tank (15D-89)

0-251-1Z-39: Deoxo Reactor (15Y-43)

0-251-1Z-41: Separator (15Y-451)

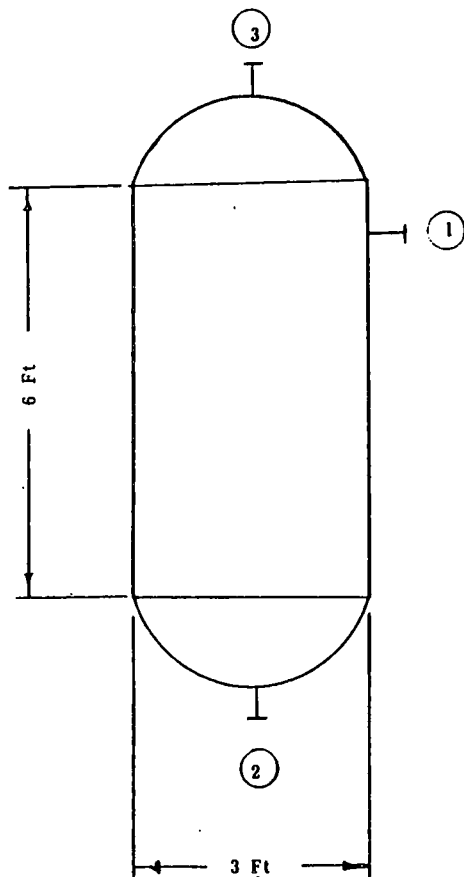
0-251-1Z-44: Separator (15Y-462)

0-251-1Z-45: Argon Dryer (15Y-47 A, B)

CR 171A - 3/76 PRD. IN USA

Airco Cryopants				☐ STANDARDS ☐ INSTRUCTIONS ☐ SPECIFICATIONS ☐ DATA				No.							
								WRITTEN BY				DATE			
								APPROVED BY <i>AE</i>				DATE <i>2/15/81</i>			
								APPROVED BY <i>SE</i>				DATE <i>3/11/81</i>			
								APPROVED BY <i>HNH</i>				DATE <i>3/11/81</i>			
REVISION															
PAGE															
DATE															
WRITTEN BY															
APPROVED BY															
BRECKINRIDGE PROJECT PLANT 15 OXYGEN PLANT VESSELS															
Sheet No. <u>1</u> of <u>6</u>															

ISSUED FOR PHASE 0



Position: Vertical
Shell Thickness: 1/4"
Head Thickness: 3/16"

PROCESS INFORMATION				TIME			
PROCESSING DATA		FLUID		FLOW		TEMP OF	
NO. OR NO. 1	DATA	LB/MR	DENSITY	NORM	MAX/MIN	NORM	MAX
1&2	H ₂ O	34,830	62.4	358.4	500/-10	135.3	150
VAPOR PRESS (MAX. AMP. OF = PSIA							
PROCESS CONTAMINANTS:							

METALLURGY		COMPONENT		TYP. MAT'L		CORR. ALLOW.		REMARKS	
SHELL & HEADS		A-516-70		1/8"		MIN.		Ellipsoidal Heads	
INT'L WELD - IN		None		TOTAL					
REMOVABLE		None		TOTAL					

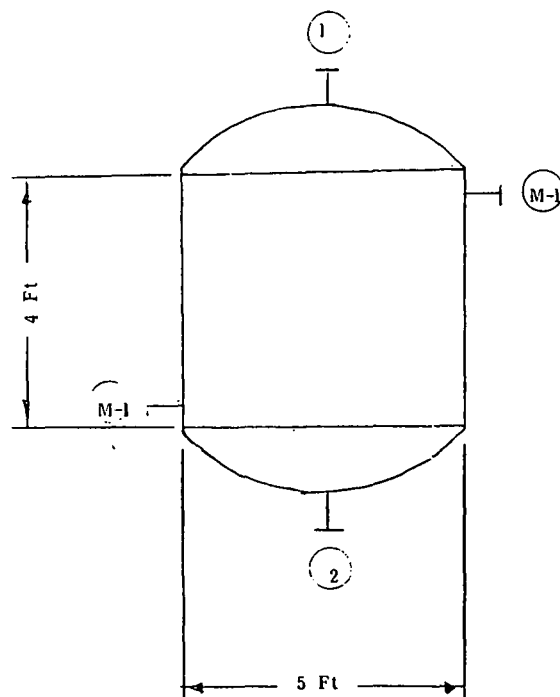
MECHANICAL DESIGN REQ.		PRESS. MARGIN		MIN. SPEC		+ 39.7		= 175 PSIG	
MIN. DESIGN PRESS AT TOP		175		PSIG (MARG + OPER.)					
SYSTEM PSV SET AT		175		PSIG		LOCATED			
MIN. DESIGN TEMP		500 °F @		175		PSIG			
EXTERNAL PRESS. DESIGN:		F.V.		FOR					
VESSEL SUPPORT DATA SKIRT		LEGS		Yes/No		LUGS			
SADDLES (C-527)									
HEIGHT		No specific requirement		MIN. ABV GRADE		FIREPROOFING		No.	

NOZZLES		SERVICE		NO. REQ'D		TEST SIZE		RATING (LBS/IN ²)		INT'L TYPE OR NOTE	
J-6											
J-5											
J-4											
J-3											
J-2											
J-1		PSV									
9											
8											
7											
6											
5											
4											
3		Steam Outlet		1		2"					
2		H ₂ O Outlet		1		4"					
1		H ₂ O Inlet		1		4"					

PROCESS INSTRUMENT		SERVICE		NO. REQ'D		TEST SIZE		RATING (LBS/IN ²)		INT'L TYPE OR NOTE	
M-1		MANWAY									

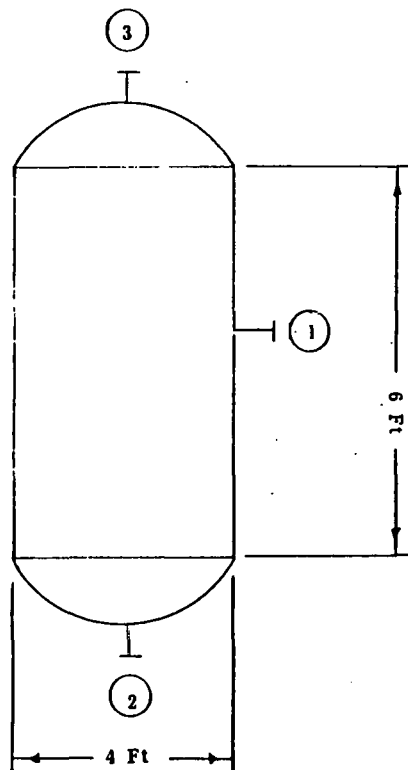
DESIGN BASIS		ISSUED FOR		PROCESS INSTRUMENT UNIT		PROJECT	
JOB NO.		VESSEL DESIGN DATA SHEET		VESSEL NO.		REV.	
251		SERVICE Oxygen Plant, Plant 15 UNIT 15-D-89 Condensate Tank, 251-1Z-31					

ISSUED FOR PHASE 0



Position: Vertical
Thickness Cylindrical Shell: 5/16"
Ellipsoidal Head: 5/16"

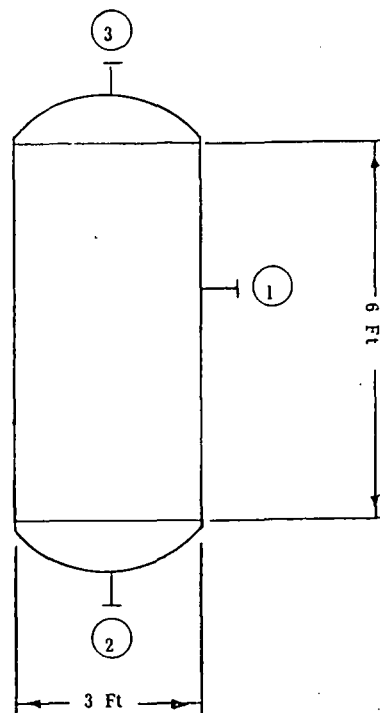
PROCESS INFORMATION	OPERATING DATA	FLUID	LB/MR	LB/CU FT	NO. OF	MAX/MIN	NO. OF	MAX	TIME	LE DATA FOR		
		1	Crude Ar	24,455	0.478	100	1000/7	57.3			75	
		2	Crude Ar	24,455	0.15	648	1000/7	57.3			75	
VAPOR PRESS @ MAX. AMB. °F = PSIA										① STD. DISPLACER RANGES (CIRCLE CHOICE) ② SPECIAL CONDIT OVER 48" ③ REFER TO DWG'S J-L-6701 & 6702 ④ SURGE, ETC. ⑤ LG WILL BE NEAREST STD. SIZE TO COVER LG RANGE. IF NO LG IS USED OR LONGER LG, REQ'D INDICATE LG DIMENSION IN SPACE PROVIDED.		
METALLURGY	COMPONENT		TYP MAT'L	CORR ALLOW	REMARKS		POST WELD HEAT TREATMENT FOR (OTHER THAN CODE)					
	SHELL & HEADS		304 S.S.	None MIN.	Ellipsoidal Heads							
	INT'L	WELD - IN		TOTAL								
		REMOVABLE	Catalvst	TOTAL								
MECHANICAL DESIGN REQ'D	PRESS MARGIN. MIN SPEC 57.3 + 17.7 = 75 PSIG										SPECIAL REQUIREMENTS	
	MIN. DESIGN PRESS AT TOP 75 PSIG (MARG + OPER.)										CODE: ASME Section VIII	
	SYSTEM PSV SET AT 75 PSIG LOCATED Outlet Piping										LOADINGS	
MIN. DESIGN TEMP 1000 °F @ 75 PSIG										SERVICE (CYCLIC, LETHAL ETC.)		
EXTERNAL PRESS DESIGN: Not Required FOR										Steady		
VESSEL SUPPORT DATA: SKIRT Yes LEGS LUGS										INSULATION: THK.		
No Specific Requirement SADDLES (C-527)												
HEIGHT MIN. ABV GRADE FIREPROOFING No												
PROCESS INSTRUMENT	NO.	SERVICE	NO. REQ'D	EST. SIZE	RATING (SPALING)	INT'L TYPE OR NOTE	NO.	SERVICE	NO. REQ'D	EST. SIZE	RATING (SPALING)	INT'L TYPE OR NOTE
	J-6											
	J-5											
J-4												
J-3												
J-2												
J-1	PSV											
9												
8												
7												
6												
5												
4												
3												
2	Crude Ar Out	1	12"									
1	Crude Ar Inlet	1	12"				M-1	MANWAY	2	18"		
DESIGN BASIS												
REV	DATE	ISSUED FOR					PROCESS	INSTRUM	UNIT	PROJ/REV		
		VESSEL DESIGN DATA SHEET										
JOB NO.		SERVICE Oxygen Plant 15										
251		UNIT 15-Y-43 Deoxo Reactor 0-251-12-39										



Position: Vertical
Shell Thickness: 3/16"
Head Thickness: 3/16"

PROCESS INFORMATION		OPERATING DATA		RESIDUE		TIME						
PROCESS INFORMATION	FLUID	CRUDE AR	24.455	0.49	100	150/-10	55.3 60					
	CRUDE AR											
VAPOR PRESS C. MAX. AMP. OF C. PSIA				① STD DISPLACED RANGES (CIRCLE CHOICE) A SPECIAL CONDIT OVER 48" ② REFER TO DWG'S J-L-6701 (6702) ③ SURGE ETC. ④ LG WILL BE NEAREST STD. SIZE TO COVER LG RANGE. IF NO LG IS USED OR LOWER LG, REQ'D INDICATE LG DIMENSION IN PAGE PROVIDED. POST WELD HEAT TREATMENT FOR _____ (OTHER THAN CODE)								
COMPONENT SHELL & HEADS INT'L WELD-IN REMOVABLE TYP MAT'L A 516-70 None None CORR ALLOW 1/8" MIN. TOTAL TOTAL REMARKS Ellipsoidal Heads				⑤ TO DISPLACED RANGES (CIRCLE CHOICE) A SPECIAL CONDIT OVER 48" ⑥ REFER TO DWG'S J-L-6701 (6702) ⑦ SURGE ETC. ⑧ LG WILL BE NEAREST STD. SIZE TO COVER LG RANGE. IF NO LG IS USED OR LOWER LG, REQ'D INDICATE LG DIMENSION IN PAGE PROVIDED. POST WELD HEAT TREATMENT FOR _____ (OTHER THAN CODE)								
PRESS MARGIN. MIN SPEC .55 + .25 = .80 PSIG				SPECIAL REQUIREMENTS								
MIN. DESIGN PRESS AT TOP 80 PSIG (MARG + OPER.)				CODE: ASME Section VIII								
SYSTEM PSV SET AT 80 PSIG LOCATED				LOADINGS								
MIN. DESIGN TEMP 150. °F @ 80 PSIG				SERVICE (CYCLIC, LETHAL ETC.)								
EXTERNAL PRESS DESIGN: Not Required FOR				Steady								
VESSEL SUPPORT DATA SKIRT Yes LEGS _____ LUGS _____				INSULATION: No THK.								
No Specific Requirement SADDLES (C-527) _____												
HEIGHT _____ MIN. ABV GRADE FIREPROOFING No												
PROCESS INSTRUMENT	NO. 1	SERVICE	NO. REQ'D	EST. SIZE	RATING (PSIG)	INT'L TYPE OR NOTE	NO. 1	SERVICE	NO. REQ'D	EST. SIZE	RATING (PSIG)	INT'L TYPE OR NOTE
	J-6											
	J-5											
	J-4											
	J-3											
	J-2											
	J-1	PSV										
	9											
	8											
	7											
6												
5												
4												
3	Crude Ar Outlet	12"										
2	H ₂ O Outlet	1"										
1	Crude Ar Inlet	12"					M-1	MANWAY				
DESIGN BASIS ISSUED FOR JOB NO. VESSEL DESIGN DATA SHEET SERVICE Oxygen Plant 15 UNIT 15-Y-451 Separator 0-251-12-41												

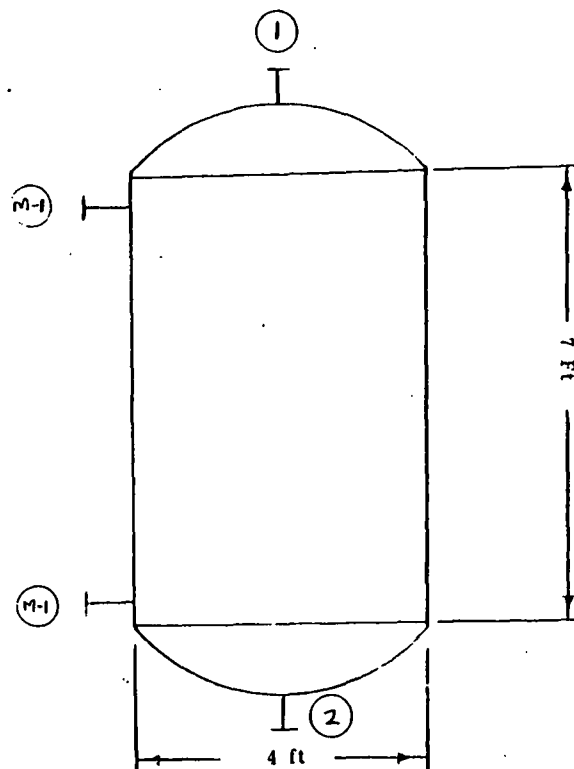
ISSUED FOR PHASE 0



Position: Vertical
Shell Thickness: 3/16"
Head Thickness: 3/16"

PROCESS INFORMATION:		OPERATING DATA		FLUID		LB/HR		LB/CU FT		NORM MAX/MIN		NORM MAX		TIME		LC DATA/CH			
				Crude oil		18,602		0.55		38		100/-10		54.3		60		LCH MLL LAM MLL LAL LLL LCL 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
				VAPOR PRESS @ MAX. AMB. @ = PSIA															
				PROCESS CONTAMINANTS															
METALLURGY		COMPONENT		TYP MAT'L		CORR ALLOW		REMARKS		(1) STD DISPLACER RANGES (CIRCLE WORK) & SPECIAL CONDUIT OVER 48" (2) REFER TO DWG'S J-L-6701 (6702) (3) SURGE, ETC. (4) LG WILL BE NEAREST STD. SIZE TO COVER LG RANGE. IF NO LG IS USED OR LONGER LG IS REQ'D INDICATE LG DIMENSION IN PAGE PROVIDED. POST WELD HEAT TREATMENT FOR _____ (OTHER THAN CODE)									
		SHELL & HEADS		A-516-70		1/8" MIN.		Ellipsoidal Heads											
		INT'L		WELD - IN		None		TOTAL											
				REMOVABLE		None		TOTAL											
MECHANICAL DESIGN REQ'D		PRESS MARGIN. MIN SPEC 55 + 2n = 30 PSIG																	
		MIN. DESIGN PRESS AT TOP 80 PSIG (MARG + OPER.)																	
		SYSTEM PSV SET AT 80 PSIG LOCATED																	
		MIN. DESIGN TEMP 150 °F @ 80 PSIG																	
		EXTERNAL PRESS DESIGN: Not Req'd FOR																	
NOZZLES		VESSEL SUPPORT DATA SKIRT _____ LEGS Yes LUGS _____																	
		No Specific SADDLES (C-527) _____																	
		HEIGHT Required MIN. ABV GRADE FIREPROOFING No																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	
PROCESS INSTRUMENT		LOADINGS																	
		SERVICE (CYCLIC, LETHAL ETC.)																	
		Steady																	
PROCESS INSTRUMENT		INSULATION: No THK.																	
		SPECIAL REQUIREMENTS																	
		CODE: ASME Section VIII																	

ISSUED FOR PHASE 0



Position: Vertical
 Shell Thickness: 3/16"
 Ellipsoidal Head Thickness: 3/16"
 No. Required: 2

TIME LL DATA FOR SCOT.

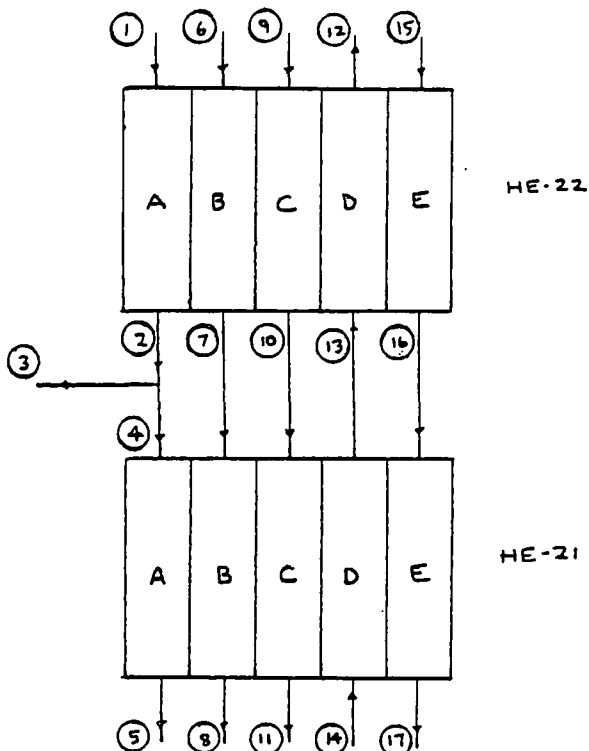
PROCESS INFORMATION		DATA		FLUID		FLOW		DENSITY		TEMP °F		PRESS PSI		TIME		LL DATA FOR																																																																																																																																																																																																	
OPERATING	DATA	LOC OR NOZZ	FLUID	LB/HR	LB/CU FT	NORM	MAX/MIN	NORM	MAX	NORM	MAX	NORM	MAX	NORM	MAX	NORM	MAX																																																																																																																																																																																																
			Crude Ar	18,398	0.29	38	450/-10	54.3	65																																																																																																																																																																																																								
VAPOR PRESS & MAX. AND. °F = PSIA																																																																																																																																																																																																																	
PROCESS CONTAMINANTS																																																																																																																																																																																																																	
METALLURGY		COMPONENT		TYP. MAT'L		CORR. ALLOW		REMARKS																																																																																																																																																																																																									
		SHELL & HEADS		A-516-70		1/8" MIN.		Ellipsoidal Heads																																																																																																																																																																																																									
		INT'L		WELD-IN		None		TOTAL																																																																																																																																																																																																									
				REMOVABLE		Desiccant		TOTAL		Mole-sieve																																																																																																																																																																																																							
MECHANICAL DESIGN REQ		PRESS MARGIN MIN SPEC 55 + 25 = 80 PSIG																																																																																																																																																																																																															
		MIN. DESIGN PRESS AT TOP 80 PSIG (MARG + OPER.)																																																																																																																																																																																																															
		SYSTEM PSV SET AT 80 PSIG LOCATED																																																																																																																																																																																																															
		MIN. DESIGN TEMP 500 °F @ 80 PSIG																																																																																																																																																																																																															
		EXTERNAL PRESS DESIGN: None Required FOR																																																																																																																																																																																																															
		VESSEL SUPPORT DATA SKIRT Yes LEGS LUGS																																																																																																																																																																																																															
		No specific requirements SADDLES (C-527)																																																																																																																																																																																																															
		HEIGHT MIN. ABV GRADE FIREPROOFING No																																																																																																																																																																																																															
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JOB NO.		251																																																																																																																																																																																																															
SERVICE UNIT		Oxygen Plant 15 15-Y-47A, D Argon Dryer 251-12-45																																																																																																																																																																																																															
PROJECT		VESSEL NO. REV.																																																																																																																																																																																																															

4.3 Data Sheets for Exchangers

- 0-251-1Z-1: Reversing Exchangers (15E-21, 22)
- 0-251-1Z-5: Direct Cooler (15E-13)
- 0-251-1Z-11: O₂ Compressor Aftercooler (15E-508)
- 0-251-1Z-15: Liquefier Heat Exchangers (15E-71, 72, 73, 74, 75)
- 0-251-1Z-16: Refrigeration Unit (15E-60)
- 0-251-1Z-18: Nitrogen Cooler (15E-761)
- 0-251-1Z-22: Liquid Oxygen Vaporizer (15E-86)
- 0-251-1Z-24: Steam Turbine Condenser Unit (15E-113)
- 0-251-1Z-29: M.P. Liquid N₂ Vaporizer (15E-88)
- 0-251-1Z-33: Derime Heater (15E-99)
- 0-251-1Z-38: Argon Compressor Aftercooler (15E-412)
- 0-251-1Z-40: Argon Cooler (15E-45)
- 0-251-1Z-42: Freon Refrigeration Unit (15E-46)
- 0-251-1Z-43: Argon Chiller (15E-461)
- 0-251-1Z-52: Turbine Steam Condenser (15E-509 A, B)

CR 171A - 3/76 PRD. IN USA

Airco Cryopants	☐ STANDARDS ☐ INSTRUCTIONS ☐ SPECIFICATIONS ☐ DATA								NO.								
									WRITTEN BY				DATE				
									APPROVED BY <i>AE</i>				DATE <i>2/15/81</i>				
									APPROVED BY <i>ES</i>				DATE <i>3/11/81</i>				
APPROVED BY <i>HHH</i>				DATE <i>3/11/81</i>													
REVISION																	
PAGE																	
DATE																	
WRITTEN BY																	
APPROVED BY																	
BRECKINRIDGE PROJECT PLANT 15 OXYGEN PLANT EXCHANGER DATA SHEETS																	



HEAT & MATERIAL BALANCE				
PT	FLOW	TEMP	PRESSURE	Stream
	#/HR	°F	PSIA	
1	78791.3			MPN
2	78791.3			
3	78791.3			
4	-			
5	-			
6	78791.3			LPN
7	78791.3			
8	78791.3	84	15.3	
9	139867.5			O ₂
10	139867.5			
11	139867.5	84	20.9	
12	646409.0			Air
13	646409.0			
14	646409.0	90	100	
15	422752.9			WN ₂
16	422752.9			
17	422752.9	84	15.1	

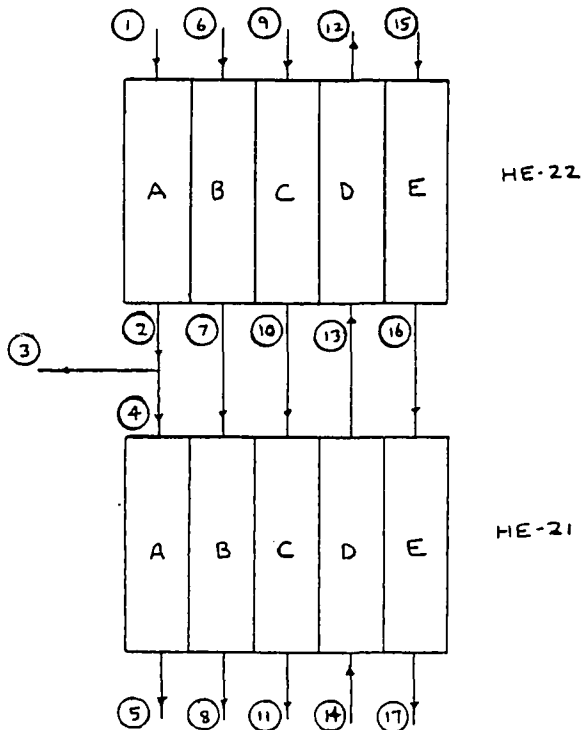
HE No.	TOTAL Q	ΔT	AREA
	BTU/HR	°F	
HE-21			
HE-22			

PRESSURE DATA				
FROM PT	TO PT.	WORKING PRESSURE	MAXIMUM PRESSURE	ALLOWABLE ΔP
		PSIA	PSIG	PSI
1	3		150	3.0
6	8		25	2.0
9	11	2	25	3.0
14	12		150	3.0
15	17		150	2.0

TURNDOWN REQUIREMENTS		
STREAM	DESCRIPTION	OPERATING RANGE
A	MPN	75-110%
B	LPN	75-110%
C	O ₂	75-110%
D	Air	75-110%
E	WN ₂ (2.0%O ₂ , .42%Ar)	75-110%
	% = WT. %	

Case V Drawing E

REMARKS:					
1) A heat leak of	BTU/HR	has			
been added to the duty of HE-22					
2) Unit to be vertical with cold end up	2	10/11/81	ADDED NOTE 6.		
3) Vendor's design should meet case VI (low conditions.	1	10/23/80	Process Data	WKF	AE 0-251-1Z-1
4) Vendor to calculate pressure drop for each stream through each exchanger	0	9/31/80	Process Data	WKF	AE 0-251-1Z-1
5) Design temp. = -320°/+150°F for all streams	Issue	Date	Description of Issue	Chg.	App'd. Spec No. S.M. No.
6) THREE UNITS REQUIRED					
AIRCO Cryopants Corporation					
SHEET 2 OF 19					
Manufacturer	Reversing Exchanger		Mr. Ref.	P.O. No.	
Service of Unit			Units Reg'd.	Cores per Unit	
Size	Type		Position	Cores in parallel	
Surfaces per Unit	Surfaces per Core			Cores in series	



HEAT & MATERIAL BALANCE				
PT	FLOW #/HR	TEMP °F	PRESSURE PSIA	Stream
1	89565.2			MPN
2	89565.2			
3	81430.4			
4	8134.8			
5	8134.8	84	90	
6	77278.3			L.P.N
7	77278.3			
8	77278.3	84	15.3	
9	131488.4			O ₂
10	131488.4			
11	131488.4	84	20.9	
12	646409.0			Air
13	646409.0			
14	646409.0	90	100	
15	424304.1			WN ₂
16	424304.1			
17	424304.1	84	15.1	

HE No.	TOTAL Q BTU/HR	ΔT °F	AREA
HE-21			
HE-22			

PRESSURE DATA				
FROM PT	TO PT	WORKING PRESSURE PSIA	MAXIMUM PRESSURE PSIG	ALLOWABLE ΔP PSI
1	5		150	3.0
6	8		25	2.0
9	11		25	3.0
14	12		150	3.0
15	17		150	2.0

TURNDOWN REQUIREMENTS		
STREAM	DESCRIPTION	OPERATING RANGE
A	MPN	75-110%
B	L.P.N	75-110%
C	O ₂	75-110%
D	Air	75-110%
E	WN ₂ (2.0% O ₂ , 1.22%Ar)	75-110%
	% = WT. %	

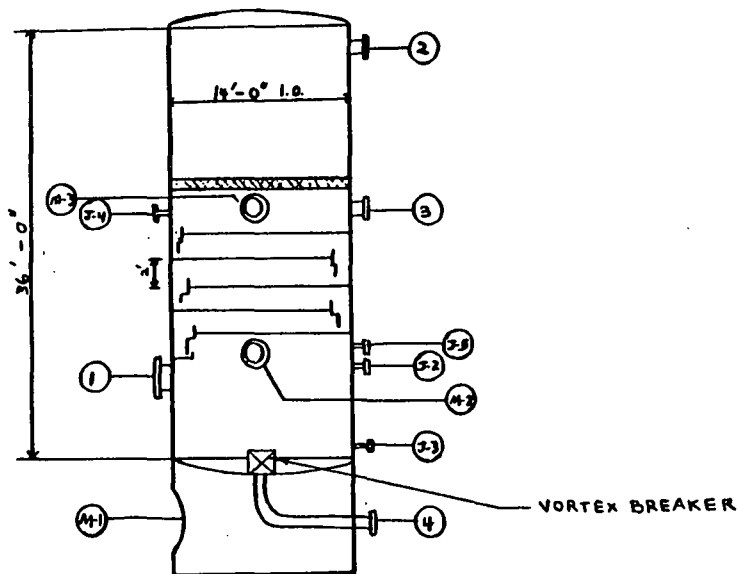
Case VI Drawing F

REMARKS:									
1) A heat leak of BTU/HR has been added to the duty of HE-22	1	10/4/81	ADDED NOTE 6.						
2) Unit to be vertical with cold end up	0	10/23/80	Process Data	WKF	AE	0-251-12-1			
3) Vendor's design should meet case V flow conditions	0	9/31/80	Process Data	WKF	AE	0-251-12-1			
4) Vendor to calculate pressure drop for each stream through each exchanger									
5) Design Temp. = -320°F/+150°F for all streams									
6) THREE UNITS REQUIRED									
Manufacturer	Service of Unit			Mfr Ref		P.O. No.			
	Reversing Exchanger					Cores per Unit			
Size	Type			Units Req'd		Cores in parallel			

AIRCO Cryoplants Corporation

AIRCO CRYOPLANTS

ISSUED FOR PHASE 0



15-E-113

POSITION : VERTICAL
SHELL THICKNESS : 7/8"
HEAD THICKNESS : 1/2"

TIME LL DATA FOR BODY

PROCESS INFORMATION

NO. OF NELLE	FLUID	FLOW LB/MR	DENSITY LB/CU FT	TEMP °F	PRESS PSIA
1	Air	682,346	.375	256 300/32	101 125
2	Air	682,346	.510	90 80/32	100 125
3	Water	1,106,000	62.2	85 125/32	101 125
4	Water	1,106,000	62.0	115 125/32	100 125

VAPOR PRESS & MAX. AMB. °F = PSIA
PROCESS CONTAMINANTS

METALLURGY

COMPONENT	TYP MAT'L	CORR ALLOW	REMARKS
SHELL & HEADS	Carbon Steel	1/16" MIN.	Ellipsoidal Heads
INT'L WELD - IN	Trays S.S.	None TOTAL	
REMOVABLE	S.S.	None TOTAL	60 mesh screen

MECHANICAL DESIGN REQ

PRESS MARGIN. MIN SPEC 101 + 38.7 = 139.7 PSIA
MIN. DESIGN PRESS AT TOP 125 PSIG (MARG + OPER)
SYSTEM PSV SET AT 125 PSIG LOCATED
MIN. DESIGN TEMP -10° °F @ 125 PSIG
EXTERNAL PRESS DESIGN: not required FOR
VESSEL SUPPORT DATA SKIRT YES LEGS LUGS
SADDLES (C-527)
HEIGHT 4' MIN. ABV GRADE FIREPROOFING

TIME LL DATA FOR

LL DATA FOR	LL DATA FOR
LLH	LLH
LLM	LLM
LLN	LLN
LLP	LLP
LLQ	LLQ
LLR	LLR
LLS	LLS
LLT	LLT
LLU	LLU
LLV	LLV
LLW	LLW
LLX	LLX
LLY	LLY
LLZ	LLZ

STD DISPLACER GAUGES (CIRCLE LOCKS)
A SPECIAL CONDIT OVER 48"
REFER TO DWG'S J-L-6701 & 6702

SURGE, ETC.
SPECIAL REQUIREMENTS
CODE: ASME Sec. VIII Div. 1
LOADINGS
SERVICE (CYCLIC, LETHAL ETC)

POST WELD HEAT TREATMENT FOR (OTHER THAN CODE)

SPECIAL REQUIREMENTS
CODE: ASME Sec. VIII Div. 1
LOADINGS
SERVICE (CYCLIC, LETHAL ETC)
INSULATION: None THK

PROCESS INSTRUMENT

NO. NO.	SERVICE	NO. REQ'D	EST SIZE	RATING (FACING)	INT'L TYPE OR NOTE	NO. NO.	SERVICE	NO. REQ'D	EST SIZE	RATING (FACING)	INT'L TYPE OR NOTE
J-6											
J-5	Level Switch	1	3"	150# RF							
J-4	Level Switch	1	3"	150# RF							
J-3	Level Control	1	2"	150# RF							
J-2	Level Control	1	2"	150# RF							
J-1	PSV										
9											
8											
7											
6											
5											
4	Water Out	1	10"	150# RF							
3	Water Inlet	1	10"	150# RF		M-3	Manhole	1	18"		
2	Air Out	1	36"	150# RF		M-2	Manhole	1	18"		
1	Air Inlet	1	38"	150# RF		M-1	MANWAY	1	24"		

DESIGN BASIS

ISSUED FOR

REV DATE

JOB NO VESSEL DESIGN DATA SHEET

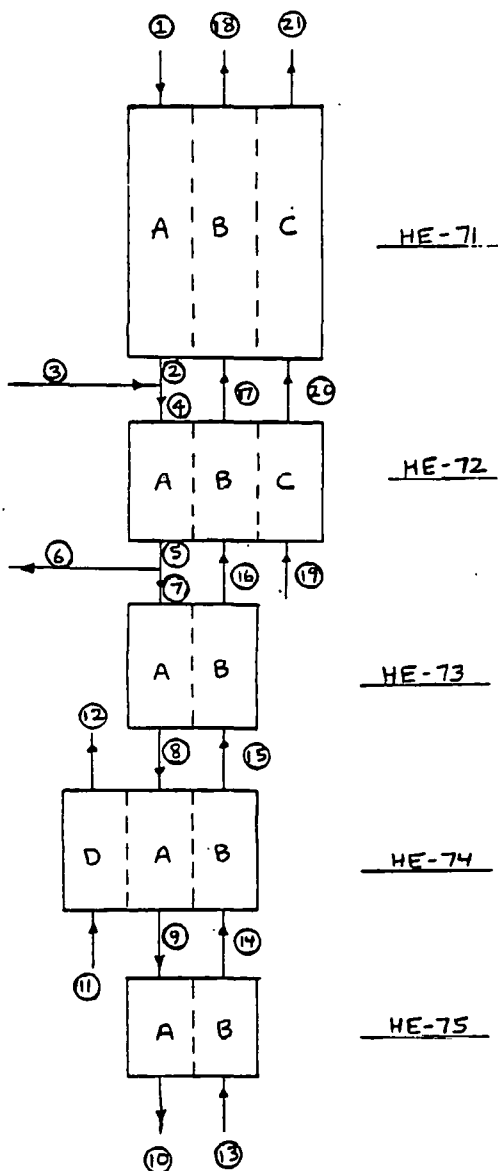


251 SERVICE UN Oxygen Plant, Plant 15 Direct Cooler, 251-12-5 AIRCO CRYOPLANTS

HEAT EXCHANGER SPECIFICATION SHEET 0-251-12-11

1	CUSTOMER AND PROJECT LOCATION Bechtel - Breckinridge, Kentucky	EXCHANGER MANUFACTURER
2	PLANT #15 Oxygen Plant EXCH. NO. 15-E-508	REQ. NO.
3	SERVICE OF UNIT O₂ Compressor Aftercooler	ITEM NO. 15-E-508
4	SIZE 2051 Sq. Ft. TYPE AEP (HORIZ/VERT) CONNECTED IN	SERIES PARALLEL
5	SURF./UNIT (IEFF/GROSS) 2051 Sq. Ft. SHELLS/UNIT One	SURF/SHELL (IEFF/GROSS) 2051
6	PERFORMANCE OF ONE UNIT	
7	FLUID ALLOCATION	SHELLSIDE TUBESIDE
8	FLUID CIRCULATED	Water Oxygen
9	TOTAL FLUID ENTERING LB/HR	258,252 131,534
10		IN OUT IN OUT
11	LIQUID	
12	VAPOR LB/HR, MW	131,534 32 131,534 32
13	NONCOND LB/HR, MW	
14	STEAM	
15	WATER lb/hr	252,252 258,252
16	FLUID VAPORIZED/CONDENSED	
17	GRAVITY, LIQ.	1.0
18	VISCOSITY, LIQ. (VAP.) CP	.79 .645
19	THERM. COND., LIQ. (VAP.) Btu/hr ft. ² °F	.360 .360
20	SPECIFIC HEAT, LIQ. (VAP.)	
21		
22	TEMPERATURE °F	85 105 264 100
23	OPERATING PRESS. (PSIA)(PSIG)	50 45 935 930
24	NO. PASSES/SHELL	one one
25	VELOCITY FT/SEC	2.7 9.3
26	PRESS. DROP, ALLOW/CALC. PSI	5 / 4.85 5 / 0.71
27	FOULING RESISTANCE	.002 .001
28	HEAT EXCHANGED 5,156,097	BTU/HR: MTD (CORR) (WTD) 60.8 °F
29	TRANSFER RATE, SERVICE 41.32	CLEAN 50.39 BTU/HR. SQ. FT. °F
30	CONSTRUCTION	
31		SHELLSIDE TUBESIDE
32	DESIGN/TEST PRESS. PSIG	75 / 150 1030 / 545
33	DESIGN TEMPERATURE °F	650 300
34	CORROSION ALLOWANCE IN	1/8" 1/8"
35	CONNECTIONS INLET	6" 8"
36	SIZE OUTLET	6" 8"
37	RATING	
38	TUBES NO. 421 OD 3/4" THK (MIN/AVG) 16BWG LENGTH 20' PITCH 5/16" FLOW → 	
39	TUBE MATERIAL Admiralty	TUBE-TUBESHEET JOINT
40	SHELL C.S. 25" 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 18 Segmental TYPE 25	% CUT (DIA/AREA) SPACING 11.2"
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 (SRI) AND PERCENT (RT) AS REQUIRED	
51		
52		
53		
54		

	REV.	DATE						JOB NO.	DRWG. NO.	REV.



HEAT & MATERIAL BALANCE

PT	FLOW	TEMP	PRESSURE	
	# / MIN	° F	PSIA	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

ISSUED FOR PHASE 0

*REMARKS: 1. UNIT SHOULD BE MOUNTED VERTICALLY WITH WARM END UP

2. ASME CODING AND STAMP REQUIRED

3. THE ΔT'S GIVEN ON THIS SHEET REPRESENT THE EMTD'S.

4. UNIT SHOULD BE IDENTICAL TO THAT USED FOR JOB 124, INDIANAPOLIS, IND.

Issue Date Description of Issue Chk App'd Spec No. 0-251-12-15 B.M. No.

Issue Date

PROCESS DATA SHEET

AE

AE

AIRCO Cryoplants Corporation

SHEET 6 OF 19

Manufacturer

Mfr Ref

P.O. No.

Service of Unit

LIQUEFIER HEAT EXCHANGERS

Cores per Unit

Size

Type

Units Rec'd.

Cores in parallel

Surfaces per Unit

Surfaces per Core

Position

Cores in series

AIRCO CRYOPLANTS ISSUED FOR PHASE 0		PROCESS SPECIFICATION REFRIGERATION UNIT NO. 0-251-1Z-16 REV. 	
EQUIPMENT TITLE Refrigeration Unit		ITEM NO. 15-E-60	
CUSTOMER	Bechtel	JOB NO. 251	
LOCATION	Breckinridge, Kentucky	DATE 9/29/80	
QUANTITY	One (1)	BY	APP'D BY
OPERATING CONDITIONS			
COMPOSITION OF GAS BEING COOLED (DRY BASIS)		100% Nitrogen	
MOLECULAR WT. OF DRY GAS		28.0134	
DOES GAS CONTAIN ANY WATER	☐ YES	☒ NO	
IS GAS SATURATED WITH WATER	☐ YES	☒ NO	
DOES GAS CONTAIN MOISTURE OTHER THAN H ₂ O	☐ YES	☒ NO	
IS GAS SATURATED WITH MOISTURE OTHER THAN H ₂ O	☐ YES	☒ NO	
COMPOSITION OF MOISTURE IF DIFFERENT THAN H ₂ O		—	
MOLECULAR WEIGHT OF MOISTURE		—	
GAS INLET TEMPERATURE		100	°F
VAPOR PRESS. OF MOISTURE AT INLET TEMP.		—	PSIA
NORMAL OPERATING PRESSURE		675	PSIA
MAX. OPERATING PRESSURE		720 PSIA	705 PSIG
DESIGN PRESSURE		750	PSIG
GAS OUTLET TEMPERATURE		-82	°F
NORMAL FLOW RATE (DRY GAS)		7167 SCFM*	31,161 LB/HR
DESIGN FLOW RATE (DRY GAS)		7525 SCFM*	32,718 LB/HR
NORMAL FLOW RATE (MOISTURE)		—	LB/HR
DESIGN FLOW RATE (MOISTURE)		—	LB/HR
AVE. SPECIFIC HEAT OF DRY GAS ENTERING		BTU/lb/°F	
AVE. SPECIFIC HEAT OF MOISTURE ENTERING		— BTU/lb/°F	
AVE. LATENT HEAT OF MOISTURE ENTERING		— BTU/lb	
LBS. MOISTURE PER LB. DRY GAS AT INLET		—	
LBS. MOISTURE PER LB. DRY GAS AT OUTLET		—	
FLUIDS CONDENSED AT DESIGN FLOW RATE		— LB/HR	
SENSIBLE HEAT LOAD (Q) AT DESIGN FLOW RATE		1,686,107	BTU/HR
LATENT HEAT LOAD (Q) AT DESIGN FLOW RATE		—	BTU/HR
TOTAL HEAT LOAD (Q) AT DESIGN FLOW RATE		1,686,107	BTU/HR
TOTAL HEAT LOAD (Q) AT DESIGN FLOW RATE		140	TONS
TYPE OF REFRIGERANT USED		Vendor to Specify	
OPERATING CONDITIONS OF REFRIGERANT IN EVAPORATOR		By Vendor PSIA By Vendor °F	
*MEASURED AT 14.7 PSIA & 70 °F			
WRITTEN BY _____ DATE _____ APPROVED _____ SHEET NO <u>7</u> OF <u>12</u>			

HEAT EXCHANGER SPECIFICATION SHEET 0-251-1Z-18

1 CUSTOMER AND PROJECT LOCATION Bechtel - Breckinridge, Kentucky		EXCHANGER MANUFACTURER	
2 PLANT #15 Oxygen Plant		3 EXCH. NO. HE-761	
4 SERVICE OF UNIT Nitrogen Cooler		5 REQ. NO.	
6 SIZE 1771 Sq Ft TYPE AEP		7 ITEM NO. 15-E-761	
8 (HORIZ/VERT) CONNECTED IN		9 SERIES PARALLEL	
10 SURF./UNIT (IEFF/GROSS) 1771 Sq Ft		11 SHELLS/UNIT One	
12 SURF/SHELL (IEFF/GROSS) 1771 Sq Ft		13 PERFORMANCE OF ONE UNIT	
14 FLUID ALLOCATION		15 SHELLSIDE	
16 FLUID CIRCULATED		17 TUBESIDE	
18 TOTAL FLUID ENTERING LB/HR		19 Water	
20 196,980		21 Nitrogen	
22 155,317		23 155,317	
24 28		25 28	
26 LIQUID		27 VAPOR	
28 NONCOND		29 STEAM	
30 WATER		31 FLUID VAPORIZED/CONDENSED	
32 GRAVITY, LIQ.		33 GRAVITY, LIQ.	
34 VISCOSITY, LIQ. (VAP.)		35 VISCOSITY, LIQ. (VAP.)	
36 THERM. COND., LIQ. (VAP.)		37 THERM. COND., LIQ. (VAP.)	
38 SPECIFIC HEAT, LIQ. (VAP.)		39 SPECIFIC HEAT, LIQ. (VAP.)	
40 TEMPERATURE		41 TEMPERATURE	
42 OPERATING PRESS.		43 OPERATING PRESS.	
44 NO. PASSES/SHELL		45 NO. PASSES/SHELL	
46 VELOCITY		47 VELOCITY	
48 PRESS. DROP, ALLOW/CALC.		49 PRESS. DROP, ALLOW/CALC.	
50 FOULING RESISTANCE		51 FOULING RESISTANCE	
52 HEAT EXCHANGED		53 HEAT EXCHANGED	
54 TRANSFER RATE, SERVICE		55 TRANSFER RATE, SERVICE	
56 CONSTRUCTION			
57 DESIGN/TEST PRESS.		58 DESIGN/TEST PRESS.	
59 DESIGN TEMPERATURE		60 DESIGN TEMPERATURE	
61 CORROSION ALLOWANCE		62 CORROSION ALLOWANCE	
63 CONNECTIONS		64 CONNECTIONS	
65 SIZE		66 SIZE	
67 RATING		68 RATING	
69 TUBES NO.		70 TUBES NO.	
71 TUBE MATERIAL		72 TUBE MATERIAL	
73 SHELL		74 SHELL	
75 CHANNEL/BONNET		76 CHANNEL/BONNET	
77 TUBESHEET-STATIONARY		78 TUBESHEET-STATIONARY	
79 FLOATING HEAD COVER		80 FLOATING HEAD COVER	
81 BAFFLES-CROSS		82 BAFFLES-CROSS	
83 BAFFLES-LONG		84 BAFFLES-LONG	
85 INSUL. THK.: SHELL		86 INSUL. THK.: SHELL	
87 GASKETS		88 GASKETS	
89 CODE REQUIREMENTS		90 CODE REQUIREMENTS	
91 WEIGHT: EACH SHELL		92 WEIGHT: EACH SHELL	
93 REMARKS: MARK (SRI) AND PERCENT (RT) AS REQUIRED		94 REMARKS: MARK (SRI) AND PERCENT (RT) AS REQUIRED	
95 NOTE: Corrosion allowance on tube side applies only to carbon steel parts			
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**AIRCO CRYOPLANTS
ISSUED FOR PHASE 0**

HEAT EXCHANGER SPECIFICATION SHEET

0-251-1Z-22

1	CUSTOMER AND PROJECT LOCATION	Bechtel, Breckinridge, Kentucky			EXCHANGER MANUFACTURER	
2	PLANT 15—Oxygen Plant	EXCH. NO.	HE-86		REQ. NO.	
3	SERVICE OF UNIT Liquid Oxygen Vaporizer				ITEM NO. 15-E-86	
4	SIZE 494 ft. ²	TYPE AEU	(HORIZ)	CONNECTED IN -	SERIES - PARALLEL	
5	SURF./UNIT (EFF./GROSS) 494 ft. ²	SHELLS One	SURF/SHELL (EFF./GROSS) 494 ft. ²			
6	PERFORMANCE OF ONE UNIT					
7	FLUID ALLOCATION	SHELLSIDE		TUBESIDE		
8	FLUID CIRCULATED	Saturated Steam		Oxygen		
9	TOTAL FLUID ENTERING LB/MR	30.330		133.377		
10		IN	OUT	IN	OUT	
11	LIQUID lb/hr			133.377		
12	VAPOR LB/MR, MW				133.377 32	
13	NONCOND LB/MR, MW					
14	STEAM lb/hr	30.330				
15	WATER lb/hr		30.330			
16	FLUID VAPORIZED/CONDENSED lb/hr	30.330		133.377		
17	GRAVITY, LIQ.		0.891			
18	VISCOSITY, LIQ. (VAP.) lb/hr.ft.	(0.0314)	0.15	.533	(.065)	
19	THERM. COND., LIQ. (VAP.) Btu/hr.ft. ^{°F}	(0.018)	0.45	.008	(.019)	
20	SPECIFIC HEAT, LIQ. (VAP.) Btu/# ^{°F}	(0.45)	1.0	.3587		
21						
22	TEMPERATURE °F	366	355.7	-300	200	
23	OPERATING PRESS. (PSIG)	150	140	935.3	925.3	
24	NO. PASSES/SHELL		1		2	
25	VELOCITY FT/SEC					
26	PRESS. DROP, ALLOW/CALC. PSI	10	.429	10	2.7	
27	FOULING RESISTANCE		.001		.001	
28	HEAT EXCHANGED 26,198,100	BTU/MR; MTD (CORR) (WTD)		358	*F	
29	TRANSFER RATE, SERVICE 247	CLEAN		BTU/MR. SQ. FT. °F		
30	CONSTRUCTION					
31		SHELLSIDE	TUBESIDE			
32	DESIGN/TEST PRESS. PSIG	175 / 350	1000 / 2000			
33	DESIGN TEMPERATURE °F	500/-320	500/-320			
34	CORROSION ALLOWANCE IN	1/16"	—			
35	CONNECTIONS INLET in	10	6			
36	SIZE OUTLET	3	10			
37	RATING					
38	TUBES NO. 126	OD S.S.	THK (MIN/AVG) 16BWG	LENGTH 20 ft	PITCH 1" FLOW → ◊ Δ ◊ □	
39	TUBE MATERIAL 304 S.S.	TUBE-TUBESHEET JOINT				
40	SHELL CS 16 inch	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		SPEC		
49	WEIGHT: EACH SHELL BUNDLE	FULL OF WATER				
50	REMARKS: MARK (SRI) AND PERCENT (RT) AS REQUIRED					
51						
52						
53						
54						
REV	△ DATE			JOB NO.	DWG. NO.	REV.
	△				03.	
	△					

SURFACE CONDENSER DATA SHEET

0-251-1Z-24

1	Customer	Bechtel		
2	Project Location	Breckinridge, Kentucky		Manufacturer Later
3	Plant	#15 Oxygen Plant	Cond. No.	Req. No.
4	Service Of Unit	Steam Turbine Condenser Units		Item No 15-E-113
5	Size	Horizontal		No. Required 2
6	Surf. (EH/Gross)	ft ²		
7	PERFORMANCE			
8	Fluid Allocation	Shellside		Tubeside
9	Fluid Circulated	Wet Steam		Water
10	Total Fluid Entering	lb/h	206,500	7,074,000
11		Design	Normal	Design Normal
12	Water	lb/h	20,400	7,074,000
13	Steam	lb/h, MW	186.100 18.02	
14	Steam Condensed	lb/h	186.100	
15	Density, Liq.	lb/ft ³	61.73	62.00
16	Viscosity, Liq. (Vap.)	cP	(.011)	.84 @ 85°
17	Therm. Cond., Liq. (Vap.)	Btu/h-ft ² °F	.372 (.012)	.353
18	Specific Heat, Liq. (Vap.)	Btu/lb °F	1.0 (.424)	1.0
19	Latent Heat, Vap.	Btu/lb	1025	
20	Temperature In/Out	°F	120.5 / 120.5	85 / 112
21	Operating Press.	(Psia) (Psig)	3.5 " HG ABS	60 50
22	No. Passes	One	One	Two
23	Velocity Allow/Calc.	ft/sec	/	8 /
24	Press. Drop, Allow/Calc.	psi	NIL / NIL	10 /
25	Cleanliness Factor	85%		
26	Heat Exchanged	191,000,000	Btu/h, MTD	18.9 °F
27	Transfer Rate, Service	Clean Btu/h-ft ² °F		
28	CONSTRUCTION			
29	Tubes	Hotwell: lb		
30	Main Condensing Sections:	Type: Capacity:		
31	No.: OD: 3/4" in. Thk: 16 BWG	Material:		
32	Length, effective: 24 ft. Overall: 30 ft	Thickness:		
33	Material: Admiralty Tube Pitch: Tri in	Tube sheets		
34	Gas Removal Sections:	Number and size:		
35	No.: OD: in. Thk.: BWG	Material: Muntz Metal Thickness: in.		
36	Length, effective: ft Overall: ft			
37	Material: Tube Pitch: in	Tube support plates		
38	Imbedment Sections:	Number:		
39	No.: OD: in. Thk: BWG	Material: Thickness: in.		
40	Length, effective: ft Overall: ft			
41	Material: Tube Pitch: in	Steam inlet neck and exhaust connection		
42	Tube - Tubesheet Joint:	Material		
43	Water boxes & Covers	Thickness: Number of sections:		
44	Material (Water box): A-516-70	Connection to shell - {flanged or welded} Turbine - {flanged or welded}		
45	Material (Covers): A-516-70	Height - top of water box flange to turbine Exhaust including		
46	Divided or non-divided: Divided	expansion joint (if any):		
47	Design pressure: 75 psig Temperature 150 °F	Provision for vertical expansion (condenser hung):		
48	Nozzles Number and Size - Inlet: 2-24" Outlet: 2-24"	(spring supports)(expansion joints):		
49	Shell	Spring supports Type:		
50	Material: A-516-70	Expansion joint Type:		
51	Thickness: in Number of sections:	Material:		
52	Provision for tube expansion	Height: Ends - (Flanged) (Welded)		
53	Number and size of venting connections:			
54	Design pressure psig Temperature °F And Full Vacuum			
	REV.	Δ 3/4/81 Steam - 3" to 3.5 Δ Water 105-112 Δ		
		JOB NO. DRWG. NO REV. DS. 1		

SURFACE CONDENSER DATA SHEET (CONTINUED)

0-251-1Z-24

55	Steam Jet Air Ejector(s)				
56	Total number of Ejector Units: <u>Later</u>				
	Size and type: <u>Later</u>	No. of elements: <u>2</u>	No. of stages: <u>2</u>		
58	Surface Inter-and After-Condensers				
59	Operating Conditions and Performance				
60	Design capacity - 100 per cent -				
61	Suction pressure:	in. Hg. abs	Suction temperature:	°F	
62	Dry air leakage:	SCFM corresponding to:			lb per h
63	Non-condensable 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:	psig	Total temp:	°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	Surfaces: 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:				
	Suction chambers:	Condenser shells:	<u>Steel</u>		
84	Diffusers:	Water chambers:	<u>Steel</u>		
85	Steam nozzles:	Tube sheets:	<u>Muntz Metal</u>		
86	Steam chests (nozzle heads):	Tubes:	<u>Adm</u>		
87	Fittings and Accessories included				
88	Air leakage meter.				
89	Other:				
90	Hogging Ejectors				
91	(Steam) (Air) (Water) Operated.	Number per condenser			Size
92	Operating Conditions and Performance				
93	Capacity:	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 °F
97					
98	Fittings and accessories included:				
99	Priming Ejector(s)				
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 °F
106					
107	Approximate weight:				
108	Condenser Dry	lb.	Ejectors: Priming	lb.	
9	Flooded	lb.	Hogging	lb.	
10			Air	lb.	
111					

ISSUED FOR PHASE 0

0-251-1Z-29

SHEET 12 OF 19

0-251-1Z-33

SHEET 13 OF 19

HEAT EXCHANGER SPECIFICATION SHEET

0-251-12-38

CUSTOMER AND PROJECT LOCATION		Bechtel - Breckinridge, Kentucky		EXCHANGER MANUFACTURER	
PLANT #15 Oxygen Plant		EXCH. NO. HE-412		REQ. NO. one	
SERVICE OF UNIT Argon Compressor Aftercooler		ITEM NO. 15 E-412			
SIZE 490 sq. ft.		TYPE AEP (HORIZ/VERT) CONNECTED IN		SERIES PARALLEL	
SURF./UNIT (EFF/GROSS) 490 sq. ft.		SHELLS/UNIT one		SURF./SHELL (EFF/GROSS) 490 sq. ft.	
PERFORMANCE OF ONE UNIT					
FLUID ALLOCATION		SHELLSIDE		TUBESIDE	
FLUID CIRCULATED		Water		Crude Argon	
TOTAL FLUID ENTERING LB/HR		46,060		24,391	
		IN OUT		IN OUT	
LIQUID					
VAPOR LB/HR, MW				24,391 40 24,391 40	
NONCOND LB/HR, MW					
STEAM					
WATER lb/hr		46,060 46,060			
FLUID VAPORIZED/CONDENSED					
GRAVITY, LIQ.					
VISCOSITY, LIQ. (VAP.) lb/ft/hr		1.92 1.56		(0.0774) (0.0557)	
THERM. COND., LIQ. (VAP.) Btu/f/ft/hr		0.36 0.36		(0.0142) (0.0105)	
SPECIFIC HEAT, LIQ. (VAP.) Btu/lb/°F		1.0 1.0		(0.128) (0.128)	
TEMPERATURE °F		85 105		394 100	
OPERATING PRESS. KPSIA (PSIG)		50 45		60 57	
NO. PASSES/SHELL		one		one	
VELOCITY FT/SEC		1.95		80.6	
PRESS. DROP, ALLOW/CALC PSI		5 / 4.6		3 / 2.3	
FOULING RESISTANCE		.002		.001	
HEAT EXCHANGED 921,200		BTU/HR; MTD (CORR) (WTD)		92.5 °F	
TRANSFER RATE, SERVICE 20.32		CLEAN 25.32		BTU/HR. SQ. FT. °F	
CONSTRUCTION					
DESIGN/TEST PRESS. PSIG		75 / 150		66 / 100	
DESIGN TEMPERATURE °F		650		500	
CORROSION ALLOWANCE IN		1/8"		—	
CONNECTIONS INLET		3"		8"	
SIZE OUTLET		3"		6"	
RATING					
TUBES NO. 126		OD 3/4" THK (MIN/AVG) 16BWG		LENGTH 20' PITCH 15/16" FLOW → ◀ ▲ ◆ □	
TUBE MATERIAL 304 S.S.		TUBE-TUBESHEET JOINT			
SHELL 13" ID OD		SHELL COVER		(INTEG) (REMOV)	
CHANNEL/BONNET		CHANNEL COVER			
TUBESHEET-STATIONARY		TUBESHEET FLOATING			
FLOATING HEAD COVER		IMPINGEMENT PLATE (YES) (NO)			
BAFFLES-CROSS 46 Segmental		TYPE 25		% CUT (DIA/AREA) SPACING 5.0"	
BAFFLES-LONG		SEAL TYPE		TUBE SUPPORTS	
INSUL THK: SHELL		CHAN.		EXPANSION JOINT	
GASKETS					
CODE REQUIREMENTS		STAMP (YES) (NO)		TEMA CLASS SPECS	
WEIGHT: EACH SHELL		BUNDLE		FULL OF WATER	
REMARKS: MARK (SRI) AND PERCENT (RT) AS REQUIRED					
NOTE: (1) Corrosion allowance on tube side applies only to carbon steel parts.					

	REV.	DATE					JOB NO.	DRWG. NO.	REV.
	△	8/2/81	AEP to AEP 10' Tubes to 20'					OS.	1
	△								

HEAT EXCHANGER SPECIFICATION SHEET

0-251-1Z-40

1	CUSTOMER AND PROJECT LOCATION		Bechtel Breckinridge, Kentucky		EXCHANGER MANUFACTURER	
2	PLANT #15 Oxygen Plant		EXCH. NO. 15-E-45		REQ. NO.	
3	SERVICE OF UNIT		Argon Cooler		ITEM NO. 15-E-45	
4	SIZE 905 Sq. Ft.	TYPE AEP	(HORIZ/VERT)	CONNECTED IN	SERIES	PARALLEL
5	SURF./UNIT (EFF/GROSS) 905 Sq. Ft.		SHELLS/UNIT One		SURF./SHELL (EFF/GROSS) 905 Sq. Ft.	
6	PERFORMANCE OF ONE UNIT					
7	FLUID ALLOCATION		SHELLSIDE		TUBESIDE	
8	FLUID CIRCULATED		Cooling Water		Crude Argon	
9	TOTAL FLUID ENTERING		LB/HR	97,669	24,455	
10			IN	OUT	IN	OUT
11	LIQUID	Lb/hr	97,669	97,669		
12	VAPOR	LB/HR, MW			24,455	40
13	NONCONO	LB/HR, MW			24,260	40
14	STEAM					
15	WATER	Lb/hr	97,669	97,669	0.0	195
16	FLUID VAPORIZED/CONDENSED	Lb/hr				00/195
17	GRAVITY, LIQ.					
18	VISCOSITY, LIQ. (VAP.)	CP	0.793	0.645	(.038)	(.0222)
19	THERM. COND., LIQ. (VAP.)	Btu/hr/ft/°F	0.36	0.36	(.0163)	(.0105)
20	SPECIFIC HEAT, LIQ. (VAP.)	Btu/lb/°F	1.0	1.0	(.119)	(.126)
21						
22	TEMPERATURE	°F	85	105	644	105
23	OPERATING PRESS.	(PSIA) (PSIG)	50	45	56.8	55.8
24	NO. PASSES/SHELL		One		One	
25	VELOCITY	FT/SEC	2.14		60.4	
26	PRESS. DROP, ALLOW/CALC.	PSI	5 / 4.5		1.0 / .87	
27	FOULING RESISTANCE		.002		.001	
28	HEAT EXCHANGED		1,950,000	BTU/HR: MTD (CORR) (WTO)	151.7	°F
29	TRANSFER RATE, SERVICE.		14.2	CLEAN	17.4	BTU/HR. SQ. FT. °F
30	CONSTRUCTION					
31			SHELLSIDE	TUBESIDE		
32	DESIGN/TEST PRESS.	PSIG	75 / 50	75 / 150		
33	DESIGN TEMPERATURE	°F	650	800		
34	CORROSION ALLOWANCE	IN	1/16"			
35	CONNECTIONS	INLET	4"	10"		
36	SIZE	OUTLET	4"	8"		
37	RATING					
38	TUBES NO. 233	OD 3/4"	THK (MIN/AVG) 16BWG	LENGTH 20'	PITCH 15"	FLOW → 
39	TUBE MATERIAL	304 SS	TUBE-TUBESHEET JOINT 1/16"			
40	SHELL CS 17"	IP	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	30 Segmental	TYPE 25	% CUT (DIA/AREA)	SPACING	7.6 in.
45	BAFFLES-LONG	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 (SRI) AND PERCENT (RT) AS REQUIRED					
51	NOTE: (1) Corrosion allowance on tube side applies only to carbon steel part.					
52						
53						
54						

	REV.	DATE					JOB NO.	DRWG. NO.	REV.
	△	8/2/81	AEU to AEP, rise 15° to 20°					DS.	
	△								



AIRCO CRYOPLANTS

ISSUED FOR PHASE 0

PROCESS
SPECIFICATION

REFRIGERATION UNIT

NO. 0-251-IZ-42

REV.

10-15-81

EQUIPMENT TITLE Freon Refrigeration Unit

ITEM NO. 15 V-46

CUSTOMER Bechtel

JOB NO. 251

LOCATION Breckinridge, Kv.

DATE 11/6/80

QUANTITY one

BY R. R. APP'D BY

OPERATING CONDITIONS

COMPOSITION OF GAS BEING COOLED (DRY BASIS) 1.6% N₂, 97.4% Ar. 1.0% H₂

MOLECULAR WT. OF DRY GAS 39.4

DOES GAS CONTAIN ANY WATER ☒ YES ☐ NOIS GAS SATURATED WITH WATER ☒ YES ☐ NODOES GAS CONTAIN MOISTURE OTHER THAN H₂O ☐ YES ☒ NOIS GAS SATURATED WITH MOISTURE OTHER THAN H₂O ☐ YES ☒ NOCOMPOSITION OF MOISTURE IF DIFFERENT THAN H₂O

MOLECULAR WEIGHT OF MOISTURE 18

GAS INLET TEMPERATURE 100 °F

VAPOR PRESS. OF MOISTURE AT INLET TEMP. 0.9487 PSIA

NORMAL OPERATING PRESSURE 70 PSIA

MAX. OPERATING PRESSURE 75 PSIA 60.3 PSIG

DESIGN PRESSURE (15% ABOVE MAX. OPER. PRESS.) 75 PSIG

GAS OUTLET TEMPERATURE °F

NORMAL FLOW RATE (DRY GAS) 3023.9 SCFM* 18,500 LB/HR

DESIGN FLOW RATE (DRY GAS) 3330 SCFM* 20,350 LB/HR

NORMAL FLOW RATE (MOISTURE) 115.8 LB/HR

DESIGN FLOW RATE (MOISTURE) 127.4 LB/HR

AVE. SPECIFIC HEAT OF DRY GAS ENTERING .1255 BTU/#/°F

AVE. SPECIFIC HEAT OF MOISTURE ENTERING .437 BTU/#/°F

AVE. LATENT HEAT OF MOISTURE ENTERING 1036.4 BTU/#

LBS. MOISTURE PER LB. DRY GAS AT INLET

LBS. MOISTURE PER LB. DRY GAS AT OUTLET

FLUIDS CONDENSED AT DESIGN FLOW RATE LB/HR

SENSIBLE HEAT LOAD (Q) AT DESIGN FLOW RATE BTU/HR

LATENT HEAT LOAD (Q) AT DESIGN FLOW RATE BTU/HR

TOTAL HEAT LOAD (Q) AT DESIGN FLOW RATE 285,780 BTU/HR

TOTAL HEAT LOAD (Q) AT DESIGN FLOW RATE TONS

TYPE OF REFRIGERANT USED

OPERATING CONDITIONS OF REFRIGERANT IN EVAPORATOR PSIA °F

*MEASURED AT 14.7 PSIA & 70 °F

WRITTEN BY _____ DATE _____ APPROVED _____ SHEET NO 16 OF 19

0-251-1Z-43

SHEET 17 OF 19

SURFACE CONDENSER DATA SHEET

0-251-1Z-52

1	Customer: Bechtel			
2	Project Location: Breckinridge Project		Manufacturer: Later	
3	Plant: #15 Oxygen Plant	Cond. No.	Req. No.	
4	Service Of Unit: Turbine Steam Condenser		Item No.	15-E-509A&B
5	Size	Horizontal	No. Required	2
6	Surf. (Ent/Gross) ft²			
7	PERFORMANCE			
8	Fluid Allocation	Shellside		Tubeside
9	Fluid Circulated	Wet Steam		Water
10	Total Fluid Entering	lb/h	76,080	
11		Design	Normal	
12	Water	lb/h	7515	2,604,503
13	Steam	lb/h MW	68,565	18
14	Steam Condensed	lb/h	68,565	
15	Density, Lqd.	lb/ft ³	1.0	1.0
16	Viscosity, Lqd. (Vap.)	cP	.55 (0.011)	0.84@85°
17	Therm. Cond., Lqd. (Vap.)	Btu/h-ft ² °F	.372 (0.012)	0.353
18	Specific Heat, Lqd. (Vap.)	Btu/lb °F	1.0 (.424)	1.0
19	Latent Heat, Vap.	Btu/lb	1025	—
20	Temperature In/Out	°F	120.5 / 120.5	85 / 112
21	Operating Press.	(Psia) (Psig)	3.5" hg ABS	60 / 50
22	No. Passes		One	One
23	Velocity Allow/Calc.	ft/sec	/	8 /
24	Press. Drop, Allow/Calc.	psi	NIL / NIL	10 /
25	Cleanliness Factor		85%	
26	Heat Exchanged		70,322,300	18.9 °F
27	Transfer Rate, Service		Clean	18.9 Btu/h-ft ² °F
28	CONSTRUCTION			
29	Tubes	Hotwell: lb		
30	Main Condensing Sections:	Type: De-aerating Capacity: 1 minute min.		
31	No.: 00: 3/4" in. Thk.: 16 BWG	Material: Steel		
32	Length, effective: 16' ft Overall: 20' ft	Thickness:		
33	Material: Adm Tube Pitch: Tri in	Tube sheets		
34	Gas Removal Sections:	Number and size:		
35	No.: 00: in. Thk.: 16 BWG	Material: Steel Thickness: in.		
36	Length, effective: ft Overall: ft			
37	Material: Tube Pitch: in	Tube support plates		
38	Impingement Sections:	Number:		
39	No.: 00: in. Thk.: 16 BWG	Material: Thickness: in.		
40	Length, effective: ft Overall: ft			
41	Material: Tube Pitch: in	Steam inlet neck and exhaust connection		
42	Tube - Tubesheet Joint:	Material:		
43	Water boxes & Covers	Thickness: Number of sections:		
44	Material (Water box): Carbon Steel	Connection to shell - (flanged) or (welded) Turbine - (flanged) or (welded):		
45	Material (Covers): Carbon Steel	Height - top of water box flange to turbine Exhaust including		
46	Divided or non-divided:	expansion joint (if any):		
47	Design pressure: 75 psig Temperature 150 °F	Provision for vertical expansion (condenser hung):		
48	Nozzles Number and Size - Inlet: 2-14" Outlet: 2-14"	(spring supports)(expansion joints):		
49	Shell	Spring supports Type:		
50	Material: Steel	Expansion joint Type:		
51	Thickness: in Number of sections:	Material:		
52	Provision for tube expansion	Height: Ends - (Flanged) (Welded)		
53	Number and size of venting connections:			
54	Design pressure psig Temperature °F And Full Vacuum			
	REV.	Δ		
	Δ			
	Δ			
			JOB NO.	DRWG. NO. REV.
			DS	

55	Steam Jet Air Ejectors				
56	Total number of Ejector Units <u>Later</u>				
57	Size and type: <u>Later</u>		No. of elements <u>2</u>	No. of stages <u>2</u>	
Surface Inter-and After-Condensers					
Operating Conditions and Performance					
60	Design capacity — 100 per cent —				
61	Suction pressure,	in. Hg. abs	Suction temperature:		°F
62	Dry air leakage:	SCFM corresponding to:			lb per h
63	Non-condensable 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:	psig	Total temp:		°F
70	Minimum operating pressure (at nozzle):	psig	Total temp:		°F
71	Steam Consumption (100 per cent design capacity):	lb per h			
72	Inter/After Condenser Data				
73	Surfaces ft:	Inter-Condenser		After-Condenser	
74	Heat Exchanged Btu/h	Inter-Condenser		After-Condenser	
75	Tubes, No:	OD	in	Thk	BWG: Length (Effective-oversill) 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:	Condenser shells:		Steel	
84	Diffusers:	Water chambers:		Steel	
85	Steam nozzles:	Tube sheets:		Muntz Metal	
86	Steam chests (nozzle heads):	Tubes:		Adm	
87	Fittings and Accessories included				
88	Air leakage meter.				
89	Other:				
90	Hogging Ejectors				
91	(Steam) (Air) (Water) Operated.	Number per condenser		Size	None
92	Operating Conditions and Performance				
93	Capacity:	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)				
100	(Steam) (Air) (Water) Operated.	Size		Later	
101	Operating Conditions and Performance				
102	Capacity:	Later	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				
111					

4.4 Data Sheets for Pumps and Drivers

- 0-251-1Z-6: Direct Cooler Water Pump (15G-131-1 A, B, C, 2 A, B, C)
- 0-251-1Z-20: Liquid Oxygen Transfer Pump (15G-801)
- 0-251-1Z-21: Liquid Oxygen Pump (15G-861 A, B)
- 0-251-1Z-27 Liquid Nitrogen Transfer Pump (15G-811)
- 0-251-1Z-30 Medium Pressure Liquid N₂ Pump (15G-881 A, B)
- 0-251-1Z-32 Condensate Return Pump (15G-891 A, B)
- 0-251-1Z-35 Condensate Return Pump (15G-514-1 A, B, 2 A, B)
- 0-251-1Z-48 Liquid Argon Transfer Pump (15G-851)
- 0-251-1Z-49 Liquid Oxygen Circulating Pump (15G-371-1 A, B, C, 2 A, B, C)
- 0-251-1Z-50 Crude Argon Pump (15G-291-1 A, B, C, 2 A, B, C, 3 A, B, C)
- 0-251-1Z-51 Condensate Return Pump (15G-114-1 A, B, 2 A, B)

Airco Cryopants				☐ STANDARDS ☐ INSTRUCTIONS ☐ SPECIFICATIONS ☐ DATA				No.										
								WRITTEN BY				DATE						
								APPROVED BY <i>AE</i>				DATE <i>2/15/81</i>						
								APPROVED BY <i>JS</i>				DATE <i>3/11/81</i>						
								APPROVED BY <i>HHH</i>				DATE <i>3/11/81</i>						
REVISION																		
PAGE																		
DATE																		
WRITTEN BY																		
APPROVED BY																		
BRECKINRIDGE PROJECT PLANT 15 OXYGEN PLANT PUMP DATA SHEETS																		
Sheet No. <u>1</u> of <u>12</u>																		

AIRCO CRYOPLANTS ISSUED FOR PHASE 0

0-251-1Z-6

CENTRIFUGAL PUMP DATA SHEET

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

JOB NO. 0251 ITEM NO. 15-G-131-A,B,C
PURCHASE ORDER NO. 2A, 2B, 2C
REQUISITION NO. _____
INQUIRY NO. _____
DATE 11/6/80 REVISION _____

FOR Bechtel SITE Breckinridge, Kentucky
UNIT Air Separation Plant SERVICE Direct Cooler Water Pumps
NO. PUMPS REQ'D 6 NO. MOTORS REQ'D 6 ITEM NO. — PROVIDED BY Pump Mfg MTD BY Pump Mfg.
NO. TURBINES REQ'D 0 ITEM NO. — PROVIDED BY — MTD BY —
PUMP MFR Ingersoll Rand SIZE AND TYPE 12 X 14 SD STAGES 1 SERIAL NO. —
or equal

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID <u>Water</u>	U.S. GPM at FT. HOR. <u>2205</u>	RATED <u>2500</u>	PROPOSAL CURVE NO. <u>12 X 14 SD-H</u>		
DISCH. PRESS. PSIG <u>105</u>			RPM <u>1750</u>	NPSH (WATER) <u>15'</u>	
PT. F. HOR. <u>85</u> MAX.	SUCT. PRESS. PSIG MAX <u>50</u>	RATED <u>50</u>	EFF. <u>85%</u>	BHP RATED <u>94</u>	
SP. GR. at FT. <u>0.996</u>	DIFF. PRESS. PSI <u>55</u>		MAX. BHP RATED IMP. <u>110</u>		
VAP. PRESS. at FT. PSIA <u>0.6</u>	DIFF. HEAD. FT. <u>127</u>		MAX. HEAD RATED IMP. <u>170</u>		
VIS. at FT. <u>0.8</u> CP	NPSHA FT. <u>148</u>		MIN. CONTINUOUS GPM <u>100</u>		
CORR./EROS. CAUSED BY <u>115 ppm Chlorides</u>	HYD. HP <u>80</u>		ROTATION (VIEWED FROM CPLG END) <u>CCW</u>		

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WIT. PERF.	☐ WIT. PERF.
SUCTION	14	125	FF	Side	☒ NON-WIT. HYDRO	☐ WIT. HYDRO
DISCHARGE	12	125	FF	Side	☐ NPSH REQ'D	☐ WIT. NPSH

CASE MOUNT: ☐ CENTERLINE ☒ FOOT ☐ BRACKET ☐ VERT. (TYPE) _____
SPLIT: ☒ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL ☒ DBL ☐ DIFFUSER
PRESS: ☐ MAX. ALLOW. 250 PSIG 250 "F. ☐ HYDRO TEST 375 PSIG
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA: ☐ RATED 12-3/4 ☐ MAX 14-5/8 ☐ TYPE Closed
MOUNT: ☒ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM./CLRNC. _____
BEARINGS-TYPE: ☒ RACIAL Sleeve ☐ THRUST —
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☒ Grease
COUPLING: ☒ MFR Falco ☐ MODEL T
DRIVER HALF MTD BY: ☒ PUMP MFR ☐ DRIVER MFR ☐ PURCHASER
PACKING: ☐ MFR & TYPE Later ☐ SIZE/NO. OF RINGS Later
MECH. SEAL: ☐ MFR & MODEL — API CLASS. CODE —
☐ MFR CODE —

AUXILIARY PIPING
☐ C.W. PIPE PLAN — ☐ CU: ☐ S.S. ☐ TUBING: ☐ PIPE —
☐ TOTAL COOLING WATER REQ'D. GPM — ☐ SIGHT FL. REQ'D —
☒ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM Later ☐ 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 —

MOTOR DRIVER
HP 110 RPM 1750 FRAME 447T VOLTS/PHASE/CYCLES 460/3/60
MFR GE or equal BEARINGS Ball LUBE Grease
TYPE Induction INSUL B FULL LOAD AMPS 230
ENC TEFC TEMP RISE C 80 LOCKED ROTOR AMPS 1450
☐ VHS ☐ VSS VERT. THRUST CAP. LB. — SERVICE FACTOR 1.0

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 ☐
Cast Iron
BASEPLATE ☐ Steel
VERTICAL PUMPS
FT 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
TURBINE DRIVER
None
APPROX. WT. PUMP & BASE 2340
MOTOR 2165 TURBINE —

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED.



				JOB NO.	DRAWING NO.	REV.
NO.	DATE			SHEET _____ OF _____		

AIRCO CRYOPLANTS

ISSUED FOR PHASE 0

CENTRIFUGAL PUMP DATA SHEET

0-251-1Z-20

JOB NO. 251 ITEM NO. 15-G-801
 PURCHASE ORDER NO. _____
 REQUISITION NO. _____
 INQUIRY NO. _____
 DATE 11/7/80 REVISION _____

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

FOR Bechtel SITE Breckinridge, Kentucky
 UNIT Air Separation Plant SERVICE Liquid Oxygen Transfer Pump
 NO. PUMPS REQ'D 1 NO. MOTORS REQ'D 1 ITEM NO. —
 NO. TURBINES REQ'D 0 ITEM NO. — PROVIDED BY Pump Mfr MTD BY Pump Mfr
 PUMP MFR Airco Cryogenics SIZE AND TYPE 2 X 4 X 8-1/2 STAGES 1 SERIAL NO. —

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID <u>Oxygen</u>	U.S. GPM at FT. HOR. <u>200</u>	RATED <u>220</u>		PROPOSAL CURVE NO. <u>C-2281</u>	
	DISCH. PRESS. PSIG <u>60</u>			RPM <u>3550</u> NPSHR (WATER) <u>5'</u>	
PT. F. HOR. <u>-300</u> MAX	SUCT. PRESS. PSIG MAX <u>—</u>	RATED <u>1</u>		EFF. <u>58%</u> SHP RATED <u>13.2</u>	
SP. GR. at FT. <u>1.15</u>	DIFF. PRESS. PSI <u>59</u>			MAX. SHP RATED IMP. <u>15</u>	
VAP. PRESS. at FT. PSIA <u>13</u>	DIFF. HEAD. FT. <u>119</u>			MAX. HEAD RATED IMP. <u>170</u>	
VIS. at FT. <u>0.203</u> CP	NPSHA, FT. <u>15</u>			MIN. CONTINUOUS GPM <u>50</u>	
CORR./EROS. CAUSED BY <u>—</u>	HYD. HP <u>7.6</u>			ROTATION (VIEWED FROM CPLG END) <u>CCW</u>	

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WIT. PERF.	☐ WIT. PERF.
SUCTION	<u>4"</u>	<u>150</u>	<u>FF</u>	<u>End</u>	☒ NON-WIT. HYDRO	☐ WIT. HYDRO
DISCHARGE	<u>2"</u>	<u>150</u>	<u>FF</u>	<u>Side</u>	☐ NPSH REQ'D.	☐ WIT. NPSH
CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) <u>Close Coupled</u>					☐ SHOP INSPECTION	
SPLIT: ☐ AXIAL ☒ RAD. TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER					☐ DISMANT. & INSP. AFTER TEST	
PRESS: ☐ MAX. ALLOW. <u>100</u> PSIG <u>200</u> °F: ☐ HYDRO TEST <u>150</u> PSIG					☐ OTHER _____	
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE					MATERIALS	
IMPELLER DIA: ☐ RATED <u>6.5</u> ☐ MAX <u>8.5</u> ☐ TYPE: _____					API CASE/TRIM CLASS <u>—</u>	
MOUNT: ☐ BETWEEN BRGS ☒ OVERHUNG ☐ WEAR RG. DIAM./CLANC. _____					<u>All Bronze</u>	
BEARINGS-TYPE: ☐ RADIAL ☐ — ☐ THRUST ☐ —					BASEPLATE: ☐ <u>None</u>	
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☐ —					VERTICAL PUMPS <u>None</u>	
COUPLING: ☐ MFR ☐ — ☐ MODEL: _____					PIT OR SUMP DEPTH <u>—</u>	
DRIVER HALF MTD BY: ☐ PUMP MFR ☐ DRIVER MFR ☐ PURCHASER					MIN. SUBMERGENCE REQ'D. ☐ _____	
PACKING: ☐ MFR & TYPE <u>—</u> ☐ SIZE/NO. OF RINGS <u>—</u>					COLUMN PIPE: ☐ FLANGED ☐ THREADED	
MECH. SEAL: ☐ MFR & MODEL <u>Airco Cryogenics</u> API CLASS CODE <u>—</u>					LINE SHAFT: ☐ OPEN ☐ ENCLOSED	
☐ MFR CODE <u>Mechanical</u>					BRGS: ☐ BOWL ☐ LINE SHAFT	
					BAG. LUBE ☐ WATER ☐ OIL ☐ GREASE	
					FLOAT & ROD ☐ C.S. ☐ S.S. ☐ BRZ ☐ NONE	
					FLOAT SWITCH ☐ _____	
					PUMP THRUST, LB ☐ UP ☐ DOWN	

AUXILIARY PIPING			
☐ C.W. PIPE PLAN ☐ CU: ☐ S.S. ☐ TUBING: ☐ PIPE			
☐ TOTAL COOLING WATER REQ'D. GPM ☐ SIGHT F.L. 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			
MOTOR DRIVER			
HP	15	RPM	3550
FRAME	215 T	VOLTS/PHASE/CYCLES	460/3/60
MFR	GE or equal	BEARINGS	Ball
		LUBE	Grease
TYPE	Induction	INSUL.	B
		FULL LOAD AMPS	19.1
ENC.	TEFC	TEMP RISE, C	80
		LOCKED ROTOR AMPS	116
☐ VHS ☐ VSS	VERT. THRUST CAP. LB.	SERVICE FACTOR	1.0

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
TURBINE DRIVER	
None	
APPROX. WT. PUMP & BASE 290	
MOTOR	Incl.
TURBINE	

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED



NO.	DATE	JOB NO.	DRAWING NO.	REV.

Airco Cryopumps 0-251-1Z-21
CENTRIFUGAL PUMP DATA SHEET

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

JOB NO. 251 ITEM NO. 15-G-861A.B
PURCHASE ORDER NO. _____
REQUISITION NO. _____
INQUIRY NO. _____
DATE 11/27/80 REVISION _____

FOR Bechtel SITE Breckinridge, Kentucky
UNIT Air Separation Plant SERVICE Liquid Oxygen Pump
NO. PUMPS REQD. 2 NO. MOTORS REQD. 2 ITEM NO. -- PROVIDED BY Pump Mfr MTD BY Pump Mfr
NO. TURBINES REQD. -- ITEM NO. -- PROVIDED BY -- MTD BY --
PUMP MFR Lawrence Pump SIZE AND TYPE 3 RRE vert. turb. STAGES 10 SERIAL NO. --

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID <u>Oxygen</u>	U.S. GPM at FT. HOR. <u>231</u>	RATED <u>250</u>	DISCH. PRESS. PSIG <u>945</u>	PROPOSAL CURVE NO. <u>Later</u>	
PT. F. HOR. <u>-300</u> MAX	SUCT. PRESS. PSIG MAX <u>944</u>	RATED <u>1</u>		RPM <u>3550</u> NPSH (WATER) <u>20</u>	
SP. GR. at FT. <u>1.15</u>	DIFF. PRESS. PSI <u>1890</u>			EFF. <u>62%</u> BHP RATED <u>221</u>	
VAP. PRESS. at FT. PSIA <u>13</u>	DIFF. HEAD. FT. <u>15</u>			MAX BHP RATED IMP <u>Later</u>	
VIS. at FT. Sm <u>0.203</u> NPSH _A FT. <u>15</u>				MAX HEAD RATED IMP <u>Later</u>	
CORR/ENOS. CAUSED BY <u>--</u>	HYD. HP <u>137.3</u>			MIN. CONTINUOUS GPM <u>Later</u>	
				ROTATION (VIEWED FROM CPLG END) <u>Later</u>	

CONSTRUCTION <u>Later</u>					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WT. PERF.	☐ WT. PERF.
SUCTION					☐ NON-WT. HYDRO	☐ WT. HYDRO
DISCHARGE					☐ NPSH REQD.	☐ WT. NPSH
CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) _____					☐ SHOP INSPECTION	
SPLIT: ☐ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER					☐ DISMANT. & INSP. AFTER TEST	
PRESS: ☐ MAX ALLOW. _____ PSIG _____ FT. ☐ HYDRO TEST _____ PSIG					☐ OTHER _____	
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 _____						

AUXILIARY PIPING <u>Later</u>		VERTICAL PUMPS	
☐ C.W. PIPE PLAN _____ ☐ C/L ☐ S.S. ☐ TUBING ☐ PIPE		PIT OR SUMP DEPTH ☐ <u>Later</u>	
☐ TOTAL COOLING WATER REQD. GPM _____ ☐ SIGHT FL. REQD. _____		MIN. SUBMERGENCE REQD. ☐ _____	
☐ PACKING COOLING INJECTION REQD. ☐ TOTAL GPM _____ ☐ PSIG _____		COLUMN PIPE: ☐ FLANGED ☐ THREADED	
☐ SEAL FLUSH PIPE PLAN _____ ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE		LINE SHAFT: ☐ OPEN ☐ ENCLOSED	
☐ EXTERNAL SEAL FLUSH FLUID _____ ☐ GPM _____ ☐ PSIG _____		BRGS: ☐ BOW ☐ LINE SHAFT	
☐ AUXILIARY SEAL PLAN _____ ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE		BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE	
☐ AUX. SEAL QUENCH FLUID _____		FLOAT & AOG ☐ C.S. ☐ S.S. ☐ BRZ ☐ NONE	
		FLOAT SWITCH ☐ _____	
		PUMP THRUST, LB ☐ UP _____ ☐ DOWN _____	

MOTOR DRIVER				TURBINE DRIVER	
HP <u>250</u>	RPM <u>3550</u>	FRAME <u>6318P</u>	VOLTS/PHASE/CYCLES <u>460/3/60</u>		
MFR <u>GE or equal</u>	BEARINGS <u>Ball</u>	LUBE <u>Grease</u>			
TYPE <u>Induction</u>	INSUL <u>B</u>	FULL LOAD AMPS <u>278</u>			
ENC <u>TEFC</u>	TEMP RISE C <u>80</u>	LOCKED ROTOR AMPS <u>Later</u>			
☐ VHS ☐ VSS	VERT. THRUST CAP. LB <u>Later</u>	SERVICE FACTOR <u>1.0</u>			

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED



JOB NO.	DRAWING NO.	REV.
1	10-15-81	REVISED MOTOR ENC. TYPE
NO.	DATE	
		SHEET _____ CF _____

ISSUED FOR PHASE 0

Sheet 4 of 12

Airco Cryopumps 0-251-1Z-30
CENTRIFUGAL PUMP DATA SHEET

JOB NO. 251 ITEM NO. 15-G-881A,8
 PURCHASE ORDER NO. _____
 REQUESTION NO. _____
 INQUIRY NO. _____
 DATE 11/13/80 REVISION _____

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

FOR Bechtel SITE Breckinridge, Kentucky
 UNIT Air Separation Plant SERVICE Medium Pressure Liquid N₂ Pump
 NO. PUMPS REQD. 2 NO. MOTORS REQD. 2 ITEM NO. _____ PROVIDED BY Pump Mfr. MTD BY Pump Mfr.
 NO. TURBINES REQD. 0 ITEM NO. _____ PROVIDED BY _____ MTD BY _____
 PUMP MFR Airco Cryogenics SIZE AND TYPE 1X2X4-1/2 STAGES 1 SERIAL NO. _____

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID <u>Nitrogen</u>	U.S. GPM at FT. HOR. <u>14</u>	RATED <u>20</u>		PROPOSAL CURVE NO. <u>C-344</u>	
	DISCH. PRESS. PSIG <u>110.3</u>			RPM <u>7200</u> NPSH (WATER) <u>3'</u>	
FT. F. HOR. <u>-320</u> MAX	SUCT. PRESS. PSIG MAX _____	RATED <u>1.0</u>		EFF. <u>0.32</u> SHP RATED <u>4.0</u>	
SP. GR. at FT. <u>0.808</u>	DIFF. PRESS. PSI <u>109.3</u>			MAX. SHP RATED IMP <u>5</u>	
VAP. PRESS. at FT. PSIA <u>15</u>	DIFF. HEAD. FT. <u>313</u>			MAX. HEAD RATED IMP <u>340</u>	
VIS. at FT. Sg. <u>0.156</u> CP	NPSHA, FT. <u>11.5</u>			MIN. CONTINUOUS GPM <u>5</u>	
CORR./EROS. CAUSED BY _____	HYD. MP <u>1.3</u>			ROTATION (VIEWED FROM CPLG END) <u>CW</u>	

CONSTRUCTION					SHOP TESTS
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WIT. PERF. ☐ WIT. PERF. ☐ NON-WIT. HYDRO ☐ WIT. HYDRO ☐ NPSH REQD. ☐ WIT. NPSH ☐ SHOP INSPECTION ☐ DISMANT. & INSP. AFTER TEST ☐ OTHER _____
SUCTION	<u>2</u>	<u>150</u>	<u>FF</u>	<u>End</u>	
DISCHARGE	<u>1</u>	<u>150</u>	<u>FF</u>	<u>Side</u>	
CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) <u>Close Coupled Gear</u> SPLIT: ☐ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER PRESS: ☐ MAX. ALLOW. <u>100</u> PSIG <u>200</u> "F. ☐ HYDRO TEST <u>150</u> PSIG CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE IMPELLER DIA: ☐ RATED <u>4-1/4"</u> ☐ MAX. <u>4-1/4"</u> ☐ TYPE _____ MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM./CLUNG 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 <u>Airco Cryogenics</u> API CLASS CODE _____ ☐ MFR CODE <u>Mechanical</u>					MATERIALS API CASE/TRM CLASS <u>—</u> <u>Aluminum</u> BASEPLATE ☐ <u>None</u>

AUXILIARY PIPING				VERTICAL PUMPS
☐ C.W. PIPE PLAN _____	☐ C.W. ☐ S.S. ☐ TUBING ☐ PIPE _____			FIT OR SUMP DEPTH <u>—</u> MIN. SUBMERGENCE REQD. ☐ COLUMN PIPE: ☐ FLANGED ☐ THREADED LINE SHAFT: ☐ OPEN ☐ ENCLOSED BRGS: ☐ BOW _____ ☐ LINE SHAFT _____ BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE FLOAT & ROD ☐ C.S. ☐ S.S. ☐ BRZ ☐ NONE FLOAT SWITCH ☐ _____ PUMP THRUST, LB ☐ UP _____ ☐ DOWN _____
☐ TOTAL COOLING WATER REQD. GPM _____	☐ SIGHT FL. REQD. _____			TURBINE DRIVER <u>None</u>
☐ PACKING COOLING INJECTION REQD. ☐ TOTAL GPM _____	☐ PSIG _____			APPROX. WT. PUMP & BASE <u>90</u> MOTOR <u>Incl.</u> TURBINE <u>—</u>
☐ SEAL FLUSH PIPE PLAN _____	☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE _____			
☐ EXTERNAL SEAL FLUSH FLUID _____	☐ GPM _____			
☐ AUXILIARY SEAL PLAN _____	☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE _____			
☐ AUX. SEAL QUENCH FLUID _____				

MOTOR DRIVER			
HP <u>5</u>	RPM <u>3550</u>	FRAME <u>184T</u>	VOLTS/PHASE/CYCLES <u>460/3/60</u>
MFR <u>GE or Equal</u>	BEARINGS <u>ball</u>	LUBE <u>Grease</u>	
TYPE <u>Induction</u>	INSUL <u>B</u>	FULL LOAD AMPS <u>6.9</u>	
ENC. <u>TEFC</u>	TEMP RISE C. <u>80</u>	LOCKED ROTOR AMPS <u>46</u>	
☐ VHS ☐ VSS	VERT. THRUST CAP. LB <u>—</u>	SERVICE FACTOR <u>1.0</u>	

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

ISSUED FOR PHASE 0



						JOB NO.	DRAWING NO.	REV.
NO.	DATE					SHEET	OF	

0-251-1Z-32
JOB NO. 251 ITEM NO. 15-G-891A,B
PURCHASE ORDER NO. _____
REQUISITION NO. _____
INQUIRY NO. _____
DATE 11/26/80 REVISION _____

FOR <u>Bechtel</u>	SITE <u>Breckinridge Ky.</u>
UNIT <u>Air Separation Plant</u>	SERVICE <u>Condensate Return Pump</u>
NO. PUMPS REQ'D <u>2</u> NO. MOTORS REQ'D <u>2</u> ITEM NO. <u>-</u>	PROVIDED BY <u>Pump Mfr. MTD BY Pump Mfr.</u>
NO. TURBINES REQ'D <u>0</u> ITEM NO. <u>-</u>	PROVIDED BY <u>-</u> MTD BY <u>-</u>
PUMP MFR <u>AC or equal</u> SIZE AND TYPE <u>2-1/2-2 X 9 L</u>	STAGES <u>1</u> SERIAL NO. <u>-</u>

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID	Water	U.S. GPM at PT. NOR.	75	RATED	85
		DISCH. PRESS. PSIG	105.3		
PT. F. NOR.	281	MAX.	287	SUCT. PRESS. PSIG MAX.	40
				RATED	35.3
SP. GR. at PT.	0.929	DIFF. PRESS. PSI	70		
VAP. PRESS. at PT. PSIA	50	DIFF. HEAD. FT.	174		
VIS. at PT. Ssu	0.2	CP		NPSHA, FT.	8.9
CORR/EROS. CAUSED BY		HYD. HP	3.5		
				PROPOSAL CURVE NO.	—
				RPM	3500
				NPSHR (WATER)	8'
				EFF.	52%
				BHP RATED	6.7
				MAX BHP RATED IMP.	10.5
				MAX. HEAD RATED IMP.	190 ft.
				MIN. CONTINUOUS GPM	20
				ROTATION (VIEWED FROM CPLG END)	CW

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WIT. PERF.	☐ WIT. PERF.
SUCTION	2-1/2	150	FF	End	☐ NON-WIT. HYDRO	☐ WIT. HYDRO
DISCHARGE	1-1/2	150	FF	Top	☐ NPISH REQ'D.	☐ WIT. NPISH

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) _____

SPLIT: ☐ AXIAL ☐ RAD: TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER

PRESS: ☐ MAX. ALLOW. 125 PSIG 250 "F: ☐ HYDRO TEST 185 PSIG

CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE

IMPELLER DIA: ☐ RATED 7 ☐ MAX 9 ☐ TYPE: Closed

MOUNT ☐ BETWEEN BRGS ☒ OVERHUNG ☐ WEAR. RG. DIAM./CLANG. _____

BEARINGS-TYPE: ☐ RADIAL Ball ☐ THRUST Ball

LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☐ Grease

COUPLING: ☐ MFR Falk ☐ MODEL Steelflex

DRIVER HALF MTD BY: ☐ PUMP MFR ☐ DRIVER MFR ☐ PURCHASER

PACKING: ☐ MFR & TYPE Later ☐ SIZE/NO. OF RINGS Later

MECH. SEAL: ☐ MFR & MODEL _____ API CLASS. CODE _____

☐ MFR CODE _____

SHOP TESTS	
☐ NON-WIT. PERF.	☐ WIT. PERF.
☐ NON-WIT. HYDRO	☐ WIT. HYDRO
☐ NPSM REQ'D.	☐ WIT. NPSM
☐ SHOP INSPECTION	
☐ DISMANT. & INSP. AFTER TEST	
☐ OTHER _____	

API CASE/TRIM CLASS ☐ Cast Iron

BASEPLATE: ☐ Cast Iron

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 _____

None:

APPROX. WT. PUMP & BASE 340

MOTOR 169 TURBINE —

☐ C.W. PIPE PLAN _____ ☐ CU: ☐ S.S. ☐ TUBING: ☐ PIPE _____
☐ TOTAL COOLING WATER REQ'D. GPM _____ ☐ SIGHT FL. 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 _____

HP	10	RPM	3500	FRAME		VOLTS/PHASE/CYCLES	460/3/60
MFR	GE or equal	BEARINGS	Ball	LUBE	Grease		
TYPE	Induction	INSUL	B	FULL LOAD AMPS	-	13	
ENC	TEFC	TEMP RISE C	80	LOCKED ROTOR AMPS		81	
YHS	YSS	VERT. THRUST CAP. LB.	—	SERVICE FACTOR		1.15	

~~ISSUED FOR PHASE 0~~

						JOB NO.	DRAWING NO.	REV.
NO.	DATE					SHEET	7 OF 12	

Airco Cryoplants

CENTRIFUGAL PUMP DATA SHEET

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

0-251-1Z-35

JOB NO. 251 ITEM NO. 15-G-514-A, 1B

PURCHASE ORDER NO. 2A, 2B

REQUISITION NO.

INQUIRY NO.

DATE 11/26/80 REVISION

FOR Bechtel SITE Breckinridge, Kentucky
UNIT Air Separation Plant SERVICE Condensate Return Pumps
NO. PUMPS REQD. 4 NO. MOTORS REQD. 4 ITEM NO. --- PROVIDED BY Pump Mfr. MTD BY Pump Mfr.
NO. TURBINES REQD. 0 ITEM NO. --- PROVIDED BY --- MTD BY ---
PUMP MFR. A.C. or equal SIZE AND TYPE M7-VTLC Vent Turb STAGES 11 SERIAL NO. ---

OPERATING CONDITIONS, EACH PUMP

PERFORMANCE

LIQUID Water U.S. GPM at PT. NOR. 154 RATED 175 PROPOSAL CURVE NO. Later
DISCH. PRESS. PSIG 105.3 RPM 1750 NPSH (WATER) 9'
PT. F. NOR. 120.5 MAX 212 SUCT. PRESS. PSIG MAX 0 RATED 3" HG ABS EFF. 75% SHP RATED 16.3
SP. GR. at PT. 0.989 DIFF. PRESS. PSI 118.5 MAX SHP RATED IMP Later
VAP. PRESS. at PT. PSIA 1.7 DIFF. HEAD. FT. 277 MAX HEAD RATED IMP Later
VIS. at PT. Sec 0.55 CP --- NPSH_A FT. 3 MIN. CONTINUOUS GPM Later
CORR./EROS. CAUSED BY --- HYD. HP 12.2 ROTATION (VIEWED FROM CPLG END) Later

CONSTRUCTION

SHOP TESTS

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION	4	150	FF	Side
DISCHARGE	4	150	FF	Side

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)SPLIT: ☐ AXIAL ☐ RAD: TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSERPRESS: ☐ MAX. ALLOW. 340 PSIG 250 *P: ☐ HYDRO TEST 510 PSIGCONNECT: ☐ VENT ☐ DRAIN ☐ GAGEIMPELLER DIA: ☐ RATED ☐ MAX ☐ TYPEMOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR AG. DIAM./CLANG.BEARINGS-TYPE: ☐ RADIAL ☐ THRU-AXLUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☐COUPLING: ☐ MFR ☐ MODELDRIVER HALF MTD BY: ☐ PUMP MFR ☐ DRIVER MFR ☐ PURCHASERPACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGSMECH. SEAL: ☐ MFR & MODEL Later API CLASS. CODE Later☐ MFR CODE Later

AUXILIARY PIPING

☐ C.W. PIPE PLAN ☐ CU: ☐ S.S.: ☐ TUBING: ☐ PIPE☐ TOTAL COOLING WATER REQD. GPM ☐ SIGHT FL. REQD.☐ PACKING COOLING INJECTION REQD: ☐ 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

MOTOR DRIVER

HP 20 RPM 1750 FRAME 256TP VOLTS/PHASE/CYCLES 460/3/60MFR GE or equal BEARINGS Ball LUBE GreaseTYPE Induction INSUL B FULL LOAD AMPS 25.2ENC tefc TEMP RISE C 80 LOCKED ROTOR AMPS 145☐ VHS ☐ VSS VERT. THRUST CAP. LB Later SERVICE FACTOR 1.15

☐ NON-WIT. PERF. ☐ WIT. PERF.
☐ NON-WIT. HYDRO ☐ WIT. HYDRO
☐ NPSH REQD. ☐ WIT. NPSH
☐ SHOP INSPECTION
☐ DISMANT. & INSP. AFTER TEST
☐ OTHER

MATERIALS

API CASE/TRIM CLASS ☐

Cast Iron

BASEPLATE: ☐

VERTICAL PUMPS

PIT OR SUMP DEPTH 9'MIN. SUBMERGENCE REQD. ☐COLUMN PIPE: ☐ FLANGED ☐ THREADEDLINE SHAFT: ☐ OPEN ☐ ENCLOSEDBRGS. ☐ BOWL ☐ LINE SHAFTBRG. LUBE ☐ WATER ☐ OIL ☐ GREASEFLOAT & ROD ☐ C.S. ☐ S.S. ☐ BRZ ☐ NONEFLOAT SWITCH ☐PUMP THRUST. LB ☐ UP ☐ DOWN

TURBINE DRIVER

None

APPROX. WT. PUMP & BASE 800MOTOR 320 TURBINE ---

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

ISSUED FOR PHASE 0

						JOB NO.	DRAWING NO.	REV.
NO.	DATE					SHEET <u>8</u> OF <u>12</u>		

AIRCO CRYOPLANTS

CENTRIFUGAL PUMP DATA SHEET

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

0-251-12-48
 JOB NO. 251 ITEM NO. 15-G-851
 PURCHASE ORDER NO. _____
 REQUISITION NO. _____
 INQUIRY NO. _____
 DATE 11/10/80 REVISION _____

FOR Bechtel SITE Breckinridge, Kentucky
 UNIT Air Separation Plant SERVICE Liquid Argon Transfer Pumps
 NO. PUMPS REQ'D 2 NO. MOTORS REQ'D 2 ITEM NO. — PROVIDED BY Pump Mfr MTD BY Pump Mfr
 NO. TURBINES REQ'D 0 ITEM NO. — PROVIDED BY — MTD BY —
 PUMP MFR Airco Cryogenics SIZE AND TYPE 2X3X7 STAGES 1 SERIAL NO. —

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID <u>Argon</u>	U.S. GPM at PT. NOR. <u>100</u>	RATED <u>120</u>	PROPOSAL CURVE NO. <u>2243</u>		
	DISCH. PRESS. PSIG <u>60</u>		RPM <u>3500</u> NPSHR (WATER) <u>8'</u>		
PT. F. NOR. <u>-303</u> MAX.	SUCT. PRESS. PSIG MAX <u>—</u>	RATED <u>1</u>	EFF. <u>48%</u> SHP RATED <u>8.5</u>		
SP. GR. at PT. <u>1.39</u>	DIFF. PRESS. PSI <u>59</u>		MAX SHP RATED IMP. <u>8.5</u>		
VAP. PRESS. at PT. PSIA <u>14.7</u>	DIFF. HEAD. FT. <u>97.7</u>		MAX. HEAD RATED IMP. <u>160</u>		
VIS. at PT. S ₂₀ <u>0.26</u> CP	NPSHA, FT. <u>11.5</u>		MIN. CONTINUOUS GPM <u>20</u>		
CORR./EROS. CAUSED BY <u>—</u>	HYD. HP <u>4.1</u>		ROTATION (VIEWED FROM CPLG END) <u>CCW</u>		

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WIT. PERF.	☐ WIT. PERF.
SUCTION	<u>3</u>	<u>150</u>	<u>FF</u>	<u>Enc</u>	☐ NON-WIT. HYDRO	☐ WIT. HYDRO
DISCHARGE	<u>2</u>	<u>150</u>	<u>FF</u>	<u>Side</u>	☐ NPSH REQ'D.	☐ WIT. NPSH
CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) <u>Close Coupled</u>					☐ SHOP INSPECTION	
SPLIT: ☐ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER					☐ DISMANT. & INSP. AFTER TEST	
PRESS: ☐ MAX. ALLOW. <u>100</u> PSIG <u>200</u> °F. ☐ HYDRO TEST <u>150</u> PSIG					☐ OTHER _____	
CONNECT: ☐ VENT ☐ ORAIN ☐ GAGE						
IMPELLER DIA: ☐ RATED <u>6.5</u> ☐ MAX <u>7</u> ☐ TYPE: <u>Closed</u>						
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 <u>Airco Cryopumps</u> API CLASS. CODE _____						
☐ MFR CODE <u>Mechanical</u>						

AUXILIARY PIPING		VERTICAL PUMPS	
☐ C.W. PIPE PLAN _____	☐ CU: ☐ S.S.: ☐ TUBING: ☐ PIPE _____	MIT OR SUMP DEPTH ☐ _____	
☐ TOTAL COOLING WATER REQ'D. GPM _____	☐ SIGHT F.L. REQ'D. _____	MIN. SUBMERGENCE REQ'D. ☐ _____	
☐ PACKING COOLING INJECTION REQ'D. ☐ TOTAL GPM _____	☐ PSIG _____	COLUMN PIPE: ☐ FLANGED ☐ THREADED	
☐ SEAL FLUSH PIPE PLAN _____	☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE _____	LINE SHAFT: ☐ OPEN ☐ ENCLOSED	
☐ EXTERNAL SEAL FLUSH FLUID _____	☐ GPM _____	BRGS: ☐ BOWL ☐ LINE SHAFT _____	
☐ AUXILIARY SEAL PLAN _____	☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE _____	BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE	
☐ AUX. SEAL QUENCH FLUID _____	☐ PSIG _____	FLOAT & ROD ☐ C.S. ☐ S.S. ☐ BAZ ☐ NONE	
		FLOAT SWITCH ☐ _____	
		PUMP THRUST, LB ☐ UP ☐ DOWN _____	

MOTOR DRIVER				TURBINE DRIVER	
HP <u>10</u>	RPM <u>3500</u>	FRAME <u>215T</u>	VOLTS/PHASE/CYCLES <u>460/3/60</u>	None	
MFR <u>GE or equal</u>	BEARINGS <u>Ball</u>	LUBE <u>Grease</u>			
TYPE <u>Induction</u>	INSUL <u>B</u>	FULL LOAD AMPS <u>13.0</u>			
ENC <u>TEFC</u>	TEMP RISE C <u>80</u>	LOCKED ROTOR AMPS <u>81</u>			
☐ VMS ☐ VSS	VERT. THRUST CAP. LB. <u>—</u>	SERVICE FACTOR <u>1.0</u>			
APPROX. WT. PUMP & BASE <u>250</u>				MOTOR <u>Incl.</u> TURBINE <u>—</u>	

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED.

ISSUED FOR PHASE 0



		JOB NO.		DRAWING NO.		REV.
NO.	DATE			SHEET <u>9</u> OF <u>12</u>		

Airco Cryopumps 0-251-1Z-49
CENTRIFUGAL PUMP DATA SHEET

JOB NO. 251 ITEM NO. 15-G-371-1A.1B.1C
PURCHASE ORDER NO. 2A.2B.2C
REQUISITION NO.
INQUIRY NO.
DATE 11/13/80 REVISION

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

FOR Bechtel SITE Breckinridge, Kentucky
UNIT Air Separation Plant SERVICE Liquid Oxygen Circulating Pump
NO. PUMPS REQD. 6 NO. MOTORS REQD. 6 ITEM NO. — PROVIDED BY Pump Mfr MTD BY Pump Mfr
NO. TURBINES REQD. 0 ITEM NO. — PROVIDED BY — MTD BY —
PUMP MFR Airco Cryogenics SIZE AND TYPE 4X5X10-1/2 STAGES 1 SERIAL NO. —

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID Oxygen	U.S. GPM at FT. HOR. 268	RATED 280	DISCH. PRESS. PSIG 55.3	PROPOSAL CURVE NO. C-253	
PT. F. HOR. 288 MAX	SUCT. PRESS. PSIG MAX	RATED 31		RPM 1750	NPSHA (WATER) 3'
SP. GR. at FT. 1.12	DIFF. PRESS. PSI 24.3			EFF. 62.5%	BHP RATED 5.6
VAP. PRESS. at FT. PSIA 24.5	DIFF. HEAD. FT. 50			MAX. BHP RATED IMP 7.5	
VIS. at FT. Sg. 0.1735 CP	NPSHA FT. 40			MAX. HEAD RATED IMP 66	
CORR./EROS. CAUSED BY	HYD. HP 3.5			MIN. CONTINUOUS GPM 30	
				ROTATION (VIEWED FROM CPLG END) CCW	

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WT. PERF.	☐ WT. PERF.
SUCTION	5"	150	FF	End	☐ NON-WT. HYDRO	☐ WT. HYDRO
DISCHARGE	4"	150	FF	Side	☐ NPSH REQD.	☐ WT. NPSH
CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) Close Coupled					☐ SHOP INSPECTION	
SPLIT: ☐ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL. ☐ DBL. ☐ DIFFUSER					☐ DISMANT. & INSP. AFTER TEST	
PRESS: ☐ MAX ALLOW 100 PSIG 200 ☐ HYDRO TEST 150 PSIG					☐ OTHER	
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE						
IMPELLER DIA: ☐ RATED 8-1/2 ☐ MAX 10-1/2 ☐ TYPE						
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM./CLUNG						
BEARINGS-TYPE ☐ RADIAL None ☐ THRUST						
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE ☐ None						
COUPLING: ☐ MFR None ☐ MODEL None						
DRIVER HALF MTD BY: ☐ PUMP MFR ☐ DRIVER MFR ☐ PURCHASER						
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS						
MECH. SEAL: ☐ MFR & MODEL Airco Cryogenics API CLASS CODE						
☐ MFR CODE Labyrinth						

AUXILIARY PIPING		VERTICAL PUMPS	
☐ C.W. PIPE PLAN	☐ C.W. ☐ S.S. ☐ TUBING ☐ PIPE	FIT OR SUMP DEPTH	
☐ TOTAL COOLING WATER REQD. GPM	☐ SIGHT FL. REQD.	MIN. SUBMERGENCE REQD.	
☐ PACKING COOLING INJECTION REQD. ☐ TOTAL GPM	☐ PSIG	COLUMN PIPE: ☐ FLANGED ☐ THREADED	
☐ SEAL FLUSH PIPE PLAN	☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE	LINE SHAFT: ☐ OPEN ☐ ENCLOSED	
☐ EXTERNAL SEAL FLUSH FLUID	☐ GPM ☐ PSIG	BRGS: ☐ BOWL ☐ LINE SHAFT	
☐ AUXILIARY SEAL PLAN	☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE	BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE	
☐ AUX. SEAL QUENCH FLUID		FLOAT & ROG ☐ C.S. ☐ S.S. ☐ BRZ ☐ NONE	
		FLOAT SWITCH ☐	
		PUMP THRUST. LB ☐ UP ☐ DOWN	

MOTOR DRIVER				TURBINE DRIVER	
HP 7-1/2	RPM 1750	FRAME 213 T	VOLTS/PHASE/CYCLES 460/3/60	None	
MFR GE or equal	BEARINGS Ball	LUBE Grease			
TYPE Induction	INSUL B	FULL LOAD AMPS 10.8			
ENC TEFC	TEMP RISE C 80	LOCKED ROTOR AMPS 63.5			
☐ VHS ☐ VSS	VERT. THRUST CAP. LB	SERVICE FACTOR 1.0		APPROX. WT. PUMP & BASE 300	
				MOTOR Incl. TURBINE	

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

ISSUED FOR PHASE 0



NO.		DATE		JOB NO.		DRAWING NO.		REV.	

JOB NO. _____ ITEM NO. 15-G-291-1A, 1B, 1C
 PURCHASE ORDER NO. _____ 2A, 2B, 2C
 REQUISITION NO. _____ 3A, 3B, 3C
 INQUIRY NO. _____
 DATE 11/13/80 REVISION _____

FOR	Bechtel	SITE	Breckinridge, Kentucky
UNIT	Air Separation Plant	SERVICE	Crude Argon Pump
NO. PUMPS REQD.	9	NO. MOTORS REQD.	9
ITEM NO.	—	PROVIDED BY	Pump Mfr.
NO. TURBINES REQD.	0	ITEM NO.	—
PUMP MFR.	Airco Cryogenics	PROVIDED BY	—
SIZE AND TYPE	2X4X6	STAGES	1
		SERIAL NO.	—

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID 7.8% Argon	U.S. GPM at FT. NOR	113	RATED	125	PROPOSAL CURVE NO. C-2242
92.2% Oxygen	DISCH. PRESS. PSIG	-50			RPM 3550 NPSHR (WATER) 2
FT. F. NOR. +291 MAX	SUCT. PRESS. PSIG MAX		RATED	34	EFF. 45% BHP RATED 2.7
SP. GR. at FT. = 1.105	DIFF. PRESS. PSI		16		MAX. BHP RATED IMP 3
VAP. PRESS. at FT. PSA 22.6	DIFF. HEAD. FT		33.4		MAX. HEAD RATED IMP 60
VIS. at FT. Sea 0.175 CP	NPSHA, FT		50		MIN. CONTINUOUS GPM 40
CORR/EROS. CAUSED BY			HYD. HP	1.2	ROTATION (VIEWED FROM CPLG END) CCW

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WYT. PERF.	☐ WYT. PERF.
SUCTION	4"	150	FF	End	☐ NON-WYT. HYDRO	☐ WYT. HYDRO
DISCHARGE	2"	150	FF	Side	☐ NPSH REQ'D	☐ WYT. NPSH
CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) <u>Close Coupled</u>					☐ SHOP INSPECTION	
SPLIT: ☐ AXIAL ☐ RAD. TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER					☐ DISMANT. & INSP. AFTER TEST	
PRESS: ☐ MAX ALLOW. <u>100</u> PSIG <u>200</u> *F: ☐ HYDRO TEST <u>150</u> PSIG					☐ OTHER _____	
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE <u>None</u>						
IMPELLER DIA: ☐ RATED <u>4.5</u> ☐ MAX <u>6</u> ☐ 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 _____						
WEEK SEAL: ☐ MFR & MODEL <u>Airco Crvogenics</u> API CLASS CODE _____ ☐ MFR CODE <u>Labvrinth</u>						
					MATERIALS	
					API CASE/TRIM CLASS ☐	
					<u>All Bronze</u>	
					BASEPLATE ☐ <u>None</u>	
					VERTICAL PUMPS	

AUXILIARY PIPING				MIN. SUBMERGENCE REQ'D. ☐			
☐ C.W. PIPE PLAN ☐ ☐ C.W. ☐ S.S. ☐ TUBING: ☐ PIPE				COLUMN PIPE: ☐ FLANGED ☐ THREADED			
☐ TOTAL COOLING WATER REQ'D. GPM ☐ SIGHT FL. REQ'D.				LINE SHAFT: ☐ OPEN ☐ ENCLOSED			
☐ PACKING COOLING INJECTION REQ'D.: ☐ TOTAL GPM ☐ PSIG				BRGS: ☐ BOWL ☐ LINE SHAFT			
☐ SEAL FLUSH PIPE PLAN ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE				BAG. LUBE ☐ WATER ☐ OIL ☐ GREASE			
☐ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG				FLOAT & ROD ☐ C.S. ☐ S.S. ☐ BAZ ☐ NONE			
☐ AUXILIARY SEAL PLAN ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE				FLOAT SWITCH ☐			
☐ AUX. SEAL QUENCH FLUID				PUMP THRUST. LB ☐ UP ☐ DOWN			
MOTOR DRIVER				TURBINE DRIVER			
HP <u>5</u> RPM <u>3550</u> FRAME <u>184 T</u> VOLTS/PHASE/CYCLES <u>460/3/60</u>				None			
MFR <u>GE or equal</u> BEARINGS <u>ball</u> LUBE <u>grease</u>							
TYPE <u>Induction</u> INSUL <u>B</u> FULL LOAD AMPS <u>69</u>							
ENC <u>TEFC</u> TEMP RISE C. <u>80</u> LOCKED ROTOR AMPS <u>46</u>				APPROX. WT. PUMP & BASE <u>120</u>			
☐ VHS ☐ VSS VERT. THRUST CAP. LB <u> </u> SERVICE FACTOR <u>1.0</u>				MOTOR Incl. TURBINE <u> </u>			

API STANDARD 810 GOVERNS UNLESS OTHERWISE NOTED.

~~ISSUED FOR PHASE 0~~



						JOB NO.	DRAWING NO.	REV.
NO.	DATE					SHEET _____ OF _____		

Airco Cryoplants
CENTRIFUGAL PUMP DATA SHEET

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

0-251-1Z-51
JOB NO. 251 ITEM NO. 15-G-114-1A, 1B, 2A, 2B
PURCHASE ORDER NO. _____
REQUISITION NO. _____
INQUIRY NO. _____
DATE 11/26/80 REVISION _____

FOR Bechtel SITE Breckinridge, Kentucky
UNIT Air Separation Plant SERVICE Condensate Return Pumps
NO. PUMPS REQ'D 4 NO. MOTORS REQ'D 4 ITEM NO. --- PROVIDED BY Pump Mfr MTD BY Pump Mfr
NO. TURBINES REQ'D 0 ITEM NO. --- PROVIDED BY --- MTD BY ---
PUMP MFR A.C. or equal SIZE AND TYPE MID VTSC VentTur STAGES 6 SERIAL NO. ---

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID Water	U.S. GPM at FT. NOR 430	RATED 475	DISCH. PRESS. PSIG 105.3	PROPOSAL CURVE NO.	
PT. F. NOR 120.5 MAX	SUCT. PRESS. PSIG MAX 0	RATED 3"Hg ABS	EFF. 81.9% BHP RATED 40.5	MAX BHP RATED IMP	
SP. GR. at FT. 0.989	DIFF. PRESS. PSI 118.5		MAX HEAD RATED IMP		
VAP. PRESS. at FT. PSIA 1.7	DIFF. HEAD. FT. 277		MIN. CONTINUOUS GPM		
VIS. at FT. S _{max} 0.55	CP NPSHA FT. 3		ROTATION (VIEWED FROM CPLG END)		
CORR/EROS. CAUSED BY	HYD. HP 33.2				

CONSTRUCTION					SHOP TESTS	
NOZZLES	SIZE	RATING	FACING	LOCATION	☐ NON-WIT. PERF.	☐ WIT. PERF.
SUCTION	6	150	FF	Side	☐ NON-WIT. HYDRO	☐ WIT. HYDRO
DISCHARGE	6	150	FF	Side	☐ NPSH REQ'D	☐ WIT. NPSH

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE) _____
SPLIT: ☐ AXIAL ☐ RAD: TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
PRESS: ☐ MAX ALLOW. 200 PSIG 250 *F: ☐ HYDRO TEST 300 PSIG
CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA: ☐ RATED ☐ MAX ☐ TYPE _____
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR RG. DIAM./CLINC _____
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 _____

☐ 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 ☐ _____
Cast Iron
BASEPLATE: ☐ _____

VERTICAL PUMPS

PIT OR SUMP DEPTH ☐ 9'
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 ☐ None
PUMP THRUST. LB ☐ UP Later ☐ DOWN Later

TURBINE DRIVER

None
APPROX. WT. PUMP & BASE 1200
MOTOR 620 TURBINE _____

MOTOR DRIVER

HP 50 RPM 1750 FRAME 326TP VOLTS/PHASE/CYCLES 460/3/60
MFR GE or Equal BEARINGS Ball LUBE Grease
TYPE Induction INSUL B FULL LOAD AMPS 61.5
ENC TEFC TEMP RISE C 80 LOCKED ROTOR AMPS 362
☐ VHS ☐ VSS VERT. THRUST CAP. LB Later SERVICE FACTOR 1.0

API STANDARD 810 GOVERNS UNLESS OTHERWISE NOTED.

ISSUED FOR PHASE 0

				JOB NO.				DRAWING NO.				REV.			
NO.				DATE				SHEET 12 OF 12							

4.5 Data Sheets for Compressors and Drivers

- 0-251-1Z-3: Main Air Compressor (15K-11 A, B, C)
- 0-251-1Z-9: Expander Generator (15P-35)
- 0-251-1Z-10: Oxygen Compressor (15K-50 A, B, C)
- 0-251-1Z-13: Cycle Nitrogen Compressor (15K-55)
- 0-251-1Z-17: Compressor/Expander (15K-77)
- 0-251-1Z-37: Argon Compressor (15K-41)

APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT DATE _____ REVISION _____
 FOR: Bechtel UNIT: Air Separation Plant
 SITE: Breckinridge, Kentucky SERIAL NO. _____
 SERVICE: Main Air Compressors 15-K-11A,B,C NO. REQUIRED: 3
 MANUFACTURER: Sulzer (or equal) MODEL: ARI-80 (or equal) DRIVER: 2-steam turbine(A,B)
 NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ☐ BY MANUFACTURER 1-elect motor (C)

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

- ☐ GAS HANDLED (ALSO SEE PAGE _____)
☐ MMSCFD/SCFM (14.7 PSIA & 60°F DRY)
☐ WEIGHT FLOW, LBM/HR (DRY)
 INLET CONDITIONS:
☐ PRESSURE (PSIA)
☐ TEMPERATURE (°F)
☐ RELATIVE HUMIDITY (%)
☐ MOLECULAR WEIGHT (M)
☐ C_p/C_v (M₁) OR (M₂)
☐ COMPRESSIBILITY (Z₁) OR (Z₂)
☐ INLET VOLUME, (CFM/HR)
 DISCHARGE CONDITIONS:
☐ PRESSURE (PSIA)
☐ TEMPERATURE (°F)
☐ C_p/C_v (M₂) OR (M₁)
☐ COMPRESSIBILITY (Z₂) OR (Z₁)
☐ SHP REQUIRED (ALL LOSSES INCL)
☐ SPEED (RPM)
☐ ESTIMATED SURGE, (CFM (AT SPEED ABOVE))
☐ POLYTROPIC HEAD (FT)
☐ POLYTROPIC EFFICIENCY (%)
☐ GUARANTEE POINT
☐ PERFORMANCE CURVE NO.

NORMAL	RATED	OTHER CONDITIONS			
		A	B	C	D
Air	Air				
148,965	156,980				
11,373	11,985				
14.3	14.3				
96	96				
50	50				
28.96	28.96				
1.4	1.4				
1.0	1.0				
168,445	177,510				
103	103				
197	197				
1.4	1.4				
1.0	1.0				
26,510	28,082	@Turbine Coupling ± 4%			
4550	4550				
Later					
Later					
Later					
Normal					

PROCESS CONTROL

- METHOD: ☐ BYPASS FROM _____ TO _____
☐ ANTISURGE BYPASS ☐ MANUAL ☐ AUTO
☐ SUCTION THROTTLING FROM _____ TO _____
 A,B ☐ SPEED VARIATION FROM 110% TO 70%
 C ☐ OTHER Adjustable Stator Vanes
 SIGNAL: ☐ SOURCE Airco Process Controller
☐ TYPE Electronic or Electro Pneumatic
☐ RANGE: FOR PNEUMATIC CONTROL _____ RPM @ _____ PSIG & _____ RPM @ _____ PSIG
 OTHER _____

REMARKS

Required for Phase 0 Estimate

REVISION	DATE	BY	CHECKED	DESIGN	ENG	PROJ	APPV
SCALE	DESIGNED	DRAWN	CHIEF	ENGR			
JOB NO.			DRAWING NO.		REV.		
05-							



CENTRIFUGAL COMPRESSOR DATA SHEET

CENTRIFUGAL COMPRESSOR DATA SHEET

GAS ANALYSIS		NORMAL	RATED	OTHER CONDITIONS				REMARKS
☐ MOL %	☐ M.W.			A	B	C	D	
AIR	28.966	100	100					
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		100	100					
AVG. MOL. WT.		28.96	28.96					

LOCATION ☐ INDOOR ☐ HEATED ☐ UNDER ROOF ☐ OUTDOOR ☐ UNHEATED ☐ PARTIAL SIDES ☐ GRADE ☐ MEZZANINE ☐ _____ ☐ ELECTRICAL AREA CLASS _____ DIV. <u>Non Hazard</u> ☐ WINTERIZATION REQ. ☐ TROPICALIZATION REQ.		NOISE SPECIFICATIONS ☐ APPLICABLE TO MACHINE: SEE SPECIFICATION <u>0-251-1Z-3</u> ☐ APPLICABLE TO NEIGHBORHOOD SEE SPECIFICATION _____ ACOUSTIC HOUSING: ☐ YES ☐ NO 1. Vendor to quote option Vendor to advise noise level data															
SITE DATA - See 14222-A-3 ☐ ELEVATION <u>420</u> FT. BARMETER <u>14.5</u> PSIA ☐ RANGE OF AMBIENT TEMP.: <table border="1"> <thead> <tr> <th></th> <th>DRY BULB</th> <th>WET BULB</th> </tr> </thead> <tbody> <tr> <td>SITE RATED °F</td> <td><u>96</u></td> <td><u>78</u></td> </tr> <tr> <td>NORMAL °F</td> <td><u>110</u></td> <td><u></u></td> </tr> <tr> <td>MAXIMUM °F</td> <td><u>-10</u></td> <td><u></u></td> </tr> <tr> <td>MINIMUM °F</td> <td><u></u></td> <td><u></u></td> </tr> </tbody> </table>			DRY BULB	WET BULB	SITE RATED °F	<u>96</u>	<u>78</u>	NORMAL °F	<u>110</u>	<u></u>	MAXIMUM °F	<u>-10</u>	<u></u>	MINIMUM °F	<u></u>	<u></u>	APPLICABLE SPECIFICATIONS API 617 CENTRIFUGAL COMP. FOR GEN. REFINERY SERVICES Airco Cryopplants 0-251-1Z-3
	DRY BULB	WET BULB															
SITE RATED °F	<u>96</u>	<u>78</u>															
NORMAL °F	<u>110</u>	<u></u>															
MAXIMUM °F	<u>-10</u>	<u></u>															
MINIMUM °F	<u></u>	<u></u>															
UNUSUAL CONDITIONS ☐ DUST ☐ FUMES ☐ OTHER <u>Coal Processing Facility</u> <u>Coal Dust</u>		PAINTING ☐ MANUFACTURER'S STD. ☐ OTHERS _____															
		SHIPMENT ☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING REQ. ☐ OUTDOOR STORAGE OVER 3 MONTHS															

REMARKS

CENTRIFUGAL COMPRESSOR DATA SHEET

CONSTRUCTION FEATURES

☐ SPEEDS

MAX. CONT. _____ RPM TRIP _____ RPM
 CRITICALS 1ST _____ RPM 2ND _____ RPM
 MAX. TRIP SPEED _____ PSI @ RATED SPEED
 _____ PSI @ MAX. CONT. SPEED

☐ ROTATION, VIEWED FROM DRIVEN END☐ CASING

MODEL _____ ARI-80 (or equal)
 CASING SPLIT _____ Horizontal
 MATERIAL _____ Cast Iron & Welded Steel
 THICKNESS (IN.) _____ Later CORR. ALLOW. (IN.) _____ Later
 MAX. WORK. PRESS. _____ PSI MAX. DESIGN PRESS. _____ PSI
 TEST PRESS (PSIG) HELIUM _____ NYORG _____
 MAX. OPER. TEMP. _____ °F MIN. OPER. TEMP. _____ °F
 MAX. NO. OF IMPELLERS FOR CASING _____ 1 axial, 3 centrifugal
 MAX. CASING CAPACITY (CFM) _____ 205,000
 RADIOGRAPH QUALITY ☐ YES ☐ NO

☐ DIAPHRAGMS

MATERIAL _____

☐ IMPELLERS

(1-axial, 3-centrifugal)

NO. _____ DIAMETERS _____
 TYPE (OPEN, ENCLOSED, ETC.) _____ Enclosed (centrifugal)
 TYPE FABRICATION _____ welded
 MATERIAL _____ steel
 MAX. YIELD STRENGTH (PSI) _____ later
 BRINELL HARDNESS: MAX. _____ later MIN. _____ later
 SMALLEST TIP INTERNAL WIDTH (IN.) _____ later
 MAX. MACH NO. @ IMPELLER EYE _____ later
 MAX. IMPELLER HEAD @ RATED SPEED (FT.) _____ later

☐ SHAFT

MATERIAL _____ Forged Steel

DIA. @ IMPELLERS (IN.) _____ DIA. @ COUPLING (IN.) _____
 SHAFT END ☐ TAPERED ☐ CYLINDRICAL

☐ SHAFT SLEEVE

☐ AT INTERSECT. CLOSE CLEAR. PTL. ☐ MATL. _____
☐ AT SHAFT SEALS _____ ☐ MATL. _____

☐ LASTING

TYPE _____ MATERIAL _____ Later

☐ SHAFT SEALS

TYPE _____ Later
☐ SEAL SYSTEM TYPE _____
☐ INNER OIL LEAKAGE GUAR. (GAL/DAY/SEAL) _____
☐ TYPE BUFFER GAS _____
☐ BUFFER GAS FLOW (PER SEAL) _____
 NORMAL _____ SCFH @ _____ PSI ΔP
 MAX. _____ SCFH @ _____ PSI ΔP

REMARKS

☐ BEARING HOUSING CONSTRUCTION

TYPE (SEPARATE, INTEGRAL) _____ Separate SPLIT

☐ MATERIAL☐ RADIAL BEARINGS

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

☐ THRUST BEARING

LOCATION _____ Gear Box TYPE _____

MFR. _____ AREA (IN.²) _____

LOADING (PSI) ACTUAL _____ ALLOWABLE _____

GAS LOADING (LBS) _____ CPLG. SLIP LOAD (LBS) _____

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

BAL. PISTON COMPENSATING LOAD _____ LBS.

☐ MAIN CONNECTIONS

	SIZE	ANST. RATING	FACING	POSITION
INLET	82"	—		axial
DISCHARGE	36"	150		radial

☐ ALLOWABLE PIPING FORCES AND MOMENTSLater
Design
DataAXIAL
VERTICAL
HORIZ. SPAXIAL
VERTICAL
HORIZ. SP

INLET		DISCHARGE			
FORCE LB	MOMT LB	FORCE LB	MOMT LB	FORCE LB	MOMT LB

☐ OTHER CONNECTIONS

Later-Design Data

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			
ORG. HOUSING			
BETWEEN ORG. & SEAL			
BETWEEN SEAL & GAS			
SOLVENT INJECTION			

[illegible]

ISSUED FOR PHASE 0

Airco Cryoplants

ELECTRIC MOTOR DATA SHEET

0-251-1Z-3

APPLICABLE TO ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT

FOR Bechtel UNIT Air Separation Plant
SITE Breckinridge, Kentucky DRIVEN EQUIP. AXIAL/Centrifugal Compressor
SERVICE Main Air Compressor Drive 15-M-1C NO. REQUIRED One (1)
MANUFACTURER Later MODEL Later SERIAL NO. _____
NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER ☐ BY MANUFACTURER

MOTOR DESIGN DATA

APPLICABLE SPECIFICATIONS

☐ NEMA All Standards
☐ Airco 0-251-1Z-3

SITE DATA

AREA: ☐ 420' OR ☐ 0N. ☐ NONHAZARDOUS
☐ ALTITUDE 420 FT. ☐ AMBIENT TEMP: MAX. -10, MIN. -10
UNUSUAL CONDITIONS: ☐ DUST ☐ FUMES
☐ OTHER Coal Processing Facility
DRIVE SYSTEM: ☐ DIRECT CONNECTED
☐ GEAR
☐ OTHER _____

TYPE MOTOR:

☐ SCRAMBLER CAGE INDUCTION ☐ NEMA DESIGN _____
☐ SYNCHRONOUS
☐ POWER FACTOR REG. 1.0
EXCITATION: ☐ BRUSHLESS ☐ SLIP RING
☐ FIELD DISCHARGE RESISTOR BY MOTOR MFR.
☐ WOUND ROTOR INDUCTION

ENCLOSURE:

☐ CLASS _____, GROUP _____, EXP. PROOF
☐ TEFC
☐ TEVAC ☐ TEMP. 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

☐ WEATHER PROTECTED, TYPE II

☐ FORCED VENTILATED

☐ OPEN OR PROOF

☐ OPEN

BASIC DATA

☐ 5.000 VOLTS 3 PHASE 60 HERTZ
☐ NAMEPLATE HP 32.000 SERVICE FACTOR 1.0
☐ SYNCHRONOUS RPM 1200
☐ INSULATION CLASS B TYPE _____
☐ TEMP. RISE 80 °C ABOVE 40 °C BY Resistance

STARTING

☐ FULL VOLTAGE ☐ REDUCED VOLTAGE _____ %
☐ LOADED ☐ UNLOADED
☐ VOLTAGE DIP _____ %

VIBRATION

☐ NEMA STANDARD ☐ _____

NOTES:

☐ NEMA STANDARD ☐ _____

ACCESSORY EQUIPMENT

☐ BASEPLATE ☐ SOLEPLATE ☐ STATOR SHFT.
☐ MFR. STD. FANS ☐ NON-SPARKING FANS

D.C. EXCITATION:

☐ KW REQ. _____ VOLTS _____
BY: ☐ PURCHASER ☐ MANUFACTURER
DESCRIPTION Brushless

ENCLOSED COLLECTOR RINGS

☐ PURGED: MEDIUM _____ PRESS. _____ PSIG
☐ EXPLOSION-RESISTANT NONPURGED
☐ FORCED VENTILATION
☐ CFM _____ PRESS. DROP _____ IN. H₂O

BEARING TEMP. DEVICES:

☐ LOCATION _____
☐ DESCRIPTION _____
☐ SET P. _____ °C FOR ALARM _____ °C FOR SHUTDOWN

SPACE HEATERS

☐ _____ KW ☐ 460 VOLTS 3 PHASE 60 HERTZ
☐ MAX. SHEATH TEMP. _____ °C

WINDING TEMPERATURE DETECTORS

☐ THERMISTORS: NO./PHASE _____
TYPE: ☐ POS. TEMP. COEFF. ☐ NEG. TEMP. COEFF.
TEMPERATURE SWITCH: ☐ YES ☐ NO
☐ RESISTANCE TEMPERATURE DETECTORS: NO./PHASE 2
☐ RESISTANCE MATL. CU ☐ 10 OHMS
SELECTOR SWITCH & INDICATOR BY: ☐ PURCH. ☐ MFR.

MAX. STATOR WINDING TEMP.

117 °C FOR ALARM 130 °C FOR SHUTDOWN

WINDING TEMP. DETECTOR & SPACE HEATER LEADS

☐ IN SAME CONDUIT BOX
☐ IN SEPARATE CONDUIT BOXES
☐ MOTOR ARRANGED FOR DIFFERENTIAL PROTECTION
☐ SELF-BALANCE PRIMARY-CURRENT METHOD
☐ C.T. DESCRIPTION 50/5
☐ EXTENDED LEADS ☐ LENGTH _____ FT.

SURGE CAPACTORS

LIGHTNING ARRESTERS

☐ C.T. FOR AMMETER (by Airco)
☐ DESCRIPTION 1200/5

MAIN CONDUIT BOX SIZED FOR:

☐ MAIN MOTOR LEADS ☐ TYPE: Bus
☐ INSULATED ☐ NONINSULATED
☐ C.T.'S FOR DIFF. PROTECTION MOUNTED BY Motor mfr
☐ SURGE CAPACTORS MOUNTED BY Motor Mfr
☐ LIGHTNING ARRESTERS MOUNTED BY Motor Mfr
☐ C.T. FOR AMMETER MOUNTED BY _____
☐ SPACE FOR STRESS CONES
☐ AIR FILTERS

☐ MFR. _____ TYPE _____
REMARKS: Main conduit box to be 4'X4'X6' high

Furnish 2 grounding brushes on motor

Start.

Sheet 6 of 37

ISSUED FOR PHASE 0

MANUFACTURER'S DATA		SHOP INSPECTION AND TESTS	
MANUFACTURER <u>Later</u>			
FRAME NO. _____ FULL LOAD RPM (INCL) _____		SHOP INSPECTION	REQUIRED
EFFICIENCY: F.L. <u>97.8</u> 1/4L <u>97.3</u> V/L <u>97.0</u>		TESTING PER NEMA	WITNESS
PWR. FACTOR (INCL) F.L. _____ 1/4L _____ V/L _____		MFR. STD. SHOP TESTS	
CURRENT (RATED VOLT) FULL LOAD _____ LOCKED ROTOR _____		IMMERSION TEST	
LOCKED ROTOR POWER FACTOR _____		SPECIAL TESTS (LIST BELOW)	
LOCKED ROTOR WITHSTAND TIME (COLD START) _____			
TORQUES (FT.-LBS): FULL LOAD <u>140.00</u>			
LOCKED ROTOR _____ STARTING (SYN) _____			
PULL-UP (INCL) _____ PULL-IN (SYN) _____			
BREAKDOWN (INCL) _____ PULL-OUT (SYN) _____			
OPEN CIRCUIT TIME CONSTANT (SEC) _____		COUPLING	
SYMMETRICAL CONTRIBUTION TO 3 ϕ TERMINAL FAULT: _____		☐ SUPPLIED BY <u>Compressor Mfr.</u>	
AT 1/2 CYCLES _____ AT 3 CYCLES _____		☐ MFR. <u>Later</u> ☐ MODEL <u>Later</u>	
REACTANCES: SUB-TRANSIENT (X _d) _____		☐ MOTOR MFR. ☐ COMPR. MFR. ☐ PURCH. TO MOUNT MTR. HALF	
TRANSIENT (X _d) _____ SYNCHRONOUS (X _s) _____		PAINTING	
AC STATOR RESISTANCE _____ OHMS @ _____ °C		☐ MANUFACTURER'S STANDARD	
RATED KVA _____			
KVA INRUSH @ FULL VOLT. & LOCKED ROTOR (SYN) _____		SHIPMENT	
KVA @ FULL VOLTAGE & 3% SPEED _____		☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING REQUIRED	
MAX. LINE CURR. IN STATOR ON 1ST SLIP CYC. @ PULL-OUT (SYN) _____		☐ OUTDOOR STORAGE OVER 3 MONTHS	
ACCELERATION TIME (MOTOR ONLY @ RATED VOLT) _____ SEC.		REMARKS	
ACCEL. TIME (MOTOR & LOAD @ 3% RATED VOLT) _____ SEC.			
ROTOR/FIELD VK ² @ MOTOR SHAFT (LBS.-FT ²) _____			
ROTATION FACING COUPLING END _____			
NO. OF STARTS PER HOUR _____			
FIELD DISCHARGE RESISTOR _____ OHMS			
RATED EXCITATION FIELD VOLTAGE _____ V.			
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 REGD.			
SUPPLIED BY _____			
BEARING: TYPE <u>Sleeve</u> LUBR. <u>Oil</u>			
LUBE OIL REQUIRED: <u>Later</u> GPM @ <u>Later</u> PHS			
TOTAL SHAFT END FLOAT _____			
LIMIT END FLOAT TO _____			
MOTOR ROTOR: ☐ SOLID ☐ SPLIT			
MOTOR HUB: ☐ SOLID ☐ SPLIT			
FOR TEVAC & TECP MOTORS:			
COOLING WATER REQD. _____ GPM			
C.W. TEMP. RISE _____ °F PRESS. DROP _____ PSI			
HAIR (GAS) REQD. _____ SCFM PRESS. MAINT. _____ IN. H ₂ O			
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 <u>49 Tons</u> SHIPPING WEIGHT _____			
ROTOR WEIGHT <u>Later</u> MAX. ERECTION WT. <u>Later</u>			
MAX. MAINT. WT. (IDENTIFY) <u>Later</u>			
DIMENSIONS (FEET & INCHES)			
L <u>18'</u> W <u>14'</u> H <u>12'</u>			

Airco Cryoplants

0-251-1Z-3

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET

APPLICABLE TO: ☒ PROPOSALS ☐ PURCHASE ☐ AS BUILT Air Separation Plant
 FOR Bechtel UNIT
 SITE Breckinridge, Kv. SERIAL NO. _____ RATED HP _____
 SERVICE Main Air Compressor Drives K-1A.B NO. REQ'D 2
 MANUFACTURER GE or equal OUTLINE DWG. _____ SECTION DWG. _____
 MODEL Later TURBINE Later TYPE Multistage DRIVEN EQUIPMENT Axial/Centrifugal
 NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER ☐ BY MANUFACTURER
 PARAGRAPH NUMBERS WITHIN () REFER TO APPLICABLE PARTS OF THIS STANDARD

OPERATING CONDITIONS

INDICATE GUARANTEE POINT BY -

	HORSEPOWER	SPEED RPM	STEAM RATE LB/HP-HR
RATED	29,205	4550	6.81
NORMAL	27,570	4400	6.82
Max.	32,000	5000	6.81

1ST CRITICAL SPEED _____ RPM 2ND CRITICAL SPEED _____ RPM
 TRIP SPEED _____ RPM Later

STEAM CONDITIONS

	900 PSIG	750 PSIG
NORMAL		
MAX. INITIAL		
MIN. INITIAL		

	-13 PSIG	120 PSIG
NORMAL		
MAX.		
MIN.		

☐ EXTRACTION ☐ ADMISSION ☐ NONRETURN VALVE
☐ CONTROLLED ☐ UNCONTROLLED
 FLOW, LB/HR PSIG °FTT

NORMAL		
MIN.		
MAX.		

PERFORMANCE CURVE NO. Later
 MAX. THROTTLE FLOW, LB/HR _____
 MAX. FLOW TO CONDENSER, LB/HR @ IN. HG Later

DUTY ☐ CONT ☐ INTERMIT ☐ STANDBY ☐ M/T
 APPROX STEAM RATE DESIRED _____ LB/HP-HR
 STEAM COST _____ \$/MB PAYOUT PERIOD _____ YEARS

LOCATION
☐ INDOOR ☐ HEATED ☐ UNDER ROOF
☐ OUTDOOR ☐ UNHEATED ☐ PARTIAL SIDES
☐ GRADE ☐ MOUNTAIN
 SITE ELEVATION 320 FT. BAR 14.5 PSIA/IN. HG
 SITE TEMP °F 105 SUMMER -10 WINTER

☐ WINTERIZATION REQ'D ☐ TROPICALIZATION REQ'D
 UNUSUAL CONDITIONS ☐ DUST ☐ FUMES ☐ OTHER
 COOLING WATER SUPPLY TEMP 35 °F. PRESS. 30 PSIG ΔP 10

CONSTRUCTION FEATURES

TYPE ☐ VERTICAL ☐ HORIZONTAL ☐ NO. STAGES 9
 CASING SPLIT ☐ HORIZONTAL ☐ VERTICAL
 ROTOR ☐ SOLID ☐ BUILT UP
 ROTATION (FROM GOV END) ☐ CW ☐ CCW Later
 MAX. TIP SPEED _____ RPM

GOVERNOR TYPE

☐ MECH ☐ HYDR ☐ OIL RELAY NEMA CLASS Electronic
 GOVERNOR MFC Later MODEL Later
 NO. AUTO VALVES _____ TYPE LIFT ☐ CAM ☐ BAR
 HAND VALVES: ☐ MIN. STEAM PRESS. ☐ ECONOMY
☐ AIR HEAD FOR INSTRUMENT CONTROL ☐ JACKSCREW
 RANGE _____ RPM @ _____ PSIG _____ RPM @ _____ PSIG
 HAND SPEED CHANGER RPM _____ MAX. MIN.
 SEPARATE TRIP THROTTLE VALVE: ☐ HYD ☐ MECH
☐ REMOTE TRIP ☐ ACTUATION

BEARINGS

RADIAL TYPE Tilting Pad AREA Later SQ. IN.
 THRUST TYPE Kingsbury AREA Later SQ. IN.
 MAX. THRUST LOAD Later LB
 THRUST CAPACITY Later LB

PACKING TYPE

INTERSTAGE GLAND SEALS Labvrinth
 END-GLAND SEALS Labvrinth NO. PER BOX Later
☐ INSULATION ☐ JACKET MATL

TACHOMETER ☐ VIBR. REED ☐ ELECTRIC ☐ ELECTRONIC

☐ NO. SPEED INDICATOR REQ'D
 LOCATIONS Local, Control Room
☐ TACHOMETER MFR D-N or equal MODEL Later
☐ SENTINEL WARNING VALVE SET @ Later PSIG
☐ BASEPLATE BY _____
☐ UNDER TURBINE ONLY
☐ UNDER TURBINE AND GEAR
☐ UNDER TURBINE AND DRIVEN EQUIPMENT
☐ SOLEPLATES BY Turbine Mfgt.

GLAND SEALING SYSTEM

☐ STEAM EJECTOR REQ'D _____ PSIG _____ °FTT
☐ GLAND CONDENSER REQ'D ☐ VACUUM DEVICE _____
☐ TEMA _____ TEMA _____ OTHER _____
 TUBE OD _____ IN. SWG _____ MATL _____

ELECTRICAL AREA CLASS _____ CR _____ DIV _____

Non Hazardous General Purpose

ISSUED FOR TRACE

RE.	DATE	REVISIONS	BY	CHECK	DESIGN SUPV	ENG. 2	PROJ ENG	APPR
SCALE		DESIGNED		DRAWN		CHIEF ENGR		
ORIGIN		SPECIAL PURPOSE STEAM TURBINE DATA SHEET				JOB NO.		
						DRAWING NO.		25-
						DS-		

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

CONNECTIONS

	SIZE	USASI RATING	FACING	POSITION
INLET	8			
EXHAUST	90			
EXTRACTION				
ADMISSION				

ALLOWABLE PIPING FORCES AND MOMENTS

	INLET		EXHAUST		EXTRACTION	
	FORCE LB	MOMT FT-LB	FORCE LB	MOMT FT-LB	FORCE LB	MOMT FT-LB
PARALLEL TO SHAFT						
VERTICAL						
HORIZ. 90°						

WEIGHTS AND DIMENSIONS

NET WT 100,000 LB SHIPPING WT 110,000 LB
 MAX. ERECTION WT LB MAX. MAINT. WT 50,000 LB
 APPROX. FLOOR SPACE: LENGTH 205'
 WIDTH 110' HEIGHT 205'

- ☐ POTENTIAL MAX. FUTURE SHP
☐ MAX. STEAM THRU INLET VALVE LB/HR
☐ MAX. ALLOWABLE CASING PRESS. ON EXHAUST END PSIG

TURBINE MATERIALS

- ☐ HIGH-PRESS. CASING CS ☐ STEAM CHEST CS
☐ EXHAUST CASING Steel ☐ DIAPHRAGMS CR-M
☐ NOZZLES CR-Moly ☐ NOZZLE RINGS "
☐ BLADES CR-Moly ☐ SHROUGS "
☐ WHEEL " ☐ GOV. VALVE TRIM SS
☐ SHAFT "
☐ SHAFT MATERIAL UNDER SEALS
☐ APPLIED BY SPRAYING ☐ PLATING

LUBE OIL

- ☐ SEPARATE ☐ COMMON
☐ WITH DRIVER ☐ WITH DRIVEN UNIT
☐ MAIN OIL PUMP: ☐ SHAFT DRIVEN ☐ SEPARATELY DRIVEN
☐ SS OIL DRAIN HEADER
☐ SS OIL SUPPLY HEADER
☐ OIL VISCOSITY SUS @ 100 F. SUS @ 210 F.
☐ MAX. PERMISSIBLE OIL VISCOSITY @ STARTUP SUS

COUPLING

- ☐ MOUNT Y COUPLING (17A) ☐ TYPE Later
☐ MFR Later
☐ SPACER REQ'D
☐ COUPLING FURNISHED BY Compressor Mfr.
 TURBINE SHAFT ☐ TAPER ☐ CYLINDRICAL
 DRIVEN SHAFT ☐ TAPER ☐ CYLINDRICAL
 COUPLING GUARD ☐ MFR STD ☐ OTHER

APPLICABLE SPECIFICATIONS

API 612 SPECIAL-PURPOSE STEAM TURBINE
 Airco Cryoplants 0-251-1Z-3

TORSIONAL AND LATERAL CRITICAL SPEED ANALYSIS BY

SHOP TESTS

	REQUIRED	WITNESSED
SHOP INSPECTION		
HYDROSTATIC	0	0
MECHANICAL RUN	0	0
RUN SPARE ROTOR	0	0
PERFORMANCE TEST	0	0
AUXILIARY EQUIPMENT TEST	0	0
DISMANTLE-REASSEMBLY	0	0
(1) Quote optional	0	0
Extra		

GEAR None

- ☐ SPECIAL-PURPOSE GEAR REQ'D
☐ GEAR FURNISHED BY

CONTROL PANEL

FURNISHED BY ☐ VENDOR ☐ OTHERS
 MOUNTING ☐ ON TURBINE ☐ FREE STANDING OFF GROUND

ALARM CONTACTS SHALL

- ☐ OPEN TO SOUND ALARM ☐ CLOSE TO SOUND ALARM
 SHUTDOWN CONTACTS SHALL
☐ OPEN TO SHUT DOWN ☐ CLOSE TO SHUT DOWN
 CONTROL CURRENT 120 VOLTS 1 PHASE 20 HERTZ
 SWITCH ENCLOSURE ☐ EXP. PROOF ☐ WEATHERPROOF ☐

(1) Quote option for performance test

ISSUED FOR PHASE 0

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

ALARMS AND SHUTDOWNS

	ALARM	SHUT-DOWN
☐ STANDBY LUBE OIL PUMP OPERATING	☐	☐
☐ LOW OIL PRESSURE (EACH LEVEL)	☐	☐
☐ OVERSPEED TRIP OPERATION	☐	☐
☐ HIGH TURBINE EXTRACTION PRESSURE	☐	☐
☐ HIGH EXHAUST PRESSURE	☐	☐
☐ HIGH OIL FILTER ΔP	☐	☐
☐ HIGH AND LOW OIL RESERVOIR LEVEL	☐	☐
☐ HIGH OIL COOLER OUTLET TEMPERATURE	☐	☐
☐ EXCESSIVE VIBRATION IN TURBINE	☐	☐
☐ EXCESSIVE AXIAL DISPLACEMENT OF TURBINE	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐

INSTRUMENT PANEL

☐ STEAM INLET PRESSURE GAGE
☐ EXHAUST STEAM PRESSURE GAGE
☐ STEAM CHEST PRESSURE GAGE
☐ FIRST-STAGE PRESSURE GAGE
☐ EXTRACTION PRESSURE GAGE
☐ STEAM SEAL PRESSURE GAGE
☐ LUBE OIL PRESSURE GAGE
☐ CONTROL OIL PRESSURE GAGE
☐ SPEED INDICATOR
☐ GAGES FOR DRIVEN EQUIPMENT
☐ ALARM HOWLER
☐ ANNUNCIATOR
☐
☐
☐
☐

VIBRATION DETECTORS

☐ TYPE <u>Bentley Nevada or equal</u>	☐ MODEL <u></u>
☐ MFR <u>Bentley Nevada or equal</u>	
☐ NO. <u>2</u> AT EACH SHAFT BEARING	TOTAL NO. <u>4</u>
☐ NO. OF VIBRATION MONITORS <u>4</u>	
☐ ALARM ☐ SHUTDOWN	
☐ TIME DELAY <u>3</u> SEC	
☐ MONITOR LOCATION <u>Compressor Panel</u>	
☐ MONITOR ENCLOSURE <u></u>	

SKETCH

AXIAL MOVEMENT DETECTOR

☐ TYPE <u>Displacement</u>	
☐ MFR <u>Bentley Nevada or equal</u>	
☐ NO. REQUIRED <u></u>	
☐ NO. OF VIBRATION MONITORS <u></u>	
☐ ALARM ☐ SHUTDOWN	
☐ TIME DELAY <u>3</u> SEC	
☐ MONITOR LOCATION <u>Compressor Panel</u>	
☐ MONITOR ENCLOSURE <u></u>	

☐ PROVISIONS FOR FIELD BALANCING

☐ VENDOR'S REVIEW AND COMMENT
ON PURCHASER'S PIPING AND
FOUNDATION DRAWINGS ARE REQUIRED

ISSUED FOR PHASE 0

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET

LUBE OIL SYSTEM

INFORMATION BY PURCHASER	MANUFACTURER TO COMPLETE																											
SYSTEM USED ☐ MFR STD ☐ OTHER SYSTEM COMMON WITH ☐ DRIVEN EQUIP. SYSTEM SUPPLIED BY ☐ VENDOR ☐ PURCHASER APPLICABLE API STD _____ MOUNTING ARRANGEMENT: ☐ CONSOLE ☐ COLONY ☐ BASEPLATE	CAPACITY _____ GPM @ _____ PSIG FOR TURBINE PLUS _____ GPM @ _____ PSIG FOR DRIVEN EQUIP. REQ'D PRESSURE TURBINE _____ PSIG CONTROL _____ PSIG DRIVEN EQUIP. _____ PSIG																											
PUMPS <table border="1"> <thead> <tr> <th></th> <th>TYPE</th> <th>DRIVER</th> <th>HORIZONTAL OR VERTICAL</th> </tr> </thead> <tbody> <tr> <td>MAIN</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>STANDBY</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table> STANDBY PUMP CONTROL RESET ☐ MANUAL ☐ AUTO. STANDBY PUMP ☐ FULL CAPACITY ☐ MIN. CAPACITY		TYPE	DRIVER	HORIZONTAL OR VERTICAL	MAIN	_____	_____	_____	STANDBY	_____	_____	_____	PUMPS <table border="1"> <thead> <tr> <th></th> <th>GPM</th> <th>DISCHARGE PSIG</th> <th>CASE MATERIAL</th> <th>DRIVER SHP</th> </tr> </thead> <tbody> <tr> <td>MAIN</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>STANDBY</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table> RELIEF VALVE SET. PSIG _____ PUMPS _____ HEADER _____		GPM	DISCHARGE PSIG	CASE MATERIAL	DRIVER SHP	MAIN	_____	_____	_____	_____	STANDBY	_____	_____	_____	_____
	TYPE	DRIVER	HORIZONTAL OR VERTICAL																									
MAIN	_____	_____	_____																									
STANDBY	_____	_____	_____																									
	GPM	DISCHARGE PSIG	CASE MATERIAL	DRIVER SHP																								
MAIN	_____	_____	_____	_____																								
STANDBY	_____	_____	_____	_____																								
RESERVOIR ☐ BASEPLATE ☐ SEPARATE MATERIAL _____ INTERIOR COATING _____ HEATER REQ'D ☐ ELECTRIC ☐ STEAM ☐ OIL PURIFIER CONNECTIONS REQ'D LEVEL ALARM REQ'D ☐ LOW LEVEL ☐ HIGH LEVEL	RESERVOIR WORKING CAPACITY GAL _____ MINUTES RETENTION _____ VENT FILLER _____ HEATER MFR _____ TYPE _____ LEVEL ALARM MFR _____ TYPE _____																											
FILTERS ☐ SINGLE ☐ DUAL _____ MICRON ☐ CODE STAMP REQ'D	FILTERS MATERIAL _____ MAX. OPER. PRESS. _____ PSIG ΔP CLEAN _____ PSI ΔP COLLAPSE _____ PSI																											
STAINLESS AUXILIARY PIPING REQ'D ☐ ☐ COMPLETE SYSTEM ☐ DOWNSTREAM FILTERS ☐ DRAIN LINES	COOLERS MFR _____ TYPE _____ DUTY _____ BTU/HR. SURFACE _____ SQ FT SHELL OD _____ IN. THICKNESS _____ IN. MAX. OPERATING PRESS. _____ PSIG ☐ TUBES: OD _____ IN. LENGTH _____ SWG _____ NO. _____ ☐ MAT'L: SHELL _____ CHANNELS _____ COVER _____ TUBES _____ TUBE SHT _____ WATER TEMP OUT _____ °F. FLOW _____ GPM																											
LUBE OIL SYSTEM ☐ MAX. MECHANICAL STRENGTH (OIL SIDE) _____ PSIG	ACCUMULATOR MFR _____ TYPE _____ CAP. _____																											
COOLERS ☐ SINGLE ☐ DUAL ☐ TEMA "C" ☐ TEMA "X" ☐ CODE STAMP REQ'D FOUL FACTOR _____	SWITCH VALVE MFR _____ TYPE _____ MAT'L _____																											
ACCUMULATOR REQ'D ☐ YES ☐ NO ☐ CODE STAMP REQ'D	CLARIFIER MFR _____ TYPE _____ MAT'L _____ FILTRATION MEDIUM _____																											
ALARMS AND SHUTDOWNS MFR SHALL FURNISH CONTACTS FOR: <table border="1"> <thead> <tr> <th></th> <th>ALARM</th> <th>SHUTDOWN</th> </tr> </thead> <tbody> <tr> <td>LUBE OIL PRESSURE</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>LOW OIL LEVEL</td> <td>☐</td> <td>☐</td> </tr> </tbody> </table>		ALARM	SHUTDOWN	LUBE OIL PRESSURE	☐	☐	LOW OIL LEVEL	☐	☐	RELIEF VALVES MFR _____ MODEL _____ MAT'L _____																		
	ALARM	SHUTDOWN																										
LUBE OIL PRESSURE	☐	☐																										
LOW OIL LEVEL	☐	☐																										
	WEIGHTS AND DIMENSIONS OF LUBE SYSTEM NET WT _____ MAX. MAINTENANCE WT _____ FLOOR SPACE: L _____ W _____ H _____																											

Turbine Lubrication Furnished From Compressor Lube System

ISSUED FOR PHASE 0



AIRCO CRYOPLANTS

ISSUED FOR PHASE 0

PROCESS
SPECIFICATION
EXPANDERS

NO. 0-251-1Z-9

REV.

EQUIPMENT TITLE Expander Generator

ITEM NO. 15-P-35

CUSTOMER Bechtel

JOB NO. 251

LOCATION Breckinridge, Kentucky

DATE 10/9/80

QUANTITY Six (6)

BY A. E

APP'D BY

OPERATING CONDITIONS

GAS HANDLED Nitrogen

NORMAL FLOW RATE 17,774

SCFM*

NORMAL FLOW RATE 72,278

LB/HR

DESIGN FLOW RATE 19,500

SCFM*

DESIGN FLOW RATE 84,780

LB/HR

INLET TEMPERATURE -150°

°F

INLET PRESSURE 91

PSIA

OUTLET TEMPERATURE Vendor to specify

°F

OUTLET PRESSURE 17.8

PSIA

MOLECULAR WEIGHT @ INLET 28

CALCULATED THEO. WORK AT CONSTANT "S"

BTU/lb

EXPANDER EFFICIENCY

ACTUAL WORK (THEO. WORK x EFF.)

21,807

BTU/lb

BHP AT NORMAL FLOW RATE (NOT INCL. SHAFT LOSSES) 662

BHP

BHP AT DESIGN FLOW RATE (NOT INCL. SHAFT LOSSES) 126

BHP

MISC. INFORMATION

Expander to be coupled to a generator. Expander to be
Airco Cryogenics or equal.

*MEASURED AT 14.7 PSIA & 70°F

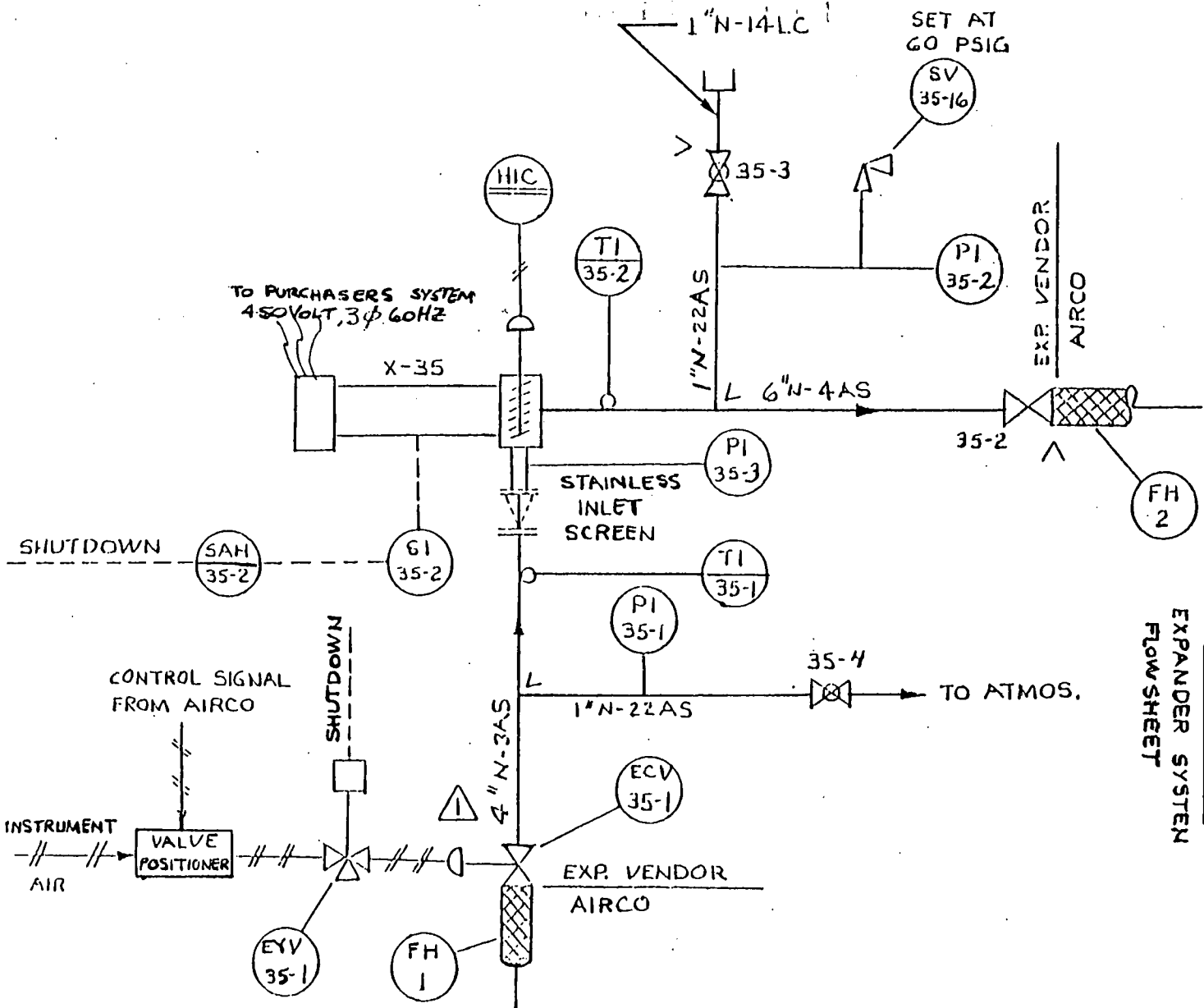
WRITTEN BY _____ DATE _____ APPROVED _____ SHEET NO. 12 OF 37

ISSUED FOR PHASE

NO. 0-251-13-9

TURBINE EXPANDER X-35

FIGURE 1 EXPANDER SYSTEM FLOWSHEET



APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT DATE _____ REVISION _____
 FOR: Bechtel UNIT: Air Separation Plant
 SITE: Breckinridge, Kentucky SERIAL NO. _____
 SERVICE: Oxygen Compressors, 15-K-50 A,B,C NO. REQUIRED: 3
 MANUFACTURER: Sulzer or equal MODEL: RZ or equal DRIVER: 2-steam turbine (A,B)
 NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ☐ BY MANUFACTURER 1-electric motor (C)

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

- ☐ GAS FLOW (SCFM) (WET) OR (DRY)
☐ WEIGHT FLOW (WET) OR (DRY)
 INLET CONDITIONS:
☐ PRESSURE (PSIA)
☐ TEMPERATURE (°F)
☐ RELATIVE HUMIDITY (%)
☐ MOLECULAR WEIGHT (lb)
☐ C/P (K) OR (°C)
☐ COMPRESSIBILITY (Z) OR (P) OR (T)
☐ INLET VOLUME (CFM) (WET)
 DISCHARGE CONDITIONS:
☐ PRESSURE (PSIA)
☐ TEMPERATURE (°F)
☐ C/P (K) OR (°C)
☐ COMPRESSIBILITY (Z) OR (P) OR (T)
☐ SHP REQUIRED (ALL LOSSES INCL)
☐ SPEED (RPM)
☐ ESTIMATED SURGE (CFM) (AT SPEED ABOVE)
☐ POLYTROPIC HEAD (FT)
☐ POLYTROPIC EFFICIENCY (%)
☐ GUARANTEE POINT
☐ PERFORMANCE CURVE NO.

NORMAL	RATED	OTHER CONDITIONS			
		A	B	C	D
Oxygen					
26,473	27,470				
2192	2318				
19.8	19.8				
84	84				
0	0				
32.04	32.04				
1.4	1.4				
1.0	1.0				
20,175	21,280				
950	950				
302	302				
1.4	1.4				
1.0	1.0				
10,590	11,715	@Turbine Coupling			
8640	8640				
Later					
Later					
Later					
Normal					
Later					

PROCESS CONTROL

METHOD: ☐ BYPASS FROM Bv-pass Aftercooler TO Suction
☐ ANTISURGE BYPASS ☐ MANUAL ☐ AUTO
☐ SUCTION THROTTLE FROM _____ TO _____
☒ SPEED VARIATION FROM _____ TO _____
☐ OTHER _____
 SIGNAL: ☐ SOURCE _____
☐ TYPE _____
☐ RANGE: FOR PNEUMATIC CONTROL _____ RPM & _____ PSIG & _____ PSIG & _____ PSIG
 OTHER _____

REMARKS:

NO.	DATE	REVISIONS	BY	CHKD	DESIGN	ENG	PROJ	APPV
SCALE	DESIGNED	DRWING	CHKD/ENG					
ORIGIN	CENTRIFUGAL COMPRESSOR DATA SHEET				JOB NO.		REV.	
				DRAWING NO.		DS-		



CENTRIFUGAL COMPRESSOR DATA SHEET

DS-

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ISSUED FOR PHASE 0

CENTRIFUGAL COMPRESSOR DATA SHEET

0-251-1Z-10

GAS ANALYSIS		NORMAL	RATED	OTHER CONDITIONS				REMARKS
☐ MOL %	☐ _____			A	B	C	D	
AIR	21.044							
OXYGEN	21.000		99.5					
NITROGEN	21.016							
WATER VAPOR	12.016							
CARBON MONOXIDE	21.010							
CARBON DIOXIDE	11.010							
HYDROGEN SULFIDE	11.076							
HYDROGEN	2.016							
METHANE	11.042							
ETHYLENE	21.032							
ETHANE	10.068							
PROPYLENE	12.078							
PROPANE	11.034							
1 - BUTANE	11.120							
2 - BUTANE	11.120							
1 - PENTANE	12.148							
2 - PENTANE	12.148							
HEXANE PLUS								
Argon	89.044		0.5					
TOTAL			100.0					
AVG. MOL. WT.			32.04					

LOCATION ☐ INDOOR ☐ HEATED ☐ UNDER ROOF ☐ OUTDOOR ☐ UNHEATED ☐ PARTIAL SIDES ☐ GRADE ☐ MEZZANINE ☐ Fire Wall Enclosure ☐ ELECTRICAL AREA CLASS _____ GR. _____ DIV. _____ ☐ WINTERIZATION REQD. ☐ TROPICALIZATION REQD. SITE DATA - SEE 14222-A-3 ☐ ELEVATION 420 FT. BAROMETER 14.5 PSIA ☐ RANGE OF AMBIENT TEMPS. _____ <table border="1"> <thead> <tr> <th></th> <th>DRY BULB</th> <th>WET BULB</th> </tr> </thead> <tbody> <tr> <td>SITE RATED °F</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>NORMAL °F</td> <td>96</td> <td>_____</td> </tr> <tr> <td>MAXIMUM °F</td> <td>105</td> <td>_____</td> </tr> <tr> <td>MINIMUM °F</td> <td>-10</td> <td>_____</td> </tr> </tbody> </table>			DRY BULB	WET BULB	SITE RATED °F	_____	_____	NORMAL °F	96	_____	MAXIMUM °F	105	_____	MINIMUM °F	-10	_____	NOISE SPECIFICATIONS ☐ APPLICABLE TO MACHINE SEE SPECIFICATION 0-251-1Z-10 ☐ APPLICABLE TO NEIGHBORHOOD SEE SPECIFICATION _____ ACOUSTIC HOUSING: ☐ YES ☐ NO (1) (1) Vendor to quote option Vendor to advise noise level data. APPLICABLE SPECIFICATIONS API 617 CENTRIFUGAL COMP. FOR GEN. REFINERY SERVICES Airco Cryoplants 0
	DRY BULB	WET BULB															
SITE RATED °F	_____	_____															
NORMAL °F	96	_____															
MAXIMUM °F	105	_____															
MINIMUM °F	-10	_____															
UNUSUAL CONDITIONS ☐ DUST ☐ FUMES ☐ OTHER Coal Processing Facilities	PAINTING ☐ MANUFACTURER'S STD. ☐ OTHERS _____ SHIPMENT ☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING RECD. ☐ OUTDOOR STORAGE OVER 3 MONTHS																

REMARKS

ISSUED FOR PHASE 0

Sheet 15 of 37

CENTRIFUGAL COMPRESSOR DATA SHEET

0-251-12-10

CONSTRUCTION FEATURES

☐ SPEEDS Later

MAX. CONT. _____ RPM TRIP _____ RPM
 CRITICAL: 1ST _____ RPM 2ND _____ RPM
 MAX. TIP SPEED: _____ FPS @ RATED SPEED
 _____ FPS @ MAX. CONT. SPEED

☐ ROTATION, VIEWED FROM DRIVEN END: Later☐ CASING

MODEL _____ RZ
 CASING SPLIT _____ Horizontal
 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 (CFM) _____
 RADIOGRAPH QUALITY ☐ YES ☐ NO

☐ DIAPHRAGMS

MATERIAL _____

☐ IMPELLERS

NO. _____ DIAMETERS _____
 TYPE (OPEN, ENCLOSED, ETC.) _____
 TYPE FABRICATION _____
 MATERIAL _____
 MAX. YIELD STRENGTH (PSI) _____
 BRINELL 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

SHAFT SLEEVES

☐ AT INTERST. CLOSE CLEAR. PTL. ☐ MATL. _____
☐ AT SHAFT SEALS _____ ☐ MATL. _____

☐ LABYRINTHS

TYPE _____ MATERIAL _____

SHAFT SEALS

☐ TYPE _____ Labyrinth
☐ SEAL SYSTEM TYPE Buffered
☐ INNER OIL LEAKAGE GUAR. (GAL/DAY/SEAL) _____
☐ TYPE BUFFER GAS Nitrogen
☐ BUFFER GAS FLOW (PER SEAL)
 NORMAL _____ CFM @ _____ PSI ΔP
 MAX. _____ CFM @ _____ PSI ΔP

REMARKS

☐ BEARING HOUSING CONSTRUCTION: Later

TYPE SEPARATE, INTEGRAL _____ SPLIT _____

MATERIAL _____

☐ RADIAL BEARINGS

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

☐ THRUST BEARING

LOCATION _____ TYPE _____
 MFR. _____ AREA (IN.²) _____
 LOADING (PSI) ACTUAL _____ ALLOWABLE _____
 GAS LOADING (LESS) _____ CPG. SLIP LOAD (LESS) _____
 CPG. COEFF. FRICT. _____ CPG. GEAR PITCH DIA. (IN.) _____
 BAL. PISTON COMPENSATING LOAD _____ LBS.

☐ MAIN CONNECTIONS

	SIZE	ANSI RATING	FACING	POSITION
INLET				
DISCHARGE				

☐ ALLOWABLE PIPING FORCES AND MOMENTS

	INLET		DISCHARGE			
	FORCE LB	MOMT LB	FORCE LB	MOMT LB	FORCE LB	MOMT LB
Later						
AXIAL						
VERTICAL						
HORIZ. 30°						
AXIAL						
VERTICAL						
HORIZ. 30°						

☐ OTHER CONNECTIONS

SERVICE	Later	
	NO.	SIZE
LUBE OIL INLET		
LUBE OIL OUTLET		
SEAL OIL INLET		
SEAL OIL OUTLET		
CASING DRAINS		
STAGE DRAINS		
VENTS		
COOLING WATER		
PRESSURE		
TEMPERATURE		
PURGE FGR		
ERG. HOUSING		
BETWEEN ERG. & SEAL		
BETWEEN SEAL & GAS		
SOLVENT INJECTION		

ISSUED FOR PHASE 0

Sheet 16 of 37

CENTRIFUGAL COMPRESSOR DATA SHEET

0-251-1Z-10

VIBRATION DETECTORS

- ☐ TYPE _____ ☐ MODEL _____
- ☐ NFR _____
- ☐ NO. AT EACH SHAFT BEARING _____ TOTAL NO. _____
- ☐ OSCILLATOR-DETECTORS SUPPLIED BY _____
- ☐ NFR _____ ☐ MODEL _____
- ☐ MONITOR SUPPLIED BY _____
- ☐ LOCATION _____ ENCLOSURE _____
- ☐ NFR _____ ☐ MODEL _____
- ☐ SCALE RANGE _____ ☐ ALARM ☐ SET P _____ MILS
- ☐ SHUTDOWN: ☐ SET P _____ MILS ☐ TIME DELAY _____ SEC.

AXIAL MOVEMENT DETECTOR:

- ☐ TYPE _____ ☐ MODEL _____
- ☐ NFR _____ ☐ NO REQUIRED _____
- ☐ OSCILLATOR-DETECTORS SUPPLIED BY _____
- ☐ NFR _____ ☐ MODEL _____
- ☐ MONITOR SUPPLIED BY _____
- ☐ LOCATION _____ ENCLOSURE _____
- ☐ NFR _____ ☐ MODEL _____
- ☐ SCALE RANGE _____ ☐ ALARM ☐ SET P _____ MILS
- ☐ SHUTDOWN ☐ SET P _____ MILS ☐ TIME DELAY _____ SEC.

COUPLINGS:

- ☐ MAKE _____ DRIVER-COMP. OR GEAR-COMP.
- ☐ MODEL _____ DRIVER-GEAR _____ GEAR-COMP.
- ☐ LUBRICATION _____ Vendor Standard
- ☐ MOUNT CPLG. HALVES _____ Later
- ☐ SPACER RECD. _____ Vendor Standard
- ☐ LIMITED END FLOAT RECD. _____
- ☐ ISLING ADAPTOR RECD. _____
- ☐ CPLG. RATING(HP/ 100 RPM) _____ Later
- ☐ KEYED (I) OR (2); OR HYDR. FIT _____ Later

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

TOTAL UTILITY CONSUMPTION:

Compressor only

COOLING WATER 1385 GPM

STEAM, NORMAL 77.500 // HR

STEAM, MAX. 81.600 // HR

INSTRUMENT AIR Later SCFM

HP (DRIVER) 12.000 HP

HP (AUXILIARIES) Later HP

SHOP INSPECTION AND TESTS

	RECD.	WITNESS
SHOP INSPECTION	☐	☐
HYDROSTATIC	☐	☐
HELIUM LEAK	☐	☐
MECHANICAL RUN	☐	☐
MECH. RUN SPARE ROTOR	☐	☐
FIT IN SPARE ROTOR	☐	☐
PERFORMANCE TEST (GAS IAW)	☐	☐
COMP. WITH DRIVER	☐	☐
COMP. LESS DRIVER	☐	☐
USE SHOP LUBE & SEAL SYS.	☐	☐
USE JOB LUBE & SEAL SYS.	☐	☐
USE SHOP VIBRATION PROBEL ETC.	☐	☐
USE JOB VIB. & AXIAL DISP. PROBEL	☐	☐
OSCILLATOR-DETECTORS & MONITOR	☐	☐
PRESSURE COMP. TO FULL OPER. PRESS	☐	☐
DISASSEMBLE-REASSEMBLE COMP. AFTER TEST	☐	☐
CHECK BRGS & SEALS AFTER TEST	☐	☐
MOISE LEVEL TEST	☐	☐

REMARKS

WEIGHTS (LBS):

Later

COMP. _____ GEAR _____ DRIVER _____ BASE _____

ROTOR: COMP. _____ DRIVER _____ GEAR _____

COMP. UPPER CASE _____

LQ. CONSOLE _____ LQ. CONSOLE _____

MAX. FOR MAINTENANCE (IDENTIFY) _____

TOTAL SHIPPING WEIGHT _____

SPACE REQUIREMENTS (FEET & INCHES):

COMPLETE UNIT: L _____ W _____ H _____

LQ. CONSOLE: L _____ W _____ H _____

LQ. CONSOLE: L _____ W _____ H _____

MISCELLANEOUS

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

REMARKS

SHEET 17 OF 37

ISSUED FOR PHASE 0

Airco Cryoplants

ELECTRIC MOTOR DATA SHEET

0-251-1Z-10

APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILTFOR BechtelUNIT Air Separation PlantSITE Breckinridge, KentuckyDRIVEN EQUIP. Centrifugal Oxygen CompressorSERVICE Oxygen Compressor Driver 15-K-5CNO. REQUIRED One (1)MANUFACTURER Later MODEL Later

SERIAL NO. _____

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

MOTOR DESIGN DATA

APPLICABLE SPECIFICATIONS

☐ NEMA Standards☐ Airco Cryoplants 0-251-1Z-10

SITE DATA

AREA ☐ C. ☐ GR. ☐ DR. ☐ NONHAZARDOUSALTITUDE 420 FT. AMBIENT TEMP: MAX. +105 MIN. -10UNUSUAL CONDITIONS: ☐ DUST ☐ FUMES☐ OTHER Coal Processing FacilityDRIVE SYSTEM: ☐ DIRECT CONNECTED☐ GEAR☐ OTHER _____

TYPE MOTOR:

☐ SQUIRREL CAGE INDUCTION ☐ NEMA DESIGN _____☐ SYNCHRONOUS☐ POWER FACTOR REG. 1.0EXCITATION: ☐ BRUSHLESS ☐ SLIP RING☐ FIELD DISCHARGE RESISTOR BY MOTOR MFR.☐ WOUND ROTOR INDUCTION

ENCLOSURE:

☐ CLASS _____, GROUP _____, EXP. PROOF☐ TEFC☐ TEVAC ☐ TESP, 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☐ WEATHER PROTECTED, TYPE II☐ FORCED VENTILATED☐ OPEN/ROTOR HOOD☐ OPEN

BASE DATA

☐ 15000 VOLTS 3 PHASE 60 HERTZ☐ NAMEPLATE HP 12,000 SERVICE FACTOR 1.0☐ SYNCHRONOUS RPM 1200☐ INSULATION CLASS B TYPE _____☐ TEMP. RISE: 80 °C ABOVE 40 °C BY Resistance

STARTING

☐ FULL VOLTAGE ☐ REDUCED VOLTAGE _____ %☐ LOADED ☐ UNLOADED☐ VOLTAGE DIF. _____ %

VIBRATION

☐ NEMA STANDARD ☐ _____

NOISE

☐ NEMA STANDARD ☐ _____

ACCESSORY EQUIPMENT

☐ BASEPLATE ☐ SOLEPLATE ☐ STATOR SHFT.☐ MFR. STD. FANS ☐ NONSPARKING FANS

D.C. EXCITATION

☐ KW REQ. _____ VOLTS _____BY: ☐ PURCHASER ☐ MANUFACTURERDESCRIPTION Brushless

ENCLOSED COLLECTOR RINGS

☐ PURGED: MEDIUM _____ PRESS. _____ PSIG☐ EXPLOSION-RESISTANT NONPURGED☐ FORCED VENTILATION☐ CFM _____ PRESS. DROP _____ IN. H₂O

BEARING TEMP. DEVICES

☐ LOCATION _____☐ DESCRIPTION _____☐ SET @ _____ °C FOR ALARM _____ °C FOR SHUTDOWN

SPACE HEATERS

☐ _____ KW ☐ 460 VOLTS 3 PHASE 60 HERTZ☐ MAX. SHEATH TEMP. _____ °C

WINDING TEMPERATURE DETECTORS

☐ THERMISTORS: NO./PHASE _____TYPE: ☐ POS. TEMP. COEFF. ☐ NEG. TEMP. COEFF.TEMPERATURE SWITCH: ☐ YES ☐ NO☐ RESISTANCE TEMPERATURE DETECTORS: NO./PHASE 2☐ RESISTANCE MATL. _____ ☐ _____ OHMSSELECTOR SWITCH & INDICATOR BY: ☐ PURCH. ☐ MFR.☐ MAX. STATOR WINDING TEMP.117 °C FOR ALARM 130 °C FOR SHUTDOWN

WINDING TEMP. DETECTOR & SPACE HEATER LEADS

☐ IN SAME CONDUIT BOX☐ IN SEPARATE CONDUIT BOXES

MOTOR ARRANGED FOR DIFFERENTIAL PROTECTION

☐ SELF-BALANCE PRIMARY-CURRENT METHOD☐ C.T. DESCRIPTION 50/5☐ EXTENDED LEADS ☐ LENGTH _____ FT.

SURGE CAPACITORS

LIGHTNING ARRESTERS

☐ C.T. FOR AMMETER By Airco 1200/5☐ DESCRIPTION _____

MAIN CONDUIT BOX SIZED FOR:

☐ MAIN MOTOR LEADS ☐ TYPE Bus☐ INSULATED ☐ NONINSULATED☐ C.T.'S FOR DIFF. PROTECTION (MOUNTED BY Motor Mfr)☐ SURGE CAPACITORS (MOUNTED BY Motor Mfr)☐ LIGHTNING ARRESTERS (MOUNTED BY Motor Mfr)☐ C.T. FOR AMMETER (MOUNTED BY _____)☐ SPACE FOR STRESS CONES

AIR FILTERS

☐ MFR. _____ ☐ TYPE _____REMARKS: Main conduit box to be 4'X4'X6' highFurnish 2 grounding brushes on motor shaft

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Aireco Cryoplants

ELECTRIC MOTOR DATA SHEET

0-251-1Z-10

MANUFACTURER'S DATA		SHOP INSPECTION AND TESTS	
MANUFACTURER <u>Later</u>			
FRAME NO. <u>Later</u> FULL LOAD RPM (INCL) <u>1200</u>		SHOP INSPECTION	☐
EFFICIENCY: F.L. <u>97.9</u> 1/4L <u>97.8</u> 1/2L <u>97.4</u>		TESTING PER NEMA	☐
PWR. FACTOR (INCL) F.L. _____ 1/4L _____ 1/2L _____		MFR. STD. SHOP TESTS	☐
CURRENT (RATED VOLT): FULL LOAD _____ LOCKED ROTOR _____		IMMERSION TEST	☐
LOCKED ROTOR POWER FACTOR _____		SPECIAL TESTS (LIST BELOW)	
LOCKED ROTOR WITHSTAND TIME (COLD START) _____			☐
TORQUES (FT.-LBS): FULL LOAD <u>52,500</u>			☐
LOCKED ROTOR _____ STARTING (SYN) _____			☐
PULL-UP (INCL) _____ PULL-IN (SYN) _____			☐
BREAKDOWN (INCL) _____ PULL-OUT (SYN) _____			☐
OPEN-CIRCUIT TIME CONSTANT (SEC) _____		COUPLING	
SYMMETRICAL CONTRIBUTION TO 18 TERMINAL FAULT:		☐ SUPPLIED BY <u>Compressor Manufacturer</u>	
AT 1/2 CYCLES _____ AT 3 CYCLES _____		☐ MFR. <u>Later</u> ☐ MODEL <u>Later</u>	
REACTANCES: SUB-TRANSIENT (X _d) _____		☐ MOTOR MFR. ☐ COMPR. MFR. ☐ PURCH. TO MOUNT MTR. HALS	
TRANSIENT (X _d) _____ SYNCHRONOUS (X _s) _____		PAINTING	
AC STATOR RESISTANCE _____ OHMS @ _____ °C		☐ MANUFACTURER'S STANDARD	
RATED KVA _____		☐ _____	
KVA (INRUSH) 1/2 FULL VOLT. & LOCKED ROTOR (SYN) _____ %		SHIPMENT	
KVA @ FULL VOLTAGE & 15% SPEED _____ %		☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING REQUIRED	
MAX. LINE CURR. IN STATOR ON 1ST SLIP CYC. @ PULL-OUT (SYN) _____		☐ OUTDOOR STORAGE OVER 3 MONTHS	
ACCELERATION TIME (MOTOR ONLY @ RATED VOLT) _____ SEC.		REMARKS	
ACCEL. TIME (MOTOR & LOAD @ 15% RATED VOLT) _____ SEC.			
ROTOR/FIELD WT. 3 MOTOR SHAFT (LBS.-FT.) _____			
ROTATION FACING COUPLING END _____			
NO. OF STARTS PER HOUR _____			
FIELD DISCHARGE RESISTOR _____ OHMS			
RATED EXCITATION FIELD VOLTAGE _____ V.			
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 REGG.			
SUPPLIED BY _____			
BEARING: TYPE <u>Sleeve</u> LUBR. <u>Oil</u>			
LUBE OIL REQUIRED: <u>Later</u> GPM @ <u>Later</u> PSI			
TOTAL SHAFT END FLOAT _____			
LIMIT END FLOAT TO _____			
MOTOR ROTOR: ☐ SOLID ☐ SPLIT			
MOTOR HUB: ☐ SOLID ☐ SPLIT			
FOR TEWAC & TEIGF MOTORS:			
COOLING WATER REGG. _____ GPM			
C.W. TEMP. RISE _____ °F PRESS. DROP _____ PSI			
AIR (GAS) REGG. _____ SCFM PRESS. MAINT. _____ IN.H ₂ O			
CURVES REGG. BASED ON MOTOR SATURATION @ RATED VOLTAGE:			
☐ SPEED VS TORQUE (ALSO @ _____ % RATED VOLTAGE)			
☐ SPEED VS POWER FACTOR			
☐ SPEED VS CURRENT			
WEIGHTS (LBS.):			
NET WEIGHT <u>24 tons</u> SHIPPING WEIGHT <u>Later</u>			
ROTOR WEIGHT <u>Later</u> MAX. ERECTION WT. <u>Later</u>			
MAX. MAINT. WT. IDENTIFY <u>Later</u>			
DIMENSIONS (FEET & INCHES):			
L <u>14'</u> W <u>13'</u> H <u>11'</u>			

ISSUED FOR PHASE 0

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Airco Cryopplants

0-251-1Z-10

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET

APPLICABLE TO: ☐ PROPOSALS ☐ PURCHASE ☐ AS BUILT
 FOR Bechtel UNIT Air Separation Plant
 SITE Breckinridge, Ky. RATED HP
 SERVICE Oxygen Compressor Driver 15-K-5 A,B NO. REQ'D 2
 MANUFACTURER GE or equal OUTLINE DWG. SECTION DWG.
 MODEL Later TURBINE Later TYPE Multi Stage DRIVEN EQUIPMENT Centrifugal Comp.

NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER ☐ BY MANUFACTURER
 PARAGRAPH NUMBERS WITHIN () REFER TO APPLICABLE PARTS OF THIS STANDARD

OPERATING CONDITIONS				CONSTRUCTION FEATURES			
INDICATE GUARANTEE POINT BY - STEAM RATE LB/HR/HR RATED <u>11,900</u> SPEED, RPM <u>8640</u> <u>7.09</u> NORMAL <u>10,800</u> <u>8170</u> <u>7.09</u> 1ST CRITICAL SPEED <u> </u> RPM 2ND CRITICAL SPEED <u> </u> RPM TRIP SPEED <u> </u> RPM <u>Later</u>				TYPE ☐ VERTICAL ☐ HORIZONTAL ☐ NO. STAGES <u>7</u> CASING SPLIT ☐ HORIZONTAL ☐ VERTICAL ROTOR ☐ SOLID ☐ BUILT UP ROTATION (FROM GOV END) ☐ CW ☐ CCW <u>Later</u> MAX. TIP SPEED <u> </u> RPM <u>Later</u>			
STEAM CONDITIONS INLET STEAM NORMAL <u>900</u> PSIG <u>750</u> FT MAX. INITIAL <u> </u> MIN. INITIAL <u> </u>				GOVERNOR TYPE ☐ MECH ☐ HYDR ☐ OIL RELAY NEMA CLASS <u>Electronic</u> GOVERNOR MFC <u>GE</u> MODEL <u> </u> NO. AUTO VALVES <u> </u> TYPE LIFT ☐ CAM ☐ BAR HAND VALVES: ☐ MIN. STEAM PRESS. ☐ ECONOMY ☐ AIR HEAD FOR INSTRUMENT CONTROL ☐ JACKSCREW RANGE <u> </u> RPM @ <u> </u> PSIG <u> </u> RPM @ <u> </u> PSIG HAND SPEED CHANGER: RPM <u> </u> MAX <u> </u> MIN. SEPARATE TRIP THROTTLE VALVE: ☐ HYD ☐ MECH ☐ REMOTE TRIP ☐ ACTUATION			
EXHAUST STEAM NORMAL <u>-13</u> PSIG <u>116</u> FT MAX. <u> </u> MIN. <u> </u> ☐ EXTRACTION ☐ ADMISSION ☐ NONRETURN VALVE ☐ CONTROLLED ☐ UNCONTROLLED FLOW, LB/HR PSIG FT NORMAL <u> </u> MIN. <u> </u> MAX. <u> </u> PERFORMANCE CURVE NO. <u>Later</u> MAX. THROTTLE FLOW, LB/HR <u>Later</u> MAX. FLOW TO CONDENSER, LB/HR @ IN. HG <u>Later</u>				BEARINGS RADIAL TYPE <u>Tilting Pad</u> AREA <u>Later</u> SQ IN. THRUST TYPE <u>Kingsbury</u> AREA <u>Later</u> SQ IN. MAX. THRUST LOAD <u> </u> LB <u>Later</u> THRUST CAPACITY <u> </u> LB			
DUTY ☐ CONT ☐ INTERMIT ☐ STANDBY HR/YR APPROX STEAM RATE DESIRED <u> </u> LB/BHP/HR STEAM COST <u> </u> \$/MLB PAYOUT PERIOD <u> </u> YEARS LOCATION ☐ INDOOR ☐ HEATED ☐ UNDER ROOF ☐ OUTDOOR ☐ UNHEATED ☐ PARTIAL SIDES ☐ GRADE ☐ MEZZANINE SITE ELEVATION <u> </u> FT, BAR <u> </u> PSIA/IN. HG SITE TEMP ° F <u> </u> SUMMER <u> </u> WINTER ☐ WINTERIZATION REQ'D ☐ TROPICALIZATION REQ'D UNUSUAL CONDITIONS ☐ DUST ☐ FUMES ☐ OTHER COOLING WATER SUPPLY TEMP <u>85</u> ° F, PRESS. <u>50</u> PSIG, ΔP <u>10</u>				PACKING TYPE INTERSTAGE GLAND SEALS <u>Labyrinth</u> END-GLAND SEALS <u>Labyrinth</u> NO. PER BOX <u> </u> ☐ INSULATION ☐ JACKET MATL.			
TACHOMETER ☐ VIBR. REED ☐ ELECTRIC ☐ ELECTRONIC ☐ NO. SPEED INDICATOR REQ'D <u>2</u> LOCATIONS <u>Local Control Room</u> ☐ TACHOMETER MFR <u>Airpax, B-Norel</u> MODEL <u>Later</u> ☐ SENTINEL WARNING VALVE SET @ <u>Later</u> PSIG ☐ BASEPLATE BY <u> </u> ☐ UNDER TURBINE ONLY ☐ UNDER TURBINE AND GEAR ☐ UNDER TURBINE AND DRIVEN EQUIPMENT ☐ SOLEPLATES BY <u>Turbine Mfr.</u>				GLAND SEALING SYSTEM ☐ STEAM EJECTOR REQ'D <u> </u> PSIG <u> </u> FT ☐ GLAND CONDENSER REQ'D ☐ VACUUM DEVICE <u> </u> ☐ TEMA <u> </u> TEMA <u> </u> OTHER <u> </u> TUBE OD <u> </u> IN. SWG <u> </u> MATL. <u> </u>			
ELECTRICAL AREA CLASS <u>GR</u> DIV <u> </u> Non Hazardous General Purpose							
REVISIONS NO. DATE BY CHK'D DESIGN SUPPLY ENG'R PROJ ENGR APPR							
SCALE <u> </u> DESIGNED <u> </u> DRAWN <u> </u> CHIEF ENGR <u> </u> JOB NO. <u> </u>							
ORIGIN <u> </u> SPECIAL PURPOSE STEAM TURBINE DATA SHEET DRAWING NO. <u> </u> REV. <u> </u>							
DS-							

0-251-1Z-10

CONNECTIONS

	SIZE	USASI RATING	FACING	POSITION
INLET	5			
EXHAUST	50			
EXTRACTION	---	---	---	---
ADMISSION	---	---	---	---

	INLET		EXHAUST		EXTRACTION	
	FORCE LB	MOM'T FT-LB	FORCE LB	MOM'T FT-LB	FORCE LB	MOM'T FT-LB
PARALLEL TO SHAFT						
VERTICAL						
HORIZ. 90°						

WEIGHTS AND DIMENSIONS
NET WT 40,000 LB SHIPPING WT 45,000 LB
MAX. ERECTION WT Later LB MAX. MAINT. WT 12,000 LB
APPROX. FLOOR SPACE: LENGTH 140'
WIDTH 100' HEIGHT 80'

- ☐ POTENTIAL MAX. FUTURE BHP _____
- ☐ MAX. STEAM THRU INLET VALVE _____ LB/HR
- ☐ MAX. ALLOWABLE CASING PRESS. ON EXHAUST END _____ PSIG

TURBINE MATERIALS		Steel		STEAM CHEST	Steel
☐	HIGH-PRESS. CASING	Steel	☐	DIAPHRAGMS	CR-Moly-B
☐	EXHAUST CASING	Steel	☐	NOZZLE RINGS	"
☐	NOZZLES	Chrome Moly B	☐	SHROUDS	"
☐	BLADES	"	☐	GOV VALVE TRIM	SS
☐	WHEEL	"			
☐	SHAFT	"			
☐	SHAFT MATERIAL UNDER SEALS				CR-Moly-B
☐	APPLIED BY SPRAYING		☐	PLATING	

- ☐ LUBE OIL
☐ SEPARATE ☐ COMMON
☐ WITH DRIVER ☐ WITH DRIVEN UNIT
☐ MAIN OIL PUMP ☐ SHAFT DRIVER ☐ SEPARATELY DRIVEN
☐ SS OIL DRAIN HEADER
☐ SS OIL SUPPLY HEADER
☐ OIL VISCOSITY _____ SUS @ 100 F _____ SUS @ 210 F
☐ MAX. PERMISSIBLE OIL VISCOSITY @ STARTUP _____ SUS

☐ MOUNT 1/4 COUPLING (17a) ☐ TYPE Later
☐ MFR Later
☐ SPACER REQ'D
☐ COUPLING FURNISHED BY Comdr. Mfr.
 TURBINE SHAFT ☐ TAPER ☐ CYLINDRICAL
 DRIVEN SHAFT ☐ TAPER ☐ CYLINDRICAL
 COUPLING GUARD ☐ MFR STD ☐ OTHER

~~Airco Cryopants 0-251-12-10~~

WITNESSED

- | | | |
|--------------------------|---|---|
| SHOP INSPECTION | 0 | 0 |
| HYDROSTATIC | 0 | 0 |
| MECHANICAL RUN | 0 | 0 |
| RUN SPARE ROTOR | 0 | 0 |
| PERFORMANCE TEST | 0 | 0 |
| AUXILIARY EQUIPMENT TEST | 0 | 0 |
| DISMANTLE-REASSEMBLY | 0 | 0 |
| _____ | 0 | 0 |
| _____ | 0 | 0 |
| _____ | 0 | 0 |
- (1)

☐ SPECIAL-PURPOSE GEAR REQD
☐ GEAR FURNISHED BY _____ Compr. Mfr.

FURNISHED BY ☐ VENDOR ☐ OTHERS
MOUNTING ☐ ON TURBINE ☐ FREE STANDING OFF GROUND

☐ OPEN TO SOUND ALARM ☐ CLOSE TO SOUND ALARM
 SHUTDOWN CONTACTS SMALL
☐ OPEN TO SHUT DOWN ☐ CLOSE TO SHUT DOWN
 CONTROL CURRENT 120 VOLTS 1 PHASE 60 HERTZ
 SWITCH ENCLOSURE ☐ EXP PROOF ☐ WEATHERPROOF ☐

SHEET 21 OF 37

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

ALARMS AND SHUTDOWNS		INSTRUMENT PANEL	
	ALARM	SHUT-DOWN	
☐ STANDBY LUBE OIL PUMP OPERATING	☐	☐	☐ STEAM INLET PRESSURE GAGE
☐ LOW OIL PRESSURE (EACH LEVEL)	☐	☐	☐ EXHAUST STEAM PRESSURE GAGE
☐ OVERSPEED TRIP OPERATION	☐	☐	☐ STEAM CHEST PRESSURE GAGE
☐ HIGH TURBINE EXTRACTION PRESSURE	☐	☐	☐ FIRST-STAGE PRESSURE GAGE
☐ HIGH EXHAUST PRESSURE	☐	☐	☐ EXTRACTION PRESSURE GAGE
☐ HIGH OIL FILTER ΔP	☐	☐	☐ STEAM SEAL PRESSURE GAGE
☐ HIGH AND LOW OIL RESERVOIR LEVEL	☐	☐	☐ LUBE OIL PRESSURE GAGE
☐ HIGH OIL COOLER OUTLET TEMPERATURE	☐	☐	☐ CONTROL OIL PRESSURE GAGE
☐ EXCESSIVE VIBRATION IN TURBINE	☐	☐	☐ SPEED INDICATOR
☐ EXCESSIVE AXIAL DISPLACEMENT OF TURBINE	☐	☐	☐ GAGES FOR DRIVEN EQUIPMENT
☐ _____	☐	☐	☐ ALARM HOWLER
☐ _____	☐	☐	☐ ANNUNCIATOR
☐ _____	☐	☐	☐ _____
☐ _____	☐	☐	☐ _____
VIBRATION DETECTORS ☐ TYPE <u>Displacement</u> ☐ MODEL _____ ☐ MFR <u>B-N or equal</u> ☐ NO. <u>2</u> AT EACH SHAFT BEARING TOTAL NO. <u>4</u> ☐ NO. OF VIBRATION MONITORS <u>4</u> ☐ ALARM ☐ SHUTDOWN ☐ TIME DELAY <u>3</u> SEC ☐ MONITOR LOCATION <u>Compressor Panel</u> ☐ MONITOR ENCLOSURE _____			SKETCH
AXIAL MOVEMENT DETECTOR ☐ TYPE <u>Displacement</u> ☐ MFR <u>B-N or equal</u> ☐ NO. REQUIRED _____ ☐ NO. OF VIBRATION MONITORS _____ ☐ ALARM ☐ SHUTDOWN ☐ TIME DELAY <u>3</u> SEC ☐ MONITOR LOCATION <u>Compressor Panel</u> ☐ MONITOR ENCLOSURE _____			
☐ PROVISIONS FOR FIELD BALANCING			
☐ VENDOR'S REVIEW AND COMMENT ON PURCHASER'S PIPING AND FOUNDATION DRAWINGS ARE REQUIRED			

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET

LUBE OIL SYSTEM

INFORMATION BY PURCHASER	MANUFACTURER TO COMPLETE																					
SYSTEM USED ☐ MFR STD ☐ OTHER SYSTEM COMMON WITH ☐ DRIVEN EQUIP. SYSTEM SUPPLIED BY ☐ VENDOR ☐ PURCHASER APPLICABLE API STD _____ MOUNTING ARRANGEMENT: ☐ CONSOLE ☐ COLONY ☐ BASEPLATE	CAPACITY _____ GPM @ _____ PSIG FOR TURBINE PLUS _____ GPM @ _____ PSIG FOR DRIVEN EQUIP. REQ'D PRESSURE _____ TURBINE _____ PSIG CONTROL _____ PSIG DRIVEN EQUIP. _____ PSIG																					
PUMPS <table border="0"> <tr> <th>TYPE</th> <th>DRIVER</th> <th>HORIZONTAL OR VERTICAL</th> </tr> <tr> <td>MAIN _____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>STANDBY _____</td> <td>_____</td> <td>_____</td> </tr> </table> STANDBY PUMP CONTROL RESET ☐ MANUAL ☐ AUTO. STANDBY PUMP ☐ FULL CAPACITY ☐ MIN. CAPACITY	TYPE	DRIVER	HORIZONTAL OR VERTICAL	MAIN _____	_____	_____	STANDBY _____	_____	_____	PUMPS <table border="0"> <tr> <th>GPM</th> <th>DISCHARGE PSIG</th> <th>CASE MATERIAL</th> <th>DRIVER SHP</th> </tr> <tr> <td>MAIN _____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>STANDBY _____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </table> RELIEF VALVE SET. PSIG _____ PUMPS _____ HEADER _____	GPM	DISCHARGE PSIG	CASE MATERIAL	DRIVER SHP	MAIN _____	_____	_____	_____	STANDBY _____	_____	_____	_____
TYPE	DRIVER	HORIZONTAL OR VERTICAL																				
MAIN _____	_____	_____																				
STANDBY _____	_____	_____																				
GPM	DISCHARGE PSIG	CASE MATERIAL	DRIVER SHP																			
MAIN _____	_____	_____	_____																			
STANDBY _____	_____	_____	_____																			
RESERVOIR ☐ BASEPLATE ☐ SEPARATE MATERIAL _____ INTERIOR COATING _____ HEATER REQ'D ☐ ELECTRIC ☐ STEAM ☐ OIL PURIFIER CONNECTIONS REQ'D LEVEL ALARM REQ'D ☐ LOW LEVEL ☐ HIGH LEVEL	RESERVOIR WORKING CAPACITY GAL _____ MINUTES RETENTION _____ VENT FILLER _____ HEATER _____ TYPE _____ LEVEL ALARM _____ TYPE _____ MFR _____ TYPE _____																					
FILTERS ☐ SINGLE ☐ DUAL _____ MICRON ☐ CODE STAMP REQ'D	FILTERS MATERIAL _____ MAX. OPER. PRESS. _____ PSIG ΔP CLEAN _____ PSI ΔP COLLAPSE _____ PSI																					
STAINLESS AUXILIARY PIPING REQ'D ☐ ☐ COMPLETE SYSTEM ☐ DOWNSTREAM FILTERS ☐ DRAIN LINES	COOLERS MFR _____ TYPE _____ DUTY _____ BTU/HR. SURFACE _____ SQ FT SHELL OD _____ IN. THICKNESS _____ IN. MAX. OPERATING PRESS. _____ PSIG ☐ TUBES: OD _____ IN. LENGTH _____ SWG NO. _____ ☐ MAT'L: SHELL _____ CHANNELS _____ COVER _____ TUBES _____ TUBE SHT _____ WATER TEMP OUT _____ °F. FLOW _____ GPM																					
COOLERS ☐ SINGLE ☐ DUAL ☐ TEMA "C" ☐ TEMA "R" ☐ CODE STAMP REQ'D FOUL FACTOR _____	ACCUMULATOR MFR _____ TYPE _____ CAP. _____																					
ACCUMULATOR REQ'D ☐ YES ☐ NO ☐ CODE STAMP REQ'D	SWITCH VALVE MFR _____ TYPE _____ MAT'L _____																					
SWITCH VALVE ☐ ONE FOR FILTER AND COOLER ☐ ONE FOR FILTER, ONE FOR COOLER	CLARIFIER MFR _____ TYPE _____ MAT'L _____ FILTRATION MEDIUM _____																					
ALARMS AND SHUTDOWNS MFR SHALL FURNISH CONTACTS FOR: <table border="0"> <tr> <th></th> <th>ALARM</th> <th>SHUTDOWN</th> </tr> <tr> <td>LUBE OIL PRESSURE</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>LOW OIL LEVEL</td> <td>☐</td> <td>☐</td> </tr> </table>		ALARM	SHUTDOWN	LUBE OIL PRESSURE	☐	☐	LOW OIL LEVEL	☐	☐	RELIEF VALVES MFR _____ MODEL _____ MAT'L _____												
	ALARM	SHUTDOWN																				
LUBE OIL PRESSURE	☐	☐																				
LOW OIL LEVEL	☐	☐																				
	WEIGHTS AND DIMENSIONS OF LUBE SYSTEM NET WT _____ MAX. MAINTENANCE WT _____ FLOOR SPACE: L _____ W _____ H _____																					

Turbine Lubrication supplied from compressor lube system

APPLICABLE TO ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT		DATE _____	REVISION _____	
FOR <u>Bechtel</u>		UNIT <u>Air Separation Plant</u>		
SITE <u>Breckinridge, Kentucky</u>		SERIAL NO. _____		
SERVICE <u>Cycle Nitrogen Compressor CP-55 15-K-55</u>		NO. REQUIRED <u>1</u>		
MANUFACTURER <u>Dresser-Clark</u> MODEL <u>ISOPAC 20-6-4</u>		DRIVER <u>Electric Motor</u>		
NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER; ☐ BY MANUFACTURER				

OPERATING CONDITIONS					
(ALL DATA ON PER UNIT BASIS)					
NORMAL	RATED	Normal		Rated	
		Sec. 1	Sec. 2	Sec. 1	Sec. 2
<u>Nitrogen</u>					
<u>See</u>					
		31	83	31	83
		95	93.5	95	93.5
		0	0	0	0
		28.01	28.01	28.01	28.01
		1.4	1.4	1.4	1.4
		1.0	1.0	1.0	1.0
		13.428	6.570	14.102	6.899
		84.5	495	84.5	495
		225	270	225	270
		1.4	1.4	1.4	1.4
		1.0	1.005	1.0	1.005
		8947	9010	—	—
		1200	1200	—	—
		11.400	5460	11.400	5460
		—	—	—	—
		—	—	—	—
		Normal	—	—	—
		—	—	—	—

PROCESS CONTROL	
METHOD:	☐ BYPASS FROM <u>Aftercooler</u> TO <u>Suction</u>
	☐ ANTI-SURGE BYPASS ☐ MANUAL ☐ AUTO with manual override
	☐ SUCTION THROTTLING FROM _____ TO _____
	☐ SPEED VARIATION FROM _____ TO _____
	☐ OTHER <u>Mass Flow Control</u>
SIGNAL:	☐ SOURCE _____
	☐ TYPE _____
	☐ RANGE: FOR PNEUMATIC CONTROL _____ RPM 1 _____ RPM 2 _____ RPM 3 _____ PSIG _____
OTHER _____	

REMARKS	
(1) Inlet temp to Section 2 assumes 105°F out intercooler and side load temp 88°F	
(2) Compressor is poster type 1200 rpm input. Duplicat Dresser Clark CT 21044	

REVIEWED FOR PHASE 0 ESTIMATE	

NO.	DATE	REVISIONS	BY	CHECKS	DESIGN SUPV	ENG 1	PROJ ENG 2	APPR
SCALE		DESIGNED		DRAWN		CHIEF ENGR		

	CENTRIFUGAL COMPRESSOR DATA SHEET	
	JOB NO. _____	
	DRAWING NO. _____	REV. _____

ISSUED FOR PHASE 0

Airco Cryoplants

0-251-1Z-13

CENTRIFUGAL COMPRESSOR DATA SH

GAS ANALYSIS		NORMAL	RATED	OTHER CONDITIONS				REMARKS
☐ MOL %	☐ WT %			A	B	C	D	
AIR	21.000							
OXYGEN	21.000							
NITROGEN	78.016		100					
WATER VAPOR	12.016							
CARBON MONOXIDE	23.010							
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			100					
AVG. MOL. WT.			28.0134					

LOCATION ☐ INDOOR ☐ HEATED ☐ UNDER ROOF ☐ OUTDOOR ☐ UNHEATED ☐ PARTIAL SIDES ☐ GRADE ☐ MEZZANINE ☐ _____ ☐ ELECTRICAL AREA CLASS _____ GR. _____ DIV. _____ ☐ WINTERIZATION RECD. ☐ TROPICALIZATION RECD.		NOISE SPECIFICATIONS ☐ APPLICABLE TO MACHINE: SEE SPECIFICATION 0-251-1Z-13 ☐ APPLICABLE TO NEIGHBORHOOD: SEE SPECIFICATION _____ ACQUSTIC HOUSING: ☐ YES ☐ NO	
SITE DATA - SEE 14222-A-3 ☐ ELEVATION 420 FT. BAROMETER 14.5 PSIA ☐ RANGE OF AMBIENT TEMP.: _____		APPLICABLE SPECIFICATIONS API 617 CENTRIFUGAL COMP. FOR GEN. REFINERY SERVICES 0-251-1Z-13	
SITE RATED °F _____ NORMAL °F 96 MAXIMUM °F 105 MINIMUM °F -10		PAINTING ☐ MANUFACTURER'S STG. ☐ OTHERS _____	
UNUSUAL CONDITIONS ☐ DUST ☐ FUMES ☐ OTHER Coal Processing Facility		SHIPMENT ☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING RECD. ☐ OUTDOOR STORAGE OVER 3 MONTHS	

REMARKS

Sheet 25 of 37

ISSUED FOR PHASE 0

CENTRIFUGAL COMPRESSOR DATA SHEET

CONSTRUCTION FEATURES

☐ SPEEDS

MAX. CONT. 1200 RPM — TRP — RPM
 CRITICALS: 1ST — RPM 2ND — RPM
 MAX. TP SPEED: — FPS @ RATED SPEED
 — FPS @ MAX. CONT. SPEED

☐ ROTATION, VIEWED FROM DRIVEN END:☐ CASING

MODEL ISOPAC 20-6-4
 CASING SPLIT Individual Poster Cases
 MATERIAL Cast Iron
 THICKNESS (IN.) — CORR. ALLOW. (IN.) —
 MAX. WORK. PRESS. — PSI MAX. DESIGN PRESS. — PSI
 TEST PRESS (PSI): HELIUM — HYDRO —
 MAX. OPER. TEMP. — °F MIN. OPER. TEMP. — °F
 MAX. NO. OF IMPELLERS FOR CASING 1 per case
 MAX. CASING CAPACITY (ICFM) —
 RADIOGRAPH QUALITY ☐ YES ☐ NO

☐ DIAPHRAGM

MATERIAL —

☐ IMPELLERS

NO. 6 DIAMETERS —
 TYPE (OPEN, ENCLOSED, ETC.) Open
 TYPE FABRICATION —
 MATERIAL 17-4
 MAX. YIELD STRENGTH (PSI) —
 BRINELL HARDNESS: MAX. — MIN. —
 SMALLEST TIP INTERNAL WIDTH (IN.) —
 MAX. MACH NO. @ IMPELLER EYE —
 MAX. IMPELLER HEAD @ RATED SPEED (FT.) —

☐ SHAFT

MATERIAL Steel
 DIA. @ IMPELLERS (IN.) — DIA. @ COUPLING (IN.) —
 SHAFT END: ☐ TAPERED ☐ CYLINDRICAL

SHAFT SLEEVE

☐ AT INTERST. CLOSE CLEAR. FTL. ☐ MATL. —
☐ AT SHAFT SEALS ☐ MATL. —

☐ LABYRINTH

TYPE — MATERIAL Aluminum

SHAFT SEALS

☐ TYPE Labvrinth
☐ SEAL SYSTEM TYPE Purged
☐ INNER OIL LEAKAGE GUAR. SEAL/BAY SEAL —
☐ TYPE SUPPER GAS Nitrogen
☐ SUPPER GAS FLOW (PER SEAL) Later
 NORMAL — MIN — PSI ΔP —
 MAX — MIN — PSI ΔP —

☐ BEARING HOUSING CONSTRUCTION

TYPE SEPARATE, INTEGRAL, SPLIT

MATERIAL —

☐ RADIAL BEARING

TYPE Tilting Pad SPAN (IN.) —
 AREA (IN.) — LOADING (PSI): ACT. — ALLOW. —

☐ THRUST BEARING

LOCATION — TYPE —
 MFR. — AREA (IN.) —
 LOADING (PSI): ACTUAL — ALLOWABLE —
 GAS LOADING (LBS) — CPLG. SLIP LOAD (LBS) —
 CPLG. COEFF. FRICT. — CPLG. GEAR PITCH DIA. (IN.) —
 BAL. PISTON COMPENSATING LOAD — LBS

☐ MAIN CONNECTIONS

	SIZE	AREA RATING	FACING	POSITION
INLET	20	150	RF	
DISCHARGE	12"	300	RF	
Side Inlet	12"	150	RF	

☐ ALLOWABLE PIPING FORCES AND MOMENTS Later

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

☐ 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	4	8"	150 RF
PRESSURE			—
TEMPERATURE			—
PURGE FLOW			—
DRG. HOUSING			—
BETWEEN DRG. & SEAL			—
BETWEEN SEAL & GAS			—
SOLVENT INJECTION			—

REMARKS

ISSUED FOR PHASE 0

CENTRIFUGAL COMPRESSOR DATA SHEET

0-257-12-13

VIBRATION DETECTORS		SHOP INSPECTION AND TESTS																													
☐ TYPE <u>Displacement</u> ☐ MODEL <u> </u> ☐ MFR <u>Bently Nevada</u> ☐ NO. AT EACH SHAFT BEARING <u>1</u> TOTAL NO. <u>8</u> ☐ OSCILLATOR-DETECTORS SUPPLIED BY <u>Vendor</u> ☐ MFR <u>Bently Nevada</u> ☐ MODEL <u> </u> ☐ MONITOR SUPPLIED BY <u>Vendor</u> ☐ LOCATION <u>Local Panel</u> ENCLOSURE <u>NEMA IV</u> ☐ MFR <u>Bently Nevada</u> ☐ MODEL <u>Series 9000</u> ☐ SCALE RANGE <u> </u> ☐ ALARM ☐ SET P <u> </u> MILS ☐ SHUTDOWN: ☐ SET P <u> </u> MILS ☐ TIME DELAY <u>3</u> SEC.	SHOP INSPECTION HYDROSTATIC HELIUM LEAK MECHANICAL RUN 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 PROBE, ETC. USE JOB VIB. & AXIAL DISP. PROBE, OSCILLATOR-DETECTORS & MONITOR PRESSURE COMP. TO FULL OPER. PRESS DISASSEMBLE-REASSEMBLE COMP. AFTER TEST CHECK BRGS & SEALS AFTER TEST NOISE LEVEL TEST REQD. WITNESS																														
AXIAL MOVEMENT DETECTOR: <u>None</u> ☐ TYPE <u> </u> ☐ MODEL <u> </u> ☐ MFR <u> </u> ☐ NO REQUIRED <u> </u> ☐ OSCILLATOR-DETECTORS SUPPLIED BY <u> </u> ☐ MFR <u> </u> ☐ MODEL <u> </u> ☐ MONITOR SUPPLIED BY <u> </u> ☐ LOCATION <u> </u> ENCLOSURE <u> </u> ☐ MFR <u> </u> ☐ MODEL <u> </u> ☐ SCALE RANGE <u> </u> ☐ ALARM ☐ SET P <u> </u> MILS ☐ SHUTDOWN: ☐ SET P <u> </u> MILS ☐ TIME DELAY <u> </u> SEC.	REMARKS: <u> </u> <u> </u> <u> </u>																														
COUPLINGS: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">DRIVER-COMP. OR DRIVER-GEAR</th> <th style="text-align: center;">GEAR-COMP.</th> </tr> </thead> <tbody> <tr><td>☐ MAKE</td><td style="text-align: center;"><u>Later</u></td><td style="text-align: center;"><u>None</u></td></tr> <tr><td>☐ MODEL</td><td style="text-align: center;"><u>Later</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ LUBRICATION</td><td style="text-align: center;"><u>None</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ MOUNT CPLG. HALVES</td><td style="text-align: center;"><u>Yes</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ SPACER REQD.</td><td style="text-align: center;"><u>Yes</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ LIMITED END FLOAT REQD.</td><td style="text-align: center;"><u>Yes</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ ISOLING ADAPTOR REQD.</td><td style="text-align: center;"><u>No</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ CPLG. RATING (HP/100 RPM)</td><td style="text-align: center;"><u>Later</u></td><td style="text-align: center;"><u> </u></td></tr> <tr><td>☐ KEYED (1) OR (2): OR HYDR. FIT</td><td style="text-align: center;"><u>Keyed</u></td><td style="text-align: center;"><u> </u></td></tr> </tbody> </table>		DRIVER-COMP. OR DRIVER-GEAR	GEAR-COMP.	☐ MAKE	<u>Later</u>	<u>None</u>	☐ MODEL	<u>Later</u>	<u> </u>	☐ LUBRICATION	<u>None</u>	<u> </u>	☐ MOUNT CPLG. HALVES	<u>Yes</u>	<u> </u>	☐ SPACER REQD.	<u>Yes</u>	<u> </u>	☐ LIMITED END FLOAT REQD.	<u>Yes</u>	<u> </u>	☐ ISOLING ADAPTOR REQD.	<u>No</u>	<u> </u>	☐ CPLG. RATING (HP/100 RPM)	<u>Later</u>	<u> </u>	☐ KEYED (1) OR (2): OR HYDR. FIT	<u>Keyed</u>	<u> </u>	☐ WEIGHTS (LBS): COMP. <u> </u> GEAR <u>45,000</u> DRIVER <u>53,000</u> BASE <u>56,000</u> ROTORS: COMP. <u>50</u> DRIVER <u>18850</u> GEAR <u>8000</u> COMP. UPPER CASE <u> </u> L.O. CONSOLE <u>Incl.</u> L.O. CONSOLE <u> </u> MAX. FOR MAINTENANCE IDENTIFY <u>18,850-Motor Rotor</u> TOTAL SHIPPING WEIGHT <u>154.00</u> lbs.
	DRIVER-COMP. OR DRIVER-GEAR	GEAR-COMP.																													
☐ MAKE	<u>Later</u>	<u>None</u>																													
☐ MODEL	<u>Later</u>	<u> </u>																													
☐ LUBRICATION	<u>None</u>	<u> </u>																													
☐ MOUNT CPLG. HALVES	<u>Yes</u>	<u> </u>																													
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☐ KEYED (1) OR (2): OR HYDR. FIT	<u>Keyed</u>	<u> </u>																													
BASEPLATE & ISOLATES: ISOLATES FOR: ☐ COMPRESSOR ☐ GEAR ☐ DRIVER BASEPLATE: ☐ COMMON (UNDER COMP., GEAR & DRIVER) ☐ UNDER COMP. ONLY ☐ OTHER <u> </u> ☐ DECKED WITH NON-SKID DECK PLATE ☐ OPEN CONSTR. ☐ DRIP PAN ☐ WITH OPEN DRAIN ☐ HORIZ. ADJUSTING SCREWS FOR EQUIPMENT ☐ SUITABLE FOR POINT SUPPORT ☐ SUITABLE FOR PERIMETER SUPPORT	☐ SPACE REQUIREMENTS (FEET & INCHES): COMPLETE UNIT: L <u>39'-9"</u> W <u>19'-4"</u> H <u>14'-6"</u> L.O. CONSOLE: L <u> </u> W <u> </u> H <u> </u> S.O. CONSOLE: L <u> </u> W <u> </u> H <u> </u>																														
☐ TOTAL UTILITY CONSUMPTION: COOLING WATER <u>1725</u> GPM STEAM, NORMAL <u> </u> / HR STEAM, MAX. <u> </u> / HR INSTRUMENT AIR <u> </u> SCFM HP (DRIVER) <u>10,000</u> HP HP (AUXILIARIES) <u>30</u> HP	MISCELLANEOUS: ☐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION <u> </u> ☐ VENDOR'S REVIEW & COMMENTS ON PURCHASER'S PIPING & FOUNDATION ☐ OPTICAL ALIGNMENT PLATS REQUIRED ON COMPRESSOR, GEAR & DRIVER ☐ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY <u> </u> ☐ TORSIONAL ANALYSIS REPORT REQUIRED																														
REMARKS: <u> </u> <u> </u> <u> </u>																															

SHEET 27 OF 37

ISSUED FOR PHASE 0

Airco Cryopplants

ELECTRIC MOTOR DATA SHEET

0-251-1Z-13

APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILTFOR BechtelUNIT Air Separation PlantSITE Breckinridge, KentuckyDRIVEN EQUIP. Centrifugal Nitrogen CompressorSERVICE Cycle Nitrogen Compressor Driver M-55NO. REQUIRED One (1)MANUFACTURER GE EM or equal model later

SERIAL NO.

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

MOTOR DESIGN DATA

APPLICABLE SPECIFICATIONS:

☐ NEMA Airco Cryopplants 0-251-1Z-17

SITE DATA:

AREA: ☐ CL. ☐ GR. ☐ SW. ☐ NONHAZARDOUS☐ ALTITUDE FT. ☐ AMBIENT TEMP: MAX. °F, MIN. °FUNUSUAL CONDITIONS: ☐ DUST ☐ FUMES☐ OTHERDRIVE SYSTEM: ☐ DIRECT CONNECTED
☐ GEAR (integral)
☐ OTHER

TYPE MOTOR:

☐ SQUIRREL CAGE INDUCTION ☐ NEMA DESIGN☐ SYNCHRONOUS☐ POWER FACTOR REGD. 1.0EXCITATION: ☐ BRUSHLESS ☐ SLIP RING☐ FIELD DISCHARGE RESISTOR BY MOTOR MFR.☐ WOUND ROTOR INDUCTION

ENCLOSURE:

☐ CLASS , GROUP , EXP. PROOF☐ TFC☐ TENVAC ☐ TEMP. 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☐ WEATHER PROTECTED, TYPE II☐ FORCED VENTILATED☐ OPEN/NO PROOF☐ OPEN

BASIC DATA:

☐ 13800 VOLTS 3 PHASE 60 HERTZ☐ NAMEPLATE HP 10 000 SERVICE FACTOR 1.0☐ SYNCHRONOUS RPM 1200☐ INSULATION CLASS B TYPE ☐ TEMP. RISE: 80 °C ABOVE 40 °C BY

STARTING:

☐ FULL VOLTAGE ☐ REDUCED VOLTAGE %☐ LOADED ☐ UNLOADED☐ VOLTAGE DFP %

VIBRATION:

☐ NEMA STANDARD ☐

NOTE:

☐ NEMA STANDARD ☐

ACCESSORY EQUIPMENT

☐ BASEPLATE ☐ SOLEPLATE ☐ STATOR SHFT.☐ MFR. STD. FANS ☐ NON-SPARKING FANS

D.C. EXCITATION:

☐ KW REGD. VOLTS BY: ☐ PURCHASER ☐ MANUFACTURERDESCRIPTION Brushless

ENCLOSED COLLECTOR RINGS:

☐ PURGED: MEDIUM PRESS. PSIG☐ EXPLOSION-RESISTANT NONPURGED☐ FORCED VENTILATION☐ CFM PRESS. DROP IN. H₂O

BEARING TEMP. DEVICES:

☐ LOCATION ☐ DESCRIPTION ☐ SET @ °C FOR ALARM °C FOR SHUTDOWN

SPACE HEATERS:

☐ KW ☐ 460 VOLTS 3 PHASE 60 HERTZ☐ MAX. SHEATH TEMP. °C

WINDING TEMPERATURE DETECTORS:

☐ THERMISTORS: NO/PHASE TYPE: ☐ POS. TEMP. COEFF. ☐ NEG. TEMP. COEFF.TEMPERATURE SWITCH: ☐ YES ☐ NO☐ RESISTANCE TEMPERATURE DETECTORS: NO/PHASE 2☐ RESISTANCE MATL. ☐ OHMSSELECTOR SWITCH & INDICATOR BY: ☐ PURCH. ☐ MFR.

MAX. STATOR WINDING TEMP:

117 °C FOR ALARM 130 °C FOR SHUTDOWN

WINDING TEMP. DETECTOR & SPACE HEATER LEADS:

☐ IN SAME CONDUIT BOX☐ IN SEPARATE CONDUIT BOXES

MOTOR ARRANGED FOR DIFFERENTIAL PROTECTION:

☐ SELF-BALANCE PRIMARY-CURRENT METHOD☐ C.T. DESCRIPTION 50/5 Bv Airco☐ EXTENDED LEADS ☐ LENGTH FT.

SURGE CAPACITORS:

LIGHTNING ARRESTERS:

C.T. FOR AMMETER:

☐ DESCRIPTION 1200/5 Bv Airco

MAIN CONDUIT BOX SIZED FOR:

☐ MAIN MOTOR LEADS ☐ TYPE Bus☐ INSULATED ☐ NONINSULATED☐ C.T.'S FOR DIFF. PROTECTION (MOUNTED BY Mfr)☐ SURGE CAPACITORS (MOUNTED BY Mfr)☐ LIGHTNING ARRESTERS (MOUNTED BY Mfr)☐ C.T. FOR AMMETER (MOUNTED BY Mfr)☐ SPACE FOR STRESS CONES

AIR FILTERS:

☐ MFR Std. ☐ TYPE Std.

REMARKS:

ISSUED FOR PHASE 0

Airco Cryoplants

0-251-1Z-13

ELECTRIC MOTOR DATA SHEET

MANUFACTURER'S DATA		SHOP INSPECTION AND TESTS	
MANUFACTURER <u>Later</u>			
FRAME NO. _____	FULL LOAD RPM (INCL) _____	SHOP INSPECTION	REQUIRED
EFFICIENCY: <u>97.3</u> %	<u>97.2</u> %	TESTING PER NEMA	WITNESS
POWER FACTOR (INCL) <u>97.3</u> %	<u>96.8</u> %	MFR. STD. SHOP TESTS	O
CURRENT (RATED VOLT) FULL LOAD _____	LOCKED ROTOR _____	IMMERSION TEST	O
LOCKED ROTOR POWER FACTOR _____		SPECIAL TESTS (LIST BELOW)	O
LOCKED ROTOR WITHSTAND TIME (COLD START) _____			O
TORQUES (FT-LBS): FULL LOAD <u>43,750</u>			O
LOCKED ROTOR _____	STARTING (SYN) _____		O
PULL-UP (INCL) _____	PULL-IN (SYN) _____		O
BREAKDOWN (INCL) _____	PULL-OUT (SYN) _____		O
OPEN-CIRCUIT TIME CONSTANT (SEC) _____		COUPLING	
SYMMETRICAL CONTRIBUTION TO 3R TERMINAL FAULT:		O SUPPLIED BY <u>Compressor Mfr</u>	
AT 1/2 CYCLES _____ AT 3 CYCLES _____		O MFR. <u>Std</u> ☐ MODEL <u>Later</u>	
REACTANCES: SUB-TRANSIENT (X _d) _____		O MOTOR MFR. ☐ COMP. MFR. ☐ PURCH. TO MOUNT MFR. HALF	
TRANSIENT (X _d) _____ SYNCHRONOUS (X _s) _____		PAINTING	
A.C. STATOR RESISTANCE _____ OHMS @ _____ °C		O MANUFACTURER'S STANDARD	
RATED KVA _____		O _____	
KVA INRUSH @ FULL VOLT. & LOCKED ROTOR (SYN) _____ %		SHIPMENT	
KVA @ FULL VOLTAGE & 15% SPEED _____ %		O DOMESTIC ☐ EXPORT ☐ EXPORT BOXING REQUIRED	
MAX. LINE CURR. IN STATOR ON 1ST SLIP CYC. @ FULL-OUT (SYN) _____		O OUTDOOR STORAGE OVER 3 MONTHS	
ACCELERATION TIME (MOTOR ONLY @ RATED VOLT) _____ SEC.		O _____	
ACCEL. TIME (MOTOR & LOAD @ 15% RATED VOLT) _____ SEC.		REMARKS _____	
ROTOR/FIELD WINDING MOTOR SHAFT (LB-FT) _____		_____	
ROTATION FACING COUPLING END _____		_____	
NO. OF STARTS PER HOUR _____		_____	
FIELD DISCHARGE RESISTOR _____ OHMS		_____	
RATED EXCITATION FIELD VOLTAGE _____ V.		_____	
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 REGD.		_____	
SUPPLIED BY _____		_____	
BEARINGS: TYPE _____ LUBR. _____		_____	
LUBE OIL REQUIRED: _____ GPM @ _____ PSI		_____	
TOTAL SHAFT END FLOAT _____		_____	
LIMIT END FLOAT TO _____		_____	
MOTOR ROTOR: ☐ SOLID ☐ SPLIT		_____	
MOTOR HUB: ☐ SOLID ☐ SPLIT		_____	
FOR TEWAC & TEIG MOTORS:		_____	
COOLING WATER REGD. _____ GPM		_____	
C.W. TEMP. RISE _____ °F PRESS. DROP _____ PSI		_____	
AIR (GAS) REGD. _____ SCFM PRESS. MAINT. _____ IN. H ₂ O		_____	
CURVES REGD. 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 _____		_____	

SHEET 29 OF 37

ISSUED FOR PHASE 0



PROCESS
SPECIFICATION

COMPRESSOR - EXPANDER

NO. 0-251-1Z-17

REV.

EQUIPMENT TITLE	Compressor/Expander	ITEM NO.	15-K-77
CUSTOMER	Bechtel	JOB NO.	251
LOCATION	Breckinridge, Kentucky	DATE	9/29/80
QUANTITY	One (1)	BY	A. E. APP'D BY

OPERATING CONDITIONS

		COMPRESSOR	EXPANDER
GAS HANDLED		Nitrogen	Nitrogen
NORMAL FLOW RATE	SCFM*		
NORMAL FLOW RATE	LB/HR		
DESIGN FLOW RATE	SCFM*		
DESIGN FLOW RATE	LB/HR		
INLET TEMPERATURE	°F	100	
INLET PRESSURE	PSIA		
OUTLET TEMPERATURE	°F	By Vendor	By Vendor
OUTLET PRESSURE	PSIA	Note 1	
MOLECULAR WEIGHT @ INLET		28.0134	28.0134
CALCULATED THEO. WORK @ CONSTANT "S"	BTU/#		
EXPANDER EFFICIENCY	%		By Vendor
ACTUAL EXPANDER WORK (THEO. WORK X EFF.)	BTU/#		By Vendor
EXPANDER BHP AT NORMAL FLOW RATE**	BHP		By Vendor
EXPANDER BHP AT DESIGN FLOW RATE**	BHP		By Vendor
EXPECTED SHAFT LOSS AT NORMAL FLOW RATE BHP			By Vendor
EXPECTED SHAFT LOSS AT DESIGN FLOW RATE BHP			By Vendor
BHP AVAIL. FOR COMPRESSOR(NORMAL FLOW RATE)	BHP		By Vendor
BHP AVAIL. FOR COMPRESSOR(DESIGN FLOW RATE)	BHP		By Vendor

1. To be specified by vendor and then become part of vendor guarantee.

2. Compressor expanders to be Airco Cryogenics Model TC 6000/TC 12,000 as supplied on A.C.D. work order 42764.

*MEASURED AT 14.7 PSIA & 70°F

**NOT INCLUDING SHAFT LOSSES

WRITTEN BY

DATE

APPROVED

SHEET NO 30 of 37

 ISSUED FOR PHASE 0 AIRCO CRYOPLANTS		PROCESS SPECIFICATION COMPRESSOR - EXPANDER		NO. 0-251-1Z-17		
				REV.		

EQUIPMENT TITLE Compressor/Expander		ITEM NO. 15-K-76	
CUSTOMER	Bechtel	JOB NO.	251
LOCATION	Breckinridge, Kentucky	DATE	9/29/80
QUANTITY	One (1)	BY A. E.	APP'D BY

OPERATING CONDITIONS			
		COMPRESSOR	EXPANDER
GAS HANDLED		Nitrogen	Nitrogen
NORMAL FLOW RATE	SCFM*		
NORMAL FLOW RATE	LB/HR		
DESIGN FLOW RATE	SCFM*		
DESIGN FLOW RATE	LB/HR		
INLET TEMPERATURE	°F	Note 1	
INLET PRESSURE	PSIA	Note 2	
OUTLET TEMPERATURE	°F	By Vendor	By Vendor
OUTLET PRESSURE	PSIA	Note 3	
MOLECULAR WEIGHT @ INLET		28.0134	28.0134
CALCULATED THEO. WORK @ CONSTANT "S"	BTU/#		By Vendor
EXPANDER EFFICIENCY	%		By Vendor
ACTUAL EXPANDER WORK (THEO. WORK X EFF.)	BTU/#		By Vendor
EXPANDER BHP AT NORMAL FLOW RATE**	BHP		By Vendor
EXPANDER BHP AT DESIGN FLOW RATE**	BHP		By Vendor
EXPECTED SHAFT LOSS AT NORMAL FLOW RATE BHP			By Vendor
EXPECTED SHAFT LOSS AT DESIGN FLOW RATE BHP			By Vendor
BHP AVAIL. FOR COMPRESSOR (NORMAL FLOW RATE)	BHP		By Vendor
BHP AVAIL. FOR COMPRESSOR (DESIGN FLOW RATE)	BHP		By Vendor

1. Same as temperature leaving compressor part of CE-77.
 2. 2 psi less than discharge pressure part of CE-77.
 3. To be specified by vendor and then become part of vendor guarantee.

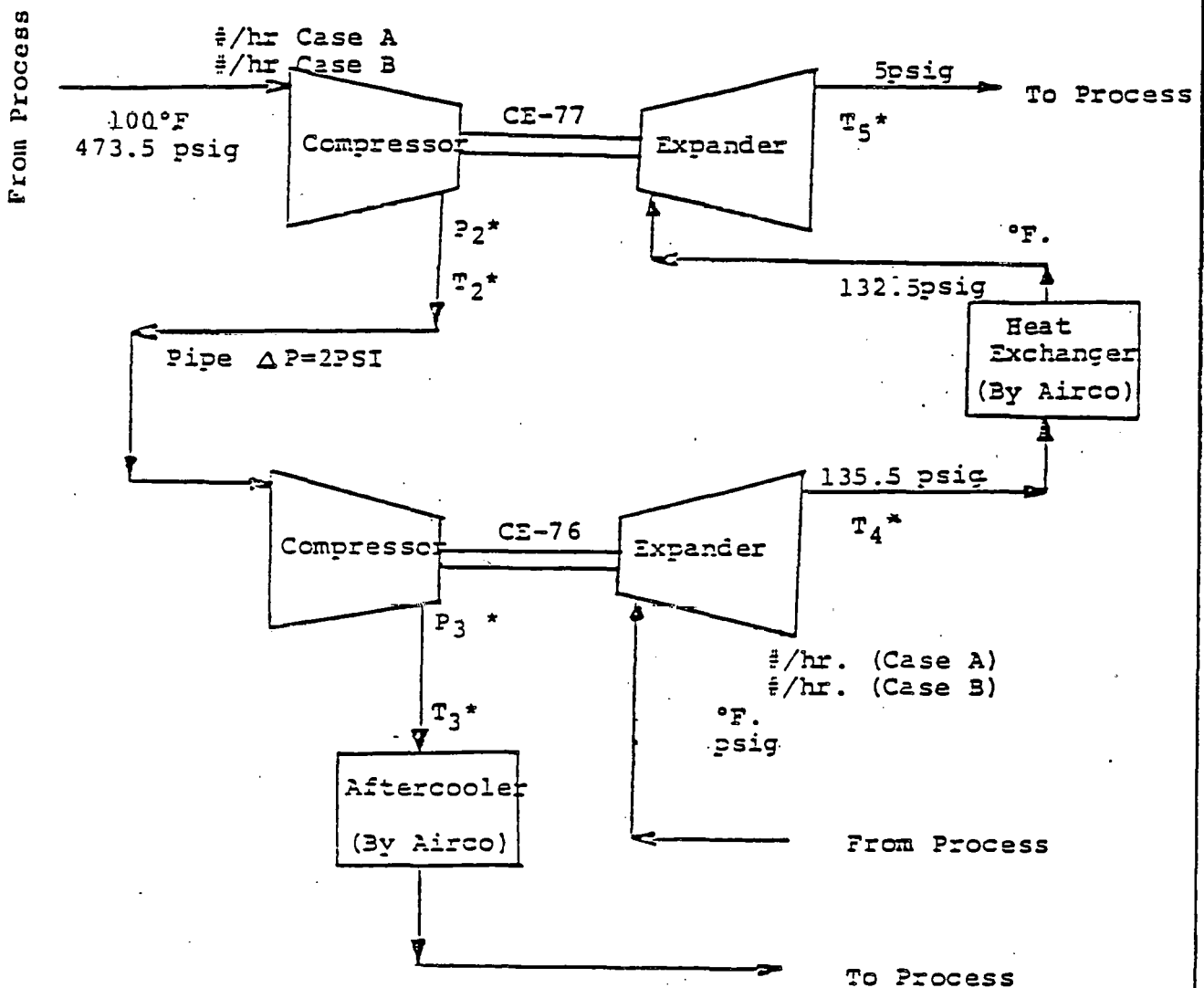
*MEASURED AT 14.7 PSIA & 70°F
 **NOT INCLUDING SHAFT LOSSES

SHEET NO. 31 of 37

TITLE

FIGURE #1 - FLOW SCHEMATIC

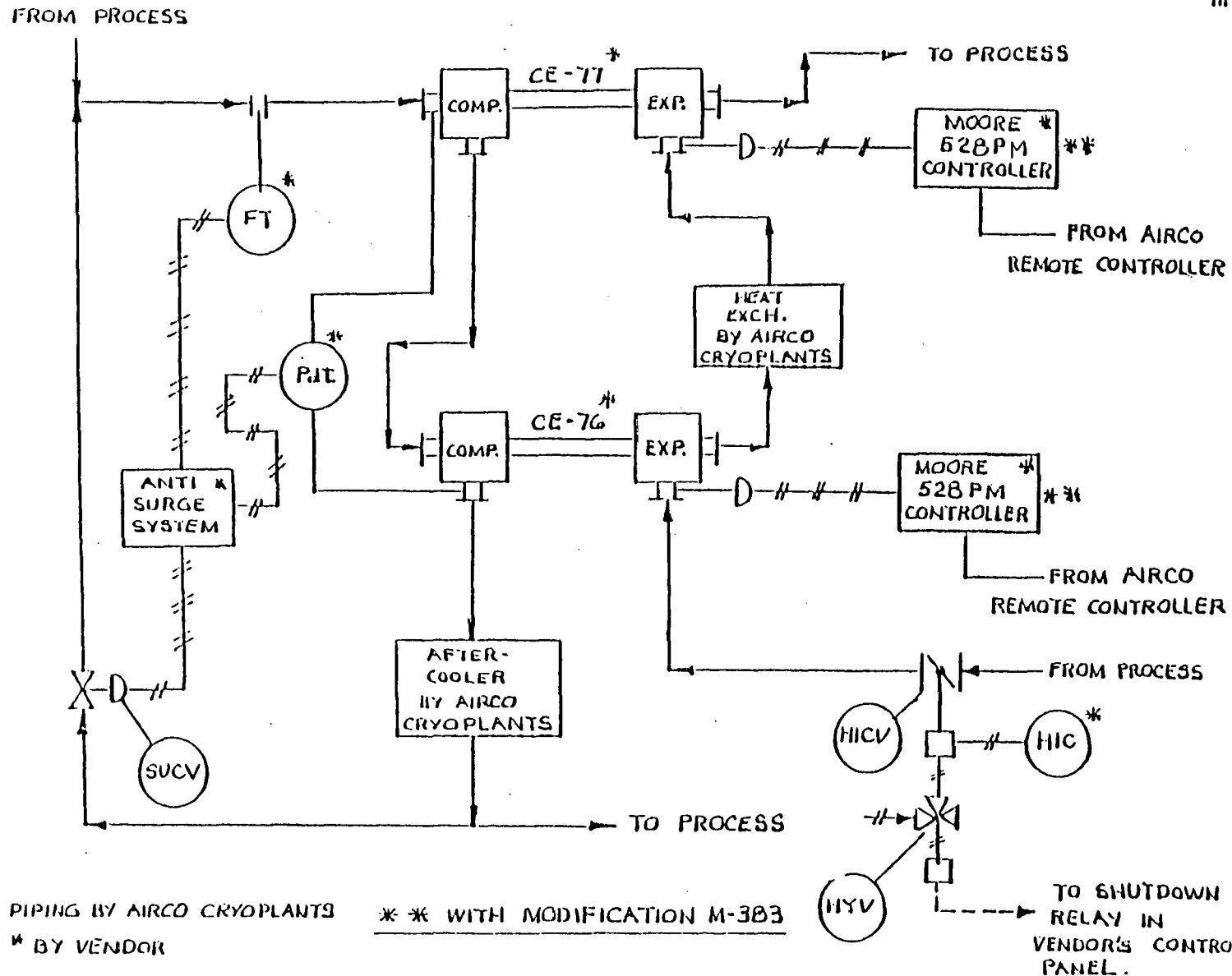
CLASSIFICATION
A - ACCESS



* By Vendor

All Shown Piping By Airco Cryoplants

FIGURE 2 - CONTROL SYSTEM SCHEMATIC



TITLE

AIRCO CRYOPLANTS

- ☐ STANDARDS
- ☐ INSTRUCTIONS
- ☒ SPECIFICATIONS
- ☐ DATA

NO. 0-251-12-17

APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT DATE _____ REVISION 0-251-12-57
 FOR Bechtel UNIT Air Separation Plant
 SITE Breckinridge, Kentucky SERIAL NO. _____
 SERVICE Argon Compressor K-41 15K-21 NO. REQUIRED 1
 MANUFACTURER Clark - I.R. MODEL _____ DRIVER Electric Motor
 NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ☐ BY MANUFACTURER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)		OTHER CONDITIONS			
NORMAL	RATED	A	B	C	D
<u>Argon</u>	<u>Argon</u>				
<u>3930</u>	<u>4205</u>				
<u>24,382</u>	<u>26,088</u>				
<u>18.8</u>	<u>18.8</u>				
<u>79</u>	<u>79</u>				
<u>—</u>	<u>—</u>				
<u>39.2</u>	<u>39.2</u>				
<u>1.64</u>					
<u>3930</u>	<u>4205</u>				
<u>80</u>	<u>80</u>				
<u>280</u>	<u>260</u>				
<u>1.64</u>	<u>1.64</u>				
<u>1.0</u>	<u>1.0</u>				
<u>660</u>	<u>700</u>				

☐ GAS HANDLED (ALSO SEE PAGE _____)
☐ MMSCFD/SCFM (14.7 PSIA & 60°F DRY)
☐ WEIGHT FLOW, LB/HR (WET) (DRY)
 INLET CONDITIONS
☐ PRESSURE (PSIA)
☐ TEMPERATURE (°F)
☐ RELATIVE HUMIDITY (%)
☐ MOLECULAR WEIGHT (M)
☐ C_p/C_v (K) OR (R_{avg})
☐ COMPRESSIBILITY (Z₁) OR (Z_{avg})
☐ INLET VOLUME, ICFM (WET)
 DISCHARGE CONDITIONS
☐ PRESSURE (PSIA)
☐ TEMPERATURE (°F)
☐ C_p/C_v (K) OR (R_{avg})
☐ COMPRESSIBILITY (Z₂) OR (Z_{avg})
☐ SHP REQUIRED (ALL LOSSES INCL)
☐ SPEED (RPM)
☐ ESTIMATED SURGE, ICFM (AT SPEED ABOVE)
☐ POLYTROPIC HEAD (FT)
☐ POLYTROPIC EFFICIENCY (%)
☐ GUARANTEE POINT
☐ PERFORMANCE CURVE NO.

PROCESS CONTROL
 METHOD: ☐ BYPASS FROM Aftercooler Outlet TO Suction
☐ ANTI-SURGE BYPASS ☐ MANUAL ☐ AUTO
☐ SUCTION THROTTLING FROM _____ TO _____
☐ SPEED VARIATION FROM _____ TO _____
☐ OTHER _____
 SIGNAL: ☐ SOURCE _____
☐ TYPE _____
☐ RANGE: FOR PNEUMATIC CONTROL _____ RPM @ _____ PSIG A _____ PSIG B _____ PSIG C _____
 OTHER _____

REMARKS _____

REQUIRED FOR HAZOP ESTIMATE

NO.	DATE	REVISIONS	BY	CHECK	DESIGN SUPV	ENG. B	PROJ ENGR	APPR
SCALE		DESIGNED	DRAWN		CHIEF ENGR			



CENTRIFUGAL COMPRESSOR DATA SHEET

JOB NO.

DRAWING NO.

REV.

DS- K

0-251-1E-37

GAS ANALYSIS		OTHER CONDITIONS				REMARKS	
MOL %	NORMAL	RATED	A	B	C		D
AIR	20.946						
OXYGEN	20.900		1.34				
NITROGEN	78.016		1.56				
WATER VAPOR	12.016		.42				
CARBON MONOXIDE	25.010						
CARBON DIOXIDE	44.010						
HYDROGEN SULFIDE	34.076						
HYDROGEN	2.016		.95				
METHANE	16.042						
ETHYLENE	28.052						
ETHANE	30.068						
PROPYLENE	42.078						
PROPANE	44.094						
i - BUTANE	58.120						
s - BUTANE	58.120						
i - PENTANE	72.146						
s - PENTANE	72.146						
HEXANE PLUS							
Argon			95.73				
TOTAL			100.00				
AVG. MOL. WT.			39.21				

LOCATION:

☐ INDOOR ☒ HEATED ☐ UNDER ROOF

☐ OUTDOOR ☐ UNHEATED ☐ PARTIAL SIDES

☐ GRADE ☐ MEZZANINE ☐

☐ ELECTRICAL AREA CLASS 1 OR D DIV. 2

☐ WINTERIZATION REQ. ☐ TROPICALIZATION REQ.

SITE DATA: - SEE 14222-A-3

☐ ELEVATION _____ FT. BAROMETER _____ PSIA

☐ RANGE OF AMBIENT TEMPS _____

	<u>DRY BULB</u>	<u>WET BULB</u>
SITE RATED °F	<u>96</u>	<u>78</u>
NORMAL °F	<u>110</u>	
MAXIMUM °F	<u>-10</u>	
MINIMUM °F		

UNUSUAL CONDITIONS: ☐ GUST ☐ FUMES

☒ OTHER Cool Processing Facility

NOISE SPECIFICATIONS:

☐ APPLICABLE TO MACHINE:
SEE SPECIFICATION Airco Spec.

☐ APPLICABLE TO NEIGHBORHOOD
SEE SPECIFICATION _____

ACOUSTIC HOUSING: ☐ YES ☐ NO

APPLICABLE SPECIFICATIONS:

API 617 CENTRIFUGAL COMP. FOR GEN. REFINERY SERVICES

PAINTING:

☐ MANUFACTURER'S STD.

☐ OTHERS _____

SHIPMENT:

☐ DOMESTIC ☐ EXPORT ☐ EXPORT BOXING REQ.

☐ OUTDOOR STORAGE OVER 3 MONTHS

REMARKS _____

CENTRIFUGAL COMPRESSOR DATA SHEET

0-251-12-37

CONSTRUCTION FEATURES

☐ SPEEDS: Later
 MAX. CONT. RPM _____ TRIP _____ RPM
 CRITICALS: 1ST _____ RPM 2ND _____ RPM
 MAX. TIP SPEED: _____ FPS @ RATED SPEED
 _____ FPS @ MAX. CONT. SPEED

☐ ROTATION, VIEWED FROM DRIVEN END:

☐ CASING

MODEL _____

CASING SPLIT Horizontal

MATERIAL Cast 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 (CFM) _____

RADIOGRAPH QUALITY ☐ YES ☐ NO

☐ DIAPHRAGMS

MATERIAL _____

☐ IMPELLERS

NO. 3 DIAMETERS _____

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 Alloy Steel

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

SHAFT END: ☐ TAPERED ☐ CYLINDRICAL

SHAFT SLEEVES

☐ AT INTERST. CLOSE CLEAR. PTL. ☐ MATL. _____

☐ AT SHAFT SEALS _____ ☐ MATL. _____

☐ LABYRINTHS

TYPE _____ MATERIAL _____

SHAFT SEALS

☐ TYPE Vendor Std.

☐ SEAL SYSTEM TYPE _____

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

☐ TYPE BUFFER GAS N₂ Available

☐ BUFFER GAS FLOW (PER SEAL) _____

NORMAL: _____ G/MIN @ _____ PSI ΔP

MAX.: _____ G/MIN @ _____ PSI ΔP

☐ BEARING HOUSING CONSTRUCTION

TYPE (SEPARATE, INTEGRAL) _____ SPLIT _____

MATERIAL _____

☐ RADIAL BEARINGS

TYPE _____ SPAN (IN.) _____

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

☐ THRUST BEARING

LOCATION _____ TYPE _____

NO. _____ AREA (IN.²) _____

LOADING (PSI) ACTUAL _____ ALLOWABLE _____

GAS LOADING (LBS) _____ CPLG. SLIP LOAD (LBS) _____

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

BAL. PISTON COMPENSATING LOAD _____ LBS.

☐ MAIN CONNECTIONS

	SIZE	ANSI RATING	FACING	POSITION
INLET	8			
DISCHARGE	6			

☐ ALLOWABLE PIPING FORCES AND MOMENTS

	INLET		DISCHARGE			
	FORCE LB	MOMT LB	FORCE LB	MOMT LB	FORCE LB	MOMT LB
AXIAL						
VERTICAL						
HORIZ. 30°						
AXIAL						
VERTICAL						
HORIZ. 30°						

☐ 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 FLOW			
ERG. HOUSING			
BETWEEN ERG. & SEAL			
BETWEEN SEAL & GAS			
SOLVENT INJECTION			

REMARKS

0-251-13-37

<u>VIBRATION DETECTORS</u>		<u>SHOP INSPECTION AND TESTS</u>																													
☐ TYPE <u>Displacement</u> ☐ MODEL _____ ☐ MFR <u>Bently Nevada or Equal</u> ☐ NO. AT EACH SHAFT BEARING <u>2</u> TOTAL NO. <u>4</u> ☐ OSCILLATOR-DETECTORS SUPPLIED BY <u>Vendor</u> ☐ MFR _____ ☐ MODEL _____ ☐ MONITOR SUPPLIED BY <u>Airco</u> ☐ LOCATION <u>Panel</u> ENCLOSURE _____ ☐ MFR. <u>B-N or Equal</u> ☐ MODEL _____ ☐ SCALE RANGE _____ ☐ ALARM ☐ SET @ _____ MILS ☐ SHUTDOWN: ☐ SET @ _____ MILS ☐ TIME DELAY <u>3</u> SEC.	RECD. _____ WITNESS _____ SHOP INSPECTION ☐ HYDROSTATIC ☐ HELIUM LEAK ☐ MECHANICAL RUN ☐ 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 PROBE, ETC. ☐ USE JOB VIS. & AXIAL CMP. PROBES. ☐ OSCILLATOR-DETECTORS & MONITOR ☐ PRESSURE COMP. TO FULL OPER. PRESS. ☐ DISEMBLE-RESEMBLE COMP. AFTER TEST ☐ CHECK BRGS & SEALS AFTER TEST ☐ MORE LEVEL TEST ☐ _____ ☐ _____ ☐																														
<u>AXIAL MOVEMENT DETECTOR:</u> ☐ TYPE <u>Displacement</u> ☐ MODEL _____ ☐ MFR <u>B-N or Equal</u> ☐ NO REQUIRED <u>1</u> ☐ OSCILLATOR-DETECTORS SUPPLIED BY <u>Vendor</u> ☐ MFR. <u>B-N or Equal</u> ☐ MODEL _____ ☐ MONITOR SUPPLIED BY <u>Airco</u> ☐ LOCATION <u>Panel</u> ENCLOSURE _____ ☐ MFR. <u>B-N or Equal</u> ☐ MODEL _____ ☐ SCALE RANGE _____ ☐ ALARM ☐ SET @ _____ MILS ☐ SHUTDOWN: ☐ SET @ _____ MILS ☐ TIME DELAY <u>3</u> SEC.	REMARKS: _____ _____ _____																														
<u>COUPLINGS:</u> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <thead> <tr> <th style="width: 40%;"></th> <th style="width: 30%;">DRIVER-COMP. OR DRIVER-GEAR</th> <th style="width: 30%;">GEAR-COMP.</th> </tr> </thead> <tbody> <tr><td>☐ MAKE _____</td><td></td><td></td></tr> <tr><td>☐ MODEL _____</td><td></td><td></td></tr> <tr><td>☐ LUBRICATION _____</td><td></td><td></td></tr> <tr><td>☐ MOUNT CPLG. HALVES _____</td><td></td><td></td></tr> <tr><td>☐ SPACER REQ. _____</td><td></td><td></td></tr> <tr><td>☐ LIMITED ENG FLOAT REQ. _____</td><td></td><td></td></tr> <tr><td>☐ IDLING ADAPTOR REQ. _____</td><td></td><td></td></tr> <tr><td>☐ CPLG. RATING (HP/100 RPM) _____</td><td></td><td></td></tr> <tr><td>☐ KEYED (1) OR (2); OR HYD. FIT _____</td><td></td><td></td></tr> </tbody> </table>		DRIVER-COMP. OR DRIVER-GEAR	GEAR-COMP.	☐ MAKE _____			☐ MODEL _____			☐ LUBRICATION _____			☐ MOUNT CPLG. HALVES _____			☐ SPACER REQ. _____			☐ LIMITED ENG FLOAT REQ. _____			☐ IDLING ADAPTOR REQ. _____			☐ CPLG. RATING (HP/100 RPM) _____			☐ KEYED (1) OR (2); OR HYD. FIT _____			☐ WEIGHTS (LBS): Later COMP. _____ GEAR _____ DRIVER _____ BASE _____ ROTORS: COMP. _____ DRIVER _____ GEAR _____ COMP. UPPER CASE _____ LG. CONSOLE _____ LG. CONSOLE _____ MAX. FOR MAINTENANCE IDENTIFY _____ TOTAL SHIPPING WEIGHT _____
	DRIVER-COMP. OR DRIVER-GEAR	GEAR-COMP.																													
☐ MAKE _____																															
☐ MODEL _____																															
☐ LUBRICATION _____																															
☐ MOUNT CPLG. HALVES _____																															
☐ SPACER REQ. _____																															
☐ LIMITED ENG FLOAT REQ. _____																															
☐ IDLING ADAPTOR REQ. _____																															
☐ CPLG. RATING (HP/100 RPM) _____																															
☐ KEYED (1) OR (2); OR HYD. FIT _____																															
<u>BASEPLATE & SOLEPLATES:</u> SOLEPLATES FOR: ☐ COMPRESSOR ☐ GEAR ☐ DRIVER BASEPLATE: ☐ COMMON (UNDER COMP., GEAR & DRIVER) ☐ UNDER COMP. ONLY ☐ OTHER _____ ☐ CHECKED WITH NON-SKID DECK PLATE ☐ OPEN CONSTR. ☐ DRIP RL. ☐ WITH OPEN DRAIN ☐ HORIZ. ADJUSTING SCREWS FOR EQUIPMENT ☐ SUITABLE FOR POINT SUPPORT ☐ SUITABLE FOR PERIMETER SUPPORT	☐ SPACE REQUIREMENTS (FEET & INCHES): COMPLETE UNIT: L _____ W _____ H _____ LG. CONSOLE: L _____ W _____ H _____ LG. CONSOLE: L _____ W _____ H _____																														
☐ TOTAL UTILITY CONSUMPTION: COOLING WATER _____ GPM STEAM, NORMAL _____ // HR STEAM, MAX. _____ // HR INSTRUMENT AIR _____ SCFM HP (DRIVER) _____ HP HP (AUXILIARIES) _____ HP	<u>MISCELLANEOUS</u> ☐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION _____ ☐ VENDOR'S REVIEW & COMMENTS ON PURCHASERS' Piping & FOUNDATION _____ ☐ OPTICAL ALIGNMENT FLATS REQUIRED ON COMPRESSOR, GEAR & DRIVER _____ ☐ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY _____ ☐ TORSIONAL ANALYSIS REPORT REQUIRED _____ _____ _____ _____ _____ _____																														
REMARKS: _____ _____ _____																															

4.6 Data Sheets for Miscellaneous Equipment

0-251-1Z-4: Air Compressor Silencer (15Y-116)

0-251-1Z-7: WN₂ Silencer (15Y-212)

0-251-1Z-12: O₂ Compressor Silencer (15Y-516)

0-251-1Z-14: N₂ Compressor Silencer (15Y-557)

0-251-1Z-34: Waste Disposal Unit (15E-1)

Airco Cryopiants				☐ STANDARDS ☐ INSTRUCTIONS ☐ SPECIFICATIONS ☐ DATA				No.							
								WRITTEN BY				DATE			
								APPROVED BY <i>AE</i>				DATE <i>2/15/81</i>			
								APPROVED BY <i>VS</i>				DATE <i>3/11/81</i>			
APPROVED BY <i>HNH</i>				DATE <i>3/11/81</i>											
REVISION															
PAGE															
DATE															
WRITTEN BY															
APPROVED BY															
BRECKINRIDGE PROJECT PLANT 15 OXYGEN PLANT MISCELLANEOUS EQUIPMENT															

AIRCO

ISSUED FOR PHASE 0

AIRCO CRYOPLANTS

PROCESS
SPECIFICATION

SILENCER

I.O. 0-251-1Z-4

REV.

EQUIPMENT TITLE Air Compressor Silencer

ITEM NO. 15-4-116

CUSTOMER Bechtel

JOB NO. 251

LOCATION Breckinridge, Kentucky

DATE 9/25/80

QUANTITY Three (3)

BY A E

APP'D BY

OPERATING CONDITIONS

COMPOSITION OF GAS BEING VENTED (DRY BASIS)

Air

MOLECULAR WT. OF DRY GAS

29

DOES GAS CONTAIN ANY WATER

☒ YES☐ NO

IS GAS SATURATED WITH WATER

☐ YES☒ NODOES GAS CONTAIN MOISTURE OTHER THAN H₂O☐ YES☒ NOIS GAS SATURATED WITH MOISTURE OTHER THAN H₂O☐ YES☒ NOCOMPOSITION OF MOISTURE IF DIFFERENT THAN H₂O

MOLECULAR WT. OF MOISTURE

18

GAS INLET TEMPERATURE

256

°F

VAPOR PRESS. OF MOISTURE AT INLET TEMP.

33.11

PSIA

NORMAL OPERATING PRESSURE

102.6

PSIA

MAX. OPERATING PRESSURE

110

PSIA

DESIGN PRESSURE

125

PSIA

110.3

PSIG

NORMAL FLOW RATE (DRY GAS)

151.822

SCFM*

682.380

LB/HR

DESIGN FLOW RATE (DRY GAS)

160.000

SCFM*

719.100

LB/HR

NORMAL FLOW RATE (MOISTURE)

6500

LB/HR

DESIGN FLOW RATE (MOISTURE)

6850

LB/HR

DEW POINT OF INLET GAS (MEASURED @ 14.7 PSIA)

-313

°F

LBS. MOISTURE PER LB. DRY GAS AT INLET

0.012

- Exit gas velocity not to exceed 12,000 ft/minute.
- Structural design of silencer to be based on an exit gas velocity of 18,000 ft/min.
- Maximum attenuated noise level shall be 80 dba measured at a distance of 25 feet parallel to the silencer discharge. Assume unit is mounted next to a reflective surface. Materials to be carbon steel. Non-metallic internals shall be non-combustable.

*MEASURED AT 14.7 PSIA & 70°F

WRITTEN BY

DATE

APPROVED

SHEET NO

2 OF 6

AIRCO

ISSUED FOR PHASE 0

AIRCO CRYOPLANTS

PROCESS
SPECIFICATION

SILENCER

NO. 0-251-1Z-7

REV.

EQUIPMENT TITLE WN₂ Silencer

ITEM NO. 15-Y-212

CUSTOMER Bechtel

JOB NO. 251

LOCATION Breckinridge, Kentucky

DATE 10/28/80

QUANTITY Twenty-four

BY R. R.

APP'D BY

OPERATING CONDITIONS

COMPOSITION OF GAS BEING VENTED (DRY BASIS) 97.5% N₂, 2% O₂, 0.5% Ar

MOLECULAR WT. OF DRY GAS 28.16

DOES GAS CONTAIN ANY WATER

☒ YES☐ NO

IS GAS SATURATED WITH WATER

☐ YES☒ NODOES GAS CONTAIN MOISTURE OTHER THAN H₂O☐ YES☒ NOIS GAS SATURATED WITH MOISTURE OTHER THAN H₂O☐ YES☒ NOCOMPOSITION OF MOISTURE IF DIFFERENT THAN H₂O —

MOLECULAR WT. OF MOISTURE

18

GAS INLET TEMPERATURE

84

°F

VAPOR PRESS. OF MOISTURE AT INLET TEMP.

0.015

PSIA

NORMAL OPERATING PRESSURE

14.5

PSIA

MAX. OPERATING PRESSURE

15.0

PSIA

DESIGN PRESSURE

25

PSIA

10.3

PSIG

NORMAL FLOW RATE (DRY GAS)

24,732

SCFM*107.530

LB/HR

DESIGN FLOW RATE (DRY GAS)

25,970

SCFM* 112.910

LB/HR

NORMAL FLOW RATE (MOISTURE)

73.5

LB/HR

DESIGN FLOW RATE (MOISTURE)

77.2

LB/HR

DEW POINT OF INLET GAS (MEASURED @ 14.7 PSIA)

-3

°F

LBS. MOISTURE PER LB. DRY GAS AT INLET

.000684

- Exit gas velocity not to exceed 12,000 ft/minute.

- Structural design of silencer to be based on an exit gas velocity of 18,000 ft/min.

- Maximum attenuated noise level shall be 80 dba measured at a distance of 25 feet parallel to the silencer discharge. Assume unit is mounted next to a reflective surface. Materials to be carbon steel. Non-metallic internals shall be non-combustable.

*MEASURED AT 14.7 PSIA & 70°F

WRITTEN BY

DATE

APPROVED

SHEET NO

3 OF 6



AIRCO CRYOPLANTS

PROCESS
SPECIFICATION
SILENCER

NO. 0-251-1Z-12

REV.

ISSUED FOR PHASE 0

EQUIPMENT TITLE O₂ Compressor Silencer

ITEM NO 15-Y-516

CUSTOMER Bechtel

JOB NO. 251

LOCATION Breckinridge, Kentucky

DATE 10/28/80

QUANTITY Three

BY R. R.

APP'D BY

OPERATING CONDITIONS

COMPOSITION OF GAS BEING VENTED (DRY BASIS)

Oxygen

MOLECULAR WT. OF DRY GAS

32

DOES GAS CONTAIN ANY WATER

☐

YES

☒

NO

IS GAS SATURATED WITH WATER

☐

YES

☒

NO

DOES GAS CONTAIN MOISTURE OTHER THAN H₂O☐

YES

☒

NO

IS GAS SATURATED WITH MOISTURE OTHER THAN H₂O☐

YES

☒

NO

COMPOSITION OF MOISTURE IF DIFFERENT THAN H₂O

—

MOLECULAR WT. OF MOISTURE

—

GAS INLET TEMPERATURE

264

°F

VAPOR PRESS. OF MOISTURE AT INLET TEMP.

—

PSIA

NORMAL OPERATING PRESSURE

950

PSIA

MAX. OPERATING PRESSURE

975

PSIA

DESIGN PRESSURE

1014.7

PSIA

1000

PSIG

NORMAL FLOW RATE (DRY GAS)

26,473

SCFM*

115,100

LB/HR

DESIGN FLOW RATE (DRY GAS)

27,800

SCFM*

120,870

LB/HR

NORMAL FLOW RATE (MOISTURE)

—

LB/HR

DESIGN FLOW RATE (MOISTURE)

—

LB/HR

DEW POINT OF INLET GAS (MEASURED @ 14.7 PSIA)

-297.

°F

LBS. MOISTURE PER LB. DRY GAS AT INLET

—

- Exit gas velocity not to exceed 12,000 ft/minute.

- Structural design of silencer to be based on an exit gas velocity of 18,000 ft/minute

- Maximum attenuated noise level shall be 80 dba measured at a distance of 25 feet parallel to the silencer discharge. Assume unit is mounted next to a reflective surface. Materials to be stainless steel. Non-metallic internals shall be noncombustible.

*MEASURED AT 14.7 PSIA & 70°F

WRITTEN BY

DATE

APPROVED

SHEET NO 4 OF 6



AIRCO CRYOPLANTS

PROCESS
SPECIFICATION

NO. 0-251-1Z-14

REV.

ISSUED FOR PHASE 0

SILENCER

EQUIPMENT TITLE N₂ Compressor Silencer

ITEM NO. 15-Y-557

CUSTOMER Bechtel

JOB NO. 251

LOCATION Breckinridge, Kentucky

DATE 10/28/80

QUANTITY One

BY R. R.

APP'D BY

OPERATING CONDITIONS

COMPOSITION OF GAS BEING VENTED (DRY BASIS)

Nitrogen

MOLECULAR WT. OF DRY GAS

28

DOES GAS CONTAIN ANY WATER

☐ YES☒ NO

IS GAS SATURATED WITH WATER

☐ YES☒ NODOES GAS CONTAIN MOISTURE OTHER THAN H₂O☐ YES☒ NOIS GAS SATURATED WITH MOISTURE OTHER THAN H₂O☐ YES☒ NOCOMPOSITION OF MOISTURE IF DIFFERENT THAN H₂O

—

MOLECULAR WT. OF MOISTURE

—

GAS INLET TEMPERATURE

95

°F

VAPOR PRESS. OF MOISTURE AT INLET TEMP.

—

PSIA

NORMAL OPERATING PRESSURE

33

PSIA

MAX. OPERATING PRESSURE

35

PSIA

DESIGN PRESSURE

50

PSIA

35.3

PSIG

NORMAL FLOW RATE (DRY GAS)

27,042

SCFM*

117,570

LB/HR

DESIGN FLOW RATE (DRY GAS)

28,400

SCFM*

123,480

LB/HR

NORMAL FLOW RATE (MOISTURE)

—

LB/HR

DESIGN FLOW RATE (MOISTURE)

—

LB/HR

DEW POINT OF INLET GAS (MEASURED @ 14.7 PSIA)

-320.

°F

LBS. MOISTURE PER LB. DRY GAS AT INLET

—

- Exit gas velocity not to exceed 12,000 ft/minute

- Structural design of silencer to be based on an exit gas velocity of
18,000 ft/minute.- Maximum attenuated noise level shall be 80 dba measured at a distance
of 25 feet parallel to the silencer discharge. Assume unit is mounted
next to a reflective surface. Materials to be carbon steel. Non-metallic
internals shall be non-combustable.

*MEASURED AT 14.7 PSIA & 70°F

WRITTEN BY

DATE

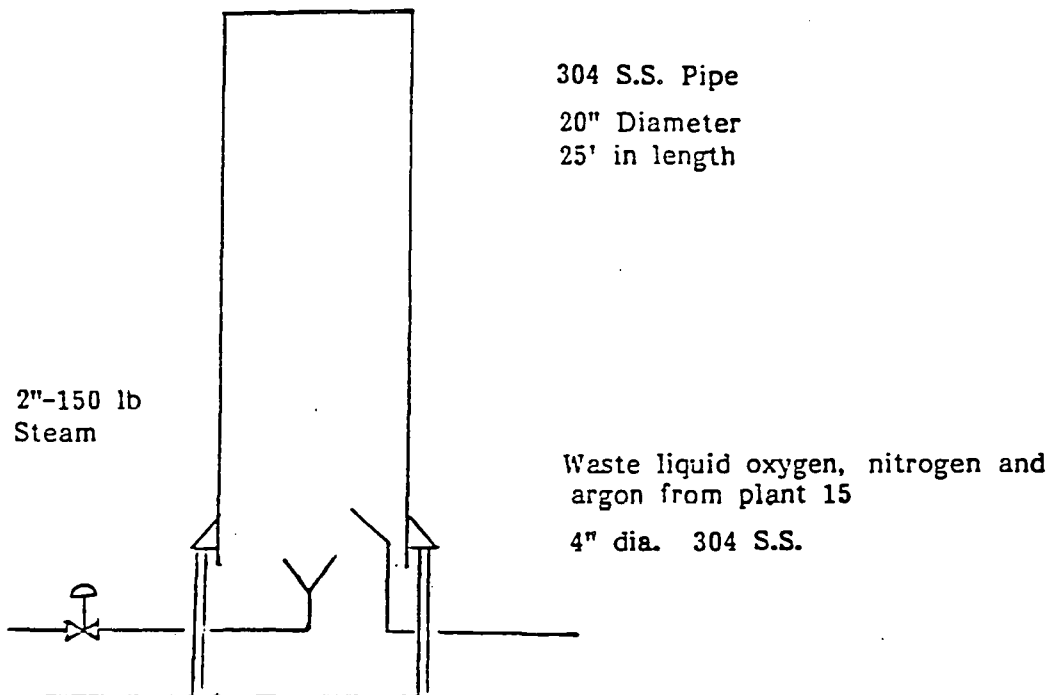
APPROVED

SHEET NO

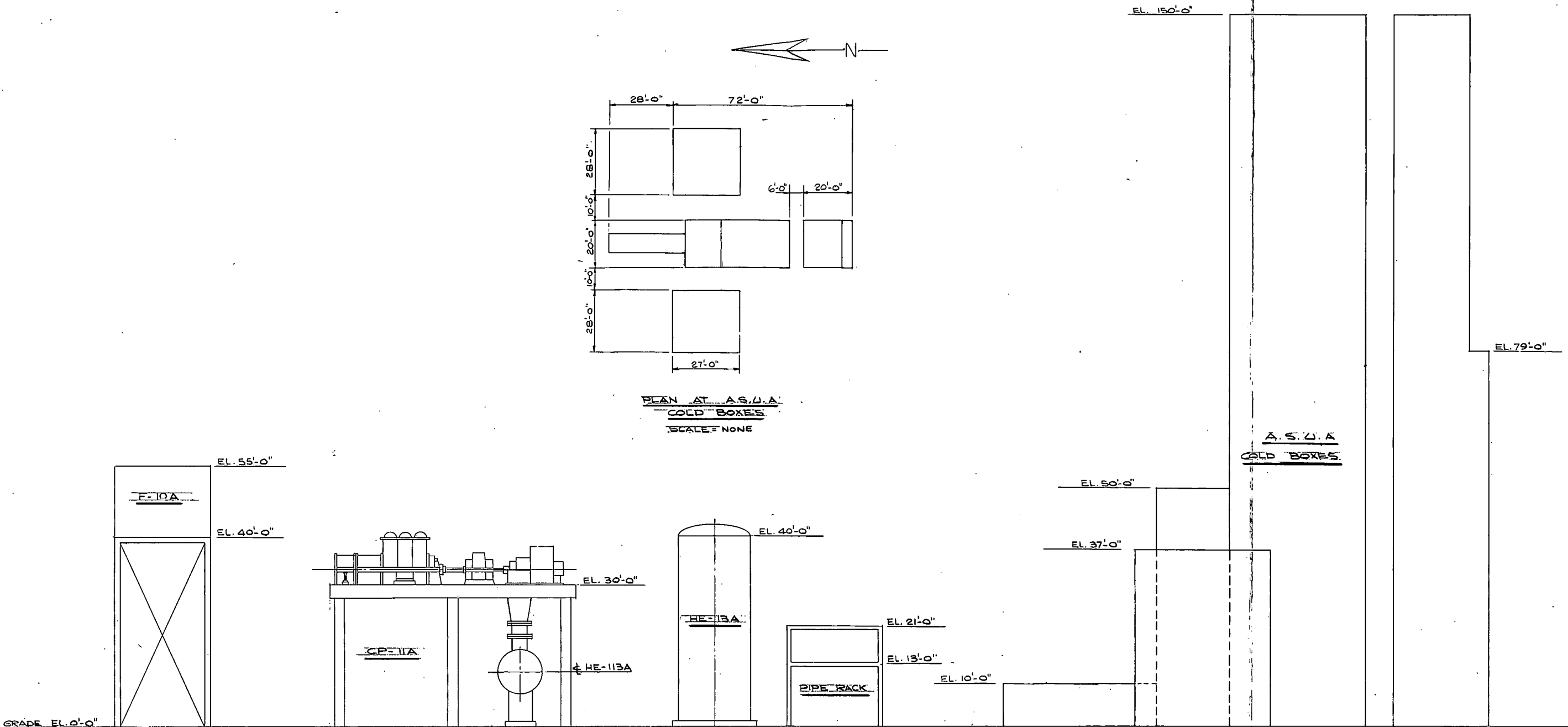
5 OF 6

TITLE WASTE DISPOSAL UNIT

WD-1



Waste liquid products, up to 450 tons per day from plant 15, are vaporized by the direct contact with steam and returned to the atmosphere.



ELEVATION @ AIR COMPRESSOR AND
COLD BOXES LOOKING EAST
SCALE = 3/32" = 1'-0"

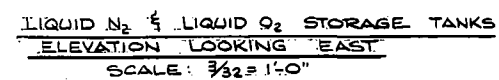
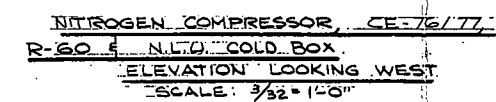
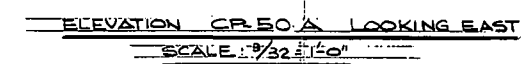
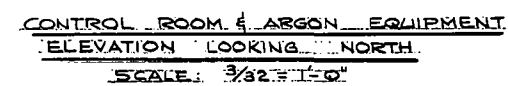
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2	1/10/82	FIRST ISSUE	D.S. J.H.					
DESIGNED J.H.			DRAWN SHALUM					
ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.			U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717					
BRECKINRIDGE COUNTY			PHASE ZERO			KENTUCKY		
AREA 15			OXYGEN PLANT					
3-1670 T/D AIR SEPARATION UNITS								
EQUIPMENT ELEVATIONS								
JOB NO.		DRAWING NO.		REV.				
14222		0-251 - 4P - 2		1				

AIRCO Corpplants

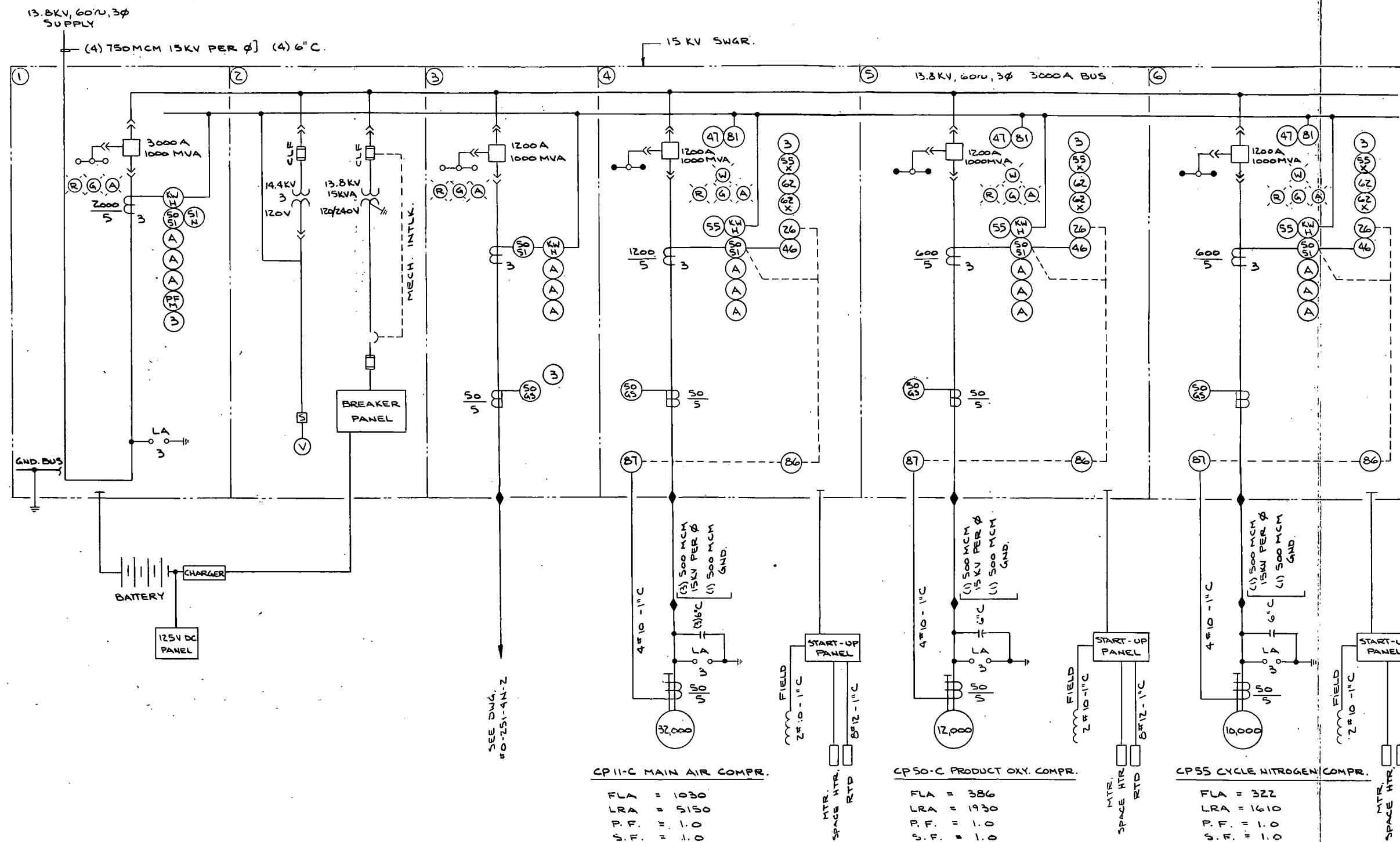


22 X 34 "D" SIZE

2-21-81
ORIGINAL
DUPLICATE



12/18/91	ISSUED FOR PHASE C						D.S.	J.H.	E.P.
12/18/91	FIRST ISSUE						D.S.	J.H.	E.P.
NO.	DATE	REVISIONS				BY	CHECK	SUPV.	ENG'D
		DESIGNED J. H.				DRAWN SHALUM			
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		
AREA 15				OXYGEN PLANT					
3-1670				T/D AIR SEPARATION UNITS					
EQUIPMENT				ELEVATIONS					
 HOUSTON	JOB NO.		DRAWING NO.				REV.		
	14222		0-251 - 4P - 3				1		



CP11-C MAIN AIR COMPR.

FLA = 1030
LRA = 5150
P.F. = 1.0
S.F. = 1.0

CP50-C PRODUCT OXY. COMPR.

FLA = 386
LRA = 1930
P.F. = 1.0
S.F. = 1.0

CP55 CYCLE NITROGEN COMPR.

FLA = 322
LRA = 1610
P.F. = 1.0
S.F. = 1.0

MAIN	AUX.	TRANSF.	CP11-C	CP50-C	CP55
BREAKER		FEEDER			
1	2	3	4	5	6

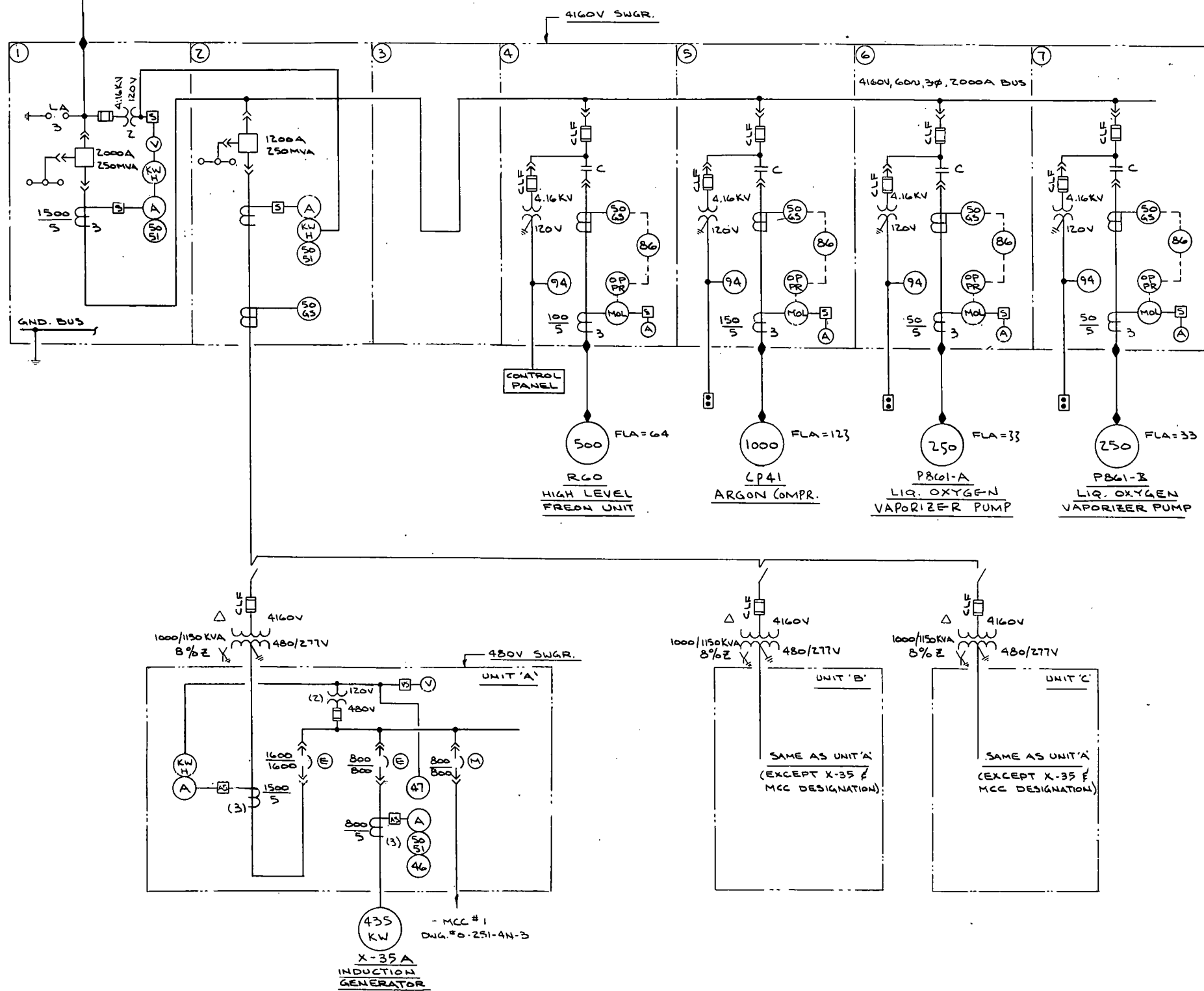
15KV SWITCHGEAR - FRONT ELEVATION
N.T.S.

DESIGNED J. VENUTO	DRAWN F.R.
ASHLAND SYNTHETIC FUELS, INC. AMCO ENERGY COMPANY, INC.	
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717	
BRECKINRIDGE PROJECT	
BRECKINRIDGE COUNTY	KENTUCKY
AREA 15	
OXYGEN PLANT	
3-1678 T/D AIR SEPARATION UNITS	
13.8KV SINGLE LINE DIAGRAM	
JOB NO. 14222	DRAWING NO. O-251-4N-1
REV. 1	

AIARGO Crvoplante



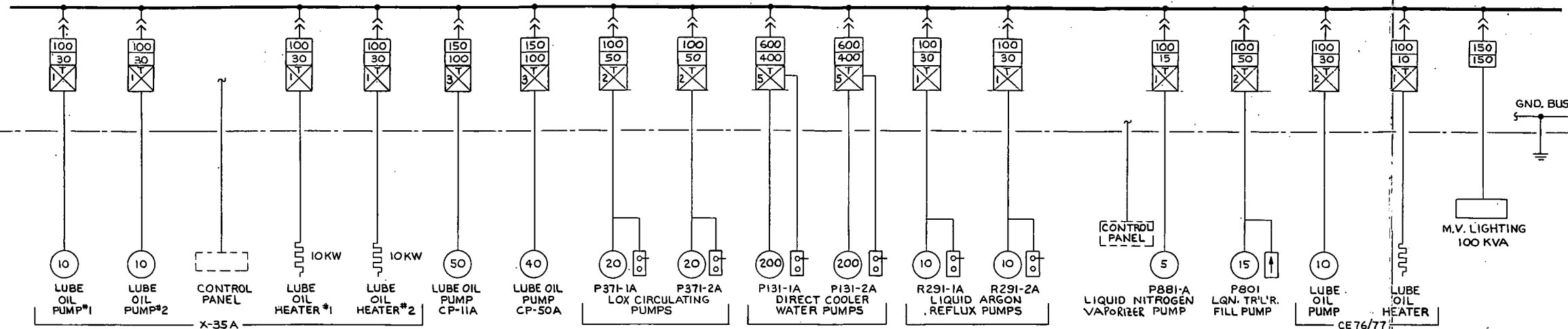
2-27-81
ORIGINAL
DUPLICATE



480V, 60 Hz, 3Ø
DWG. # 0-251-4N-2
UNIT 'A'

480 VOLT - 3Ø - 3 WIRE - 60 HZ - 800 A BUS

MOTOR CONTROL CENTER NO.1



LEGEND:

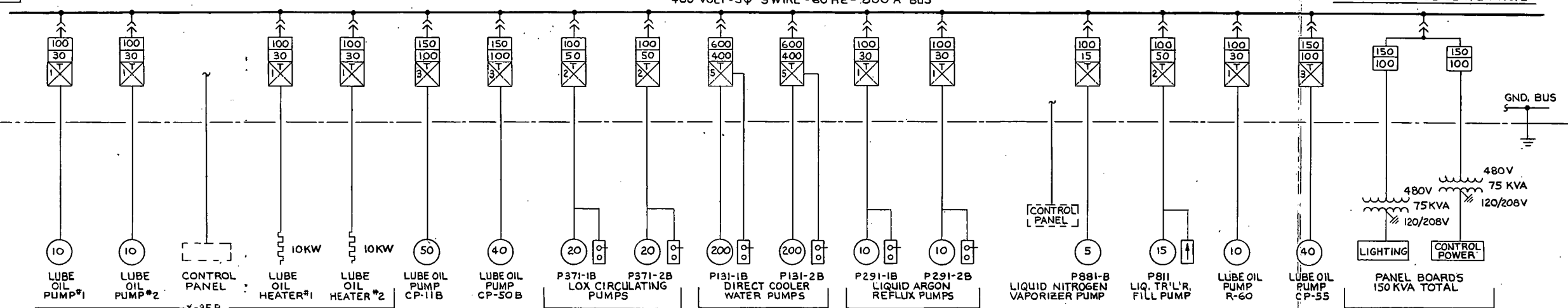
- HAND-OFF-AUTO SWITCH
- PUSH BUTTON STATION
"START-STOP" WITH LOCK-OFF STOP PUSH
- BREAKER FRAME
BREAKER TRIP CONT. RATING
480/120 V CONTROL TRANSFORMER
- NOTES (SEE BELOW)

NEMA STARTER SIZE

480V, 60 Hz, 3Ø
DWG. # 0-251-4N-2
UNIT 'B'

480 VOLT - 3Ø - 3 WIRE - 60 HZ - 800 A BUS

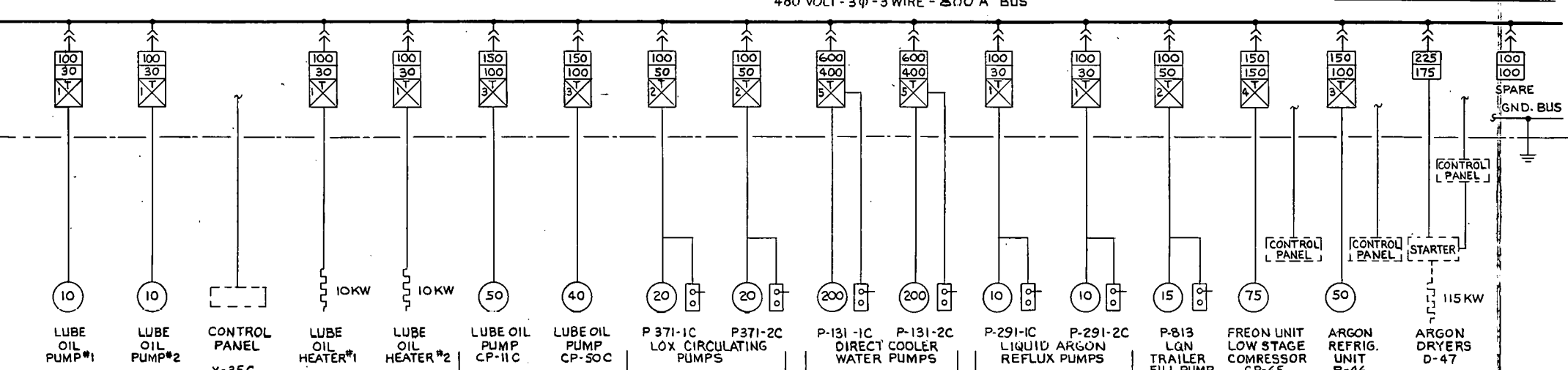
MOTOR CONTROL CENTER NO.2



480V, 60 Hz, 3Ø
DWG. # 0-251-4N-2
UNIT 'C'

480 VOLT - 3Ø - 3 WIRE - 800 A BUS

MOTOR CONTROL CENTER NO.3



NO.	DATE	REVISIONS	BY	CHK	SUPV.	ENGR.	SI	ASST
1-18-81		GENERAL REVISION	J.V.	J.H.				
12-11-80		ISSUED FOR PHASE 0	EH	J.V.				
12-11-80		FIRST ISSUE	EH	J.V.				

DESIGNED J.VENUTO DRAWN EH

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

AREA 15 OXYGEN PLANT

3 - 1670 T/D AIR SEPARATION UNITS

480V MCC'S - SINGLE LINE DIAGRAM

AIRCO Cryoplants

BECHTEL
HOUSTON

JOB NO.	DRAWING NO.	REV.
14222	0-251-4N-3	2

DUPLICATE ORIGINAL 2-27-81

15-G-114-1A & 2A
(P-114-1A & 2A)
CONDENSATE PUMPS

15-Y-10A
(F-10A)
INLET AIR FILTER

15-K-1A
(K-1A)
STEAM TURBINE

15-E-113A
(HE-113A)
SURFACE CONDENSER

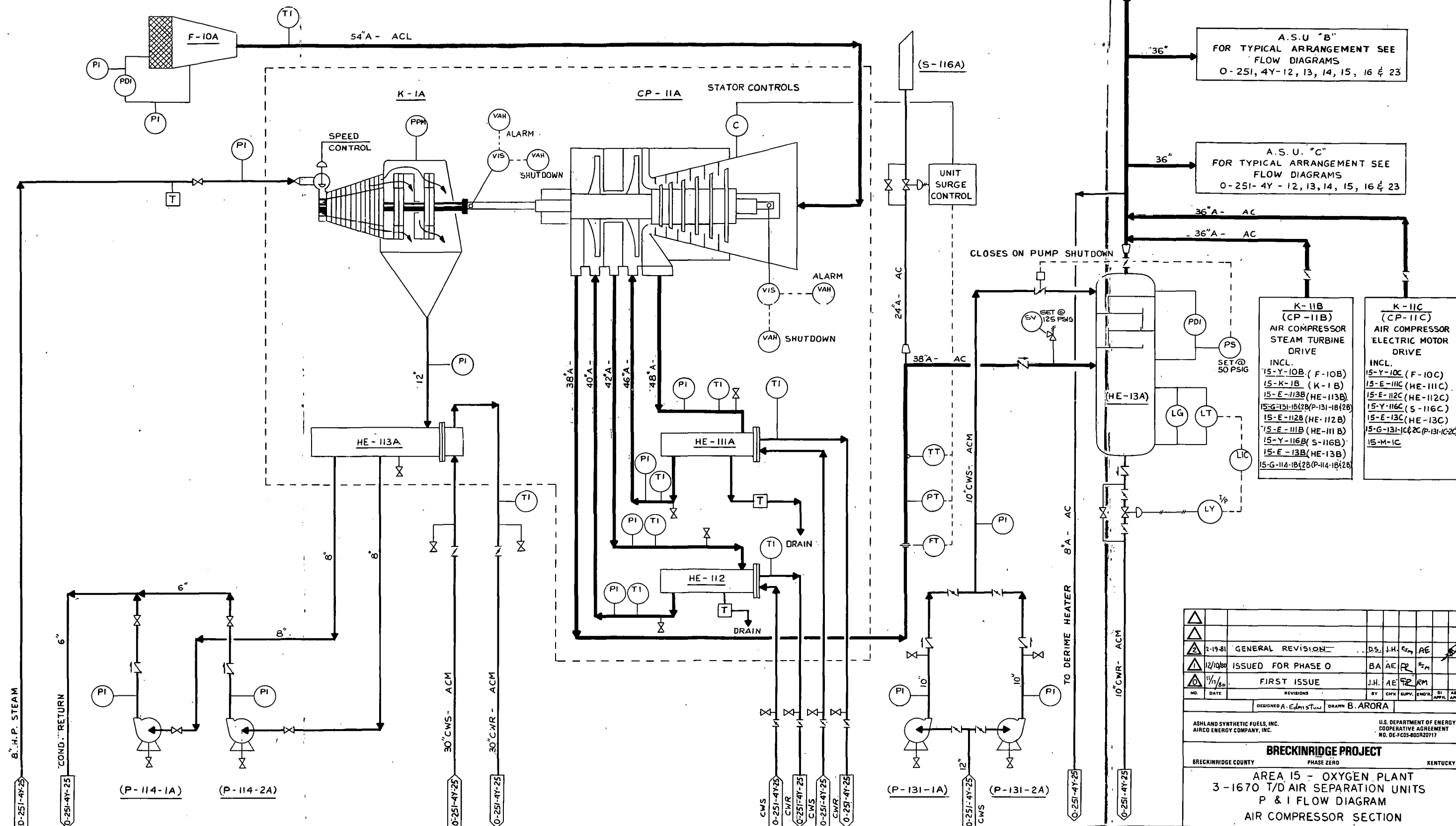
15-K-11A
(CP-11A)
AIR COMPRESSOR

15-E-111A, 15-E-112A
(HE-111A) (HE-112A)
COMPRESSOR INTERCOOLERS

15-Y-116A
(S-116A)
BLOWOFF SILENCER

15-E-13A
(HE-13A)
DIRECT COOLER

15-G-131-1A & 2A
(P-131-1A & 2A)
DIRECT COOLER WATER PUMPS



2-19-81	GENERAL REVISION	DES.	J.H.	AE	RM	APR
12/10/80	ISSUED FOR PHASE O	BA	AE	FR	RM	APR
1/1/80	FIRST ISSUE	J.H.	AE	FR	RM	APR
NO.	DATE	DESIGNED	BY	CHK	APPV.	BY
		DESIGNED A. Edmiston	BY	CHK	APPV.	BY

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

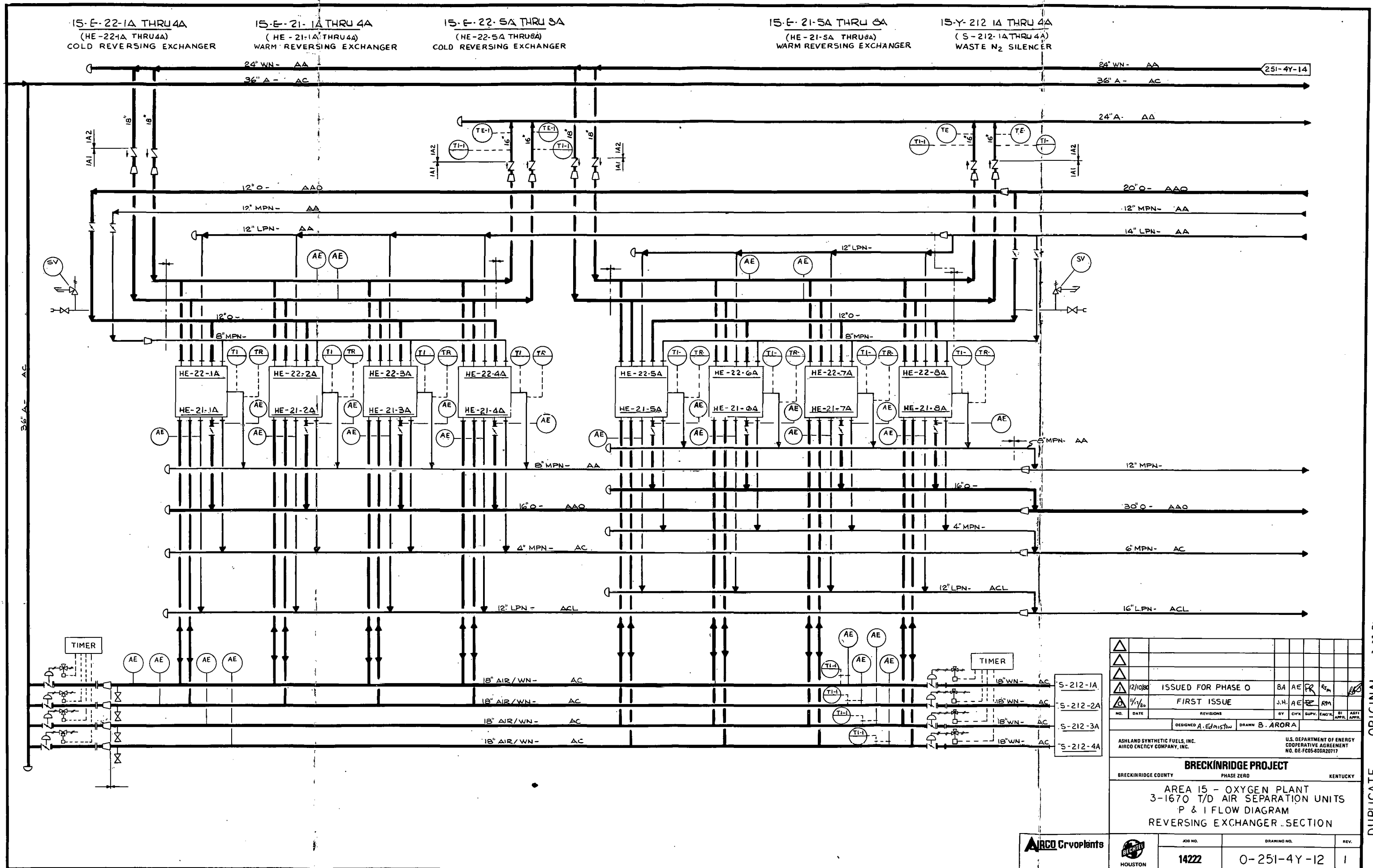
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COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

AREA 15 - OXYGEN PLANT
3-1670 T/D AIR SEPARATION UNITS
P & I FLOW DIAGRAM
AIR COMPRESSOR SECTION

ARCOCryopplants	JOB NO.	DRAWING NO.	REV.
	14222	0-251-4Y-11	2

2-27-81
ORIGINAL
DUPLICATE

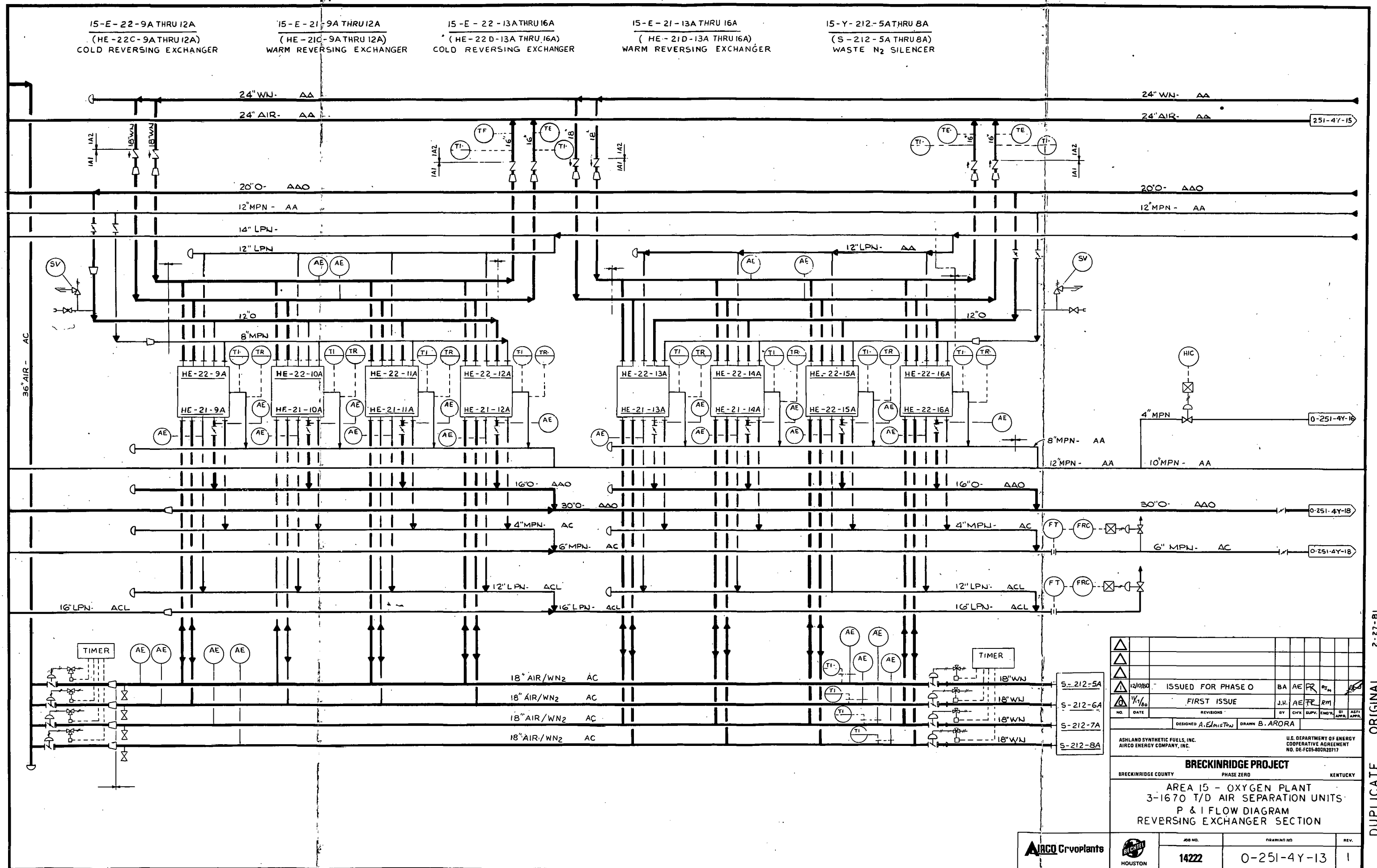


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ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.								
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717								
BRECKINRIDGE PROJECT BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY								
AREA 15 - OXYGEN PLANT 3-1670 T/D AIR SEPARATION UNITS P & I FLOW DIAGRAM REVERSING EXCHANGER SECTION								
JOB NO.		DRAWING NO.		REV.				
14222		O-251-4Y-12		1				

ARCO Cryoplants



2-27-81
 ORIGINAL
 DUPLICATE

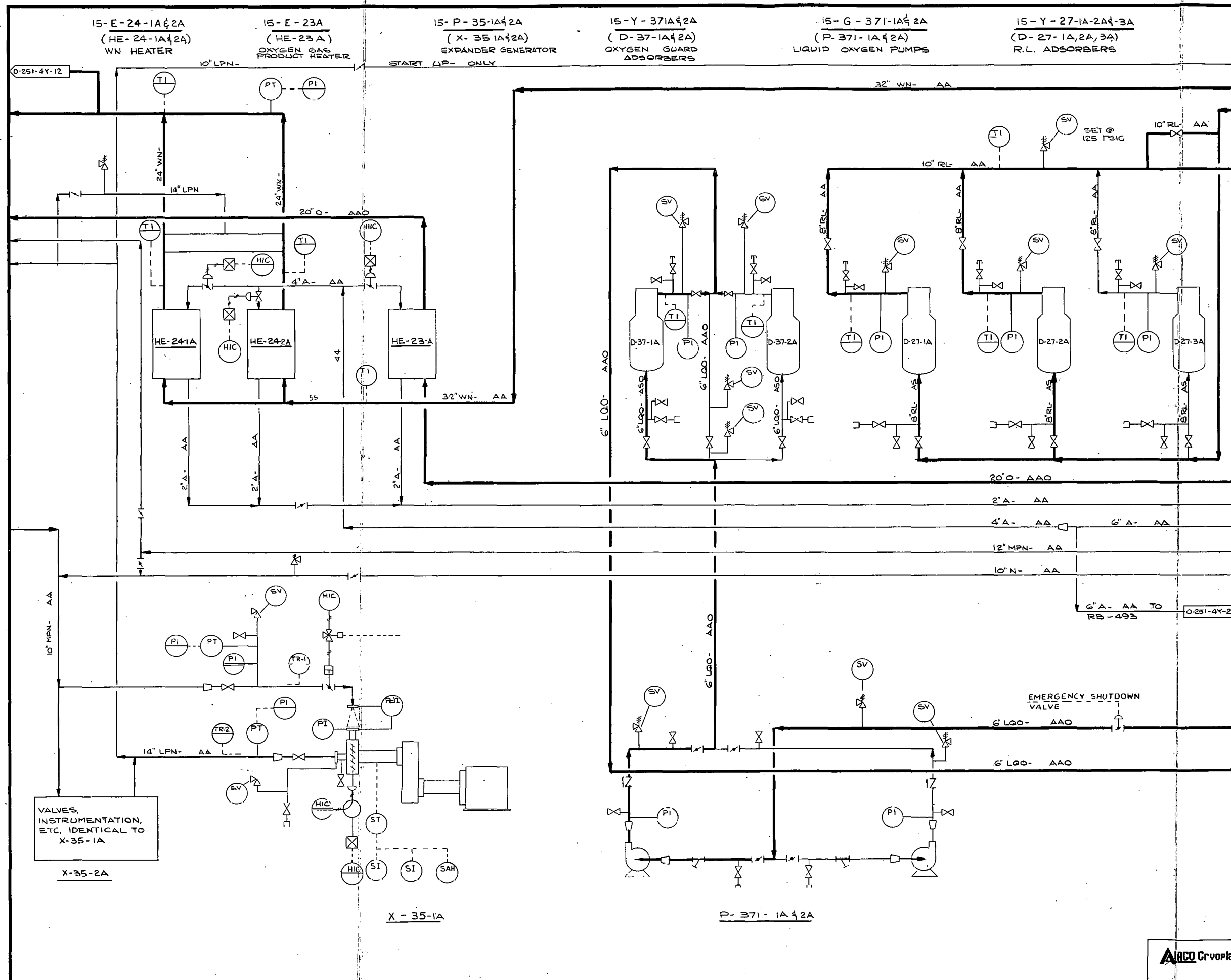


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DESIGNED A. Edmiston			DRAWN B. ARORA					
ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.								
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717								
BRECKINRIDGE PROJECT PHASE ZERO BRECKINRIDGE COUNTY, KENTUCKY								
AREA 15 - OXYGEN PLANT 3-1670 T/D AIR SEPARATION UNITS P & I FLOW DIAGRAM REVERSING EXCHANGER SECTION								
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AIRCO Cryoplants

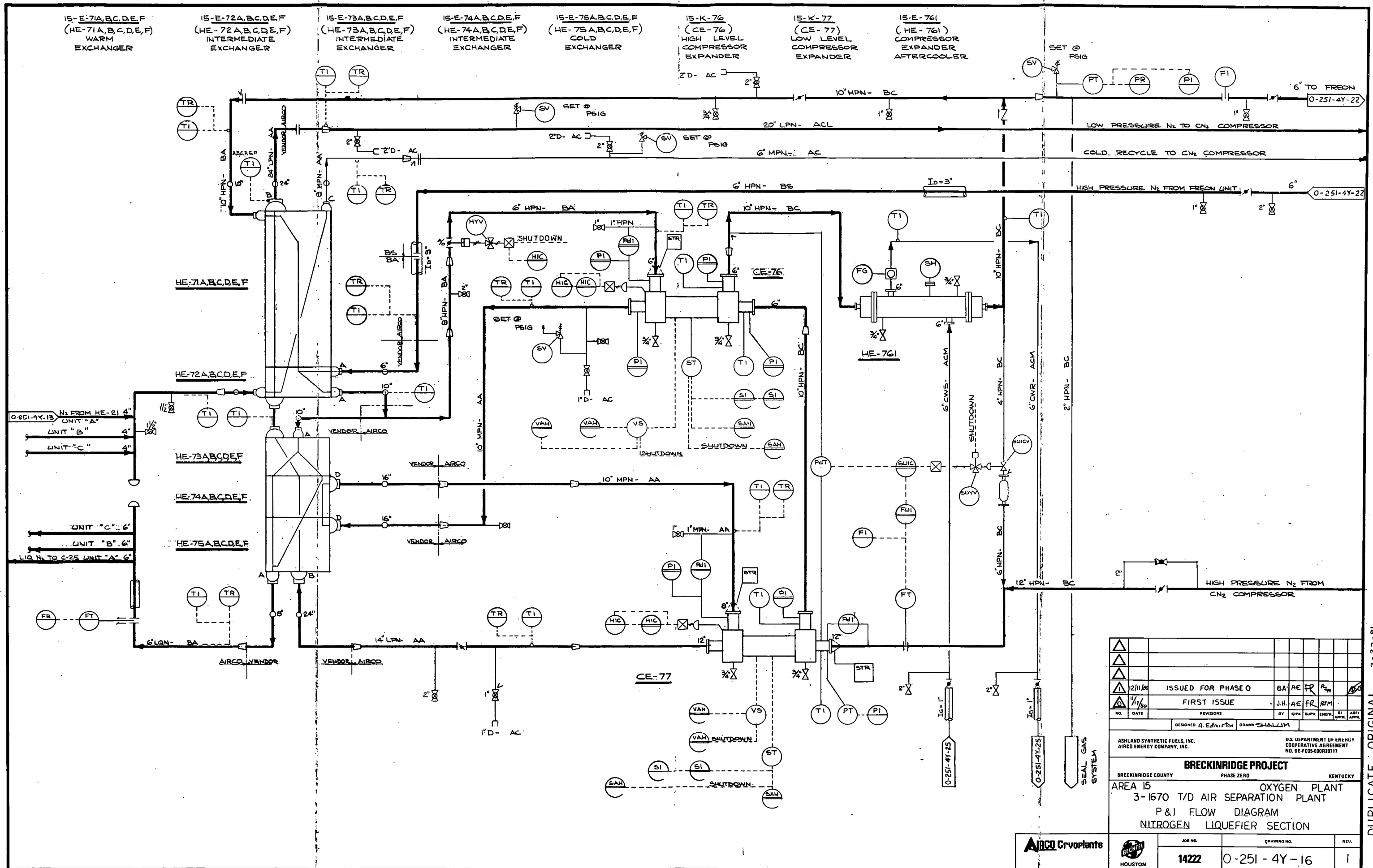
BECHTEL
HOUSTON

DUPLICATE ORIGINAL 2-27-81

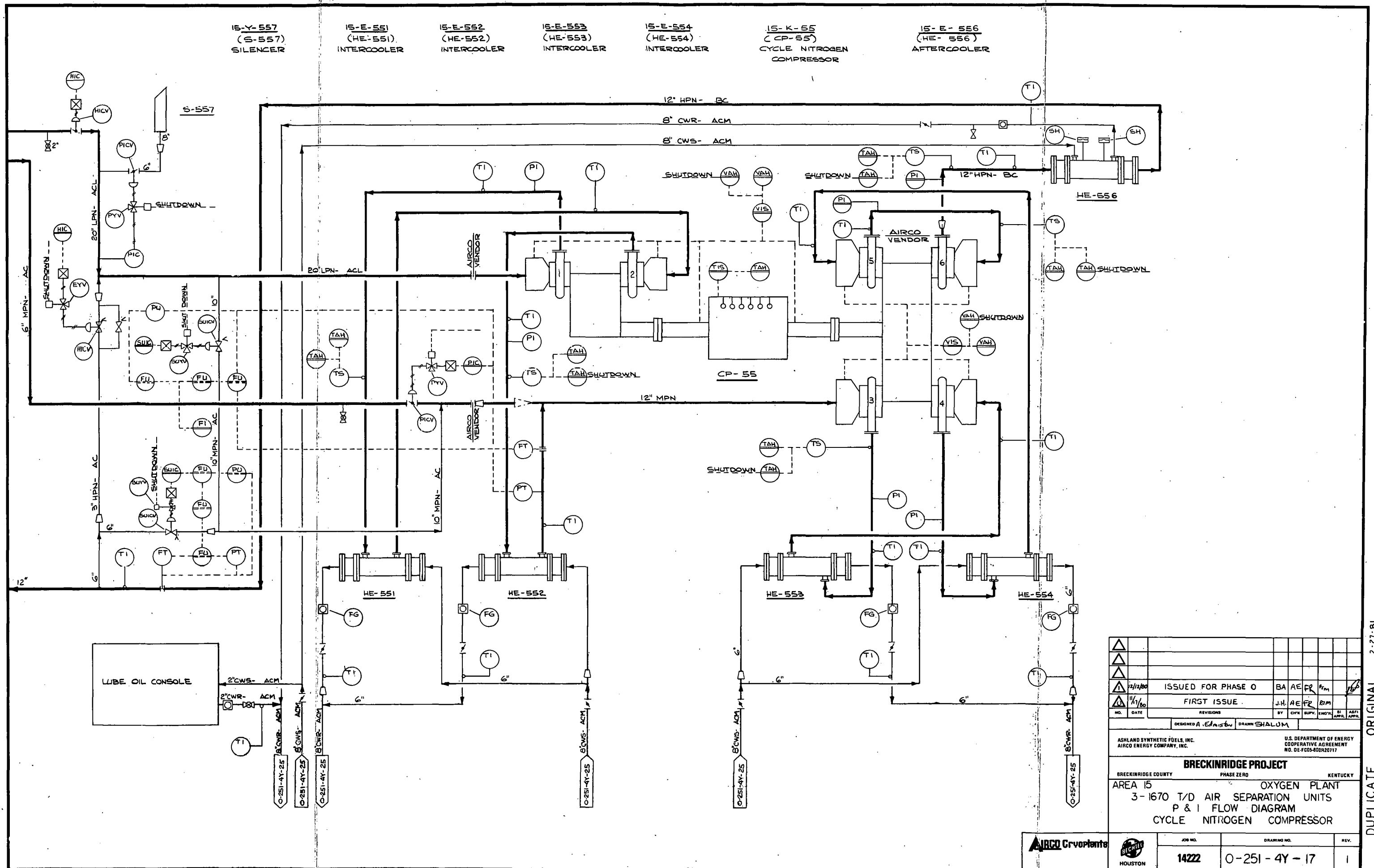


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11/1/80		FIRST ISSUE	J.H.	AE	FR				
DESIGNED A. Edmiston DRAWN SHALUM									
ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.									
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BRECKINRIDGE PROJECT									
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY									
AREA 15 OXYGEN PLANT									
3-1670 T/D AIR SEPARATION UNITS									
P & I FLOW DIAGRAM									
GUARD & R.L. ADSORBER SECTION									
ARCO Cryoplants									
BECHTEL HOUSTON									
JOB NO.	DRAWING NO.		REV.						
14222	O-251-4Y-14		1						

2-27-81
ORIGINAL
DUPLICATE



DUPLICATE ORIGINAL 2-27-81



12/12/80	ISSUED FOR PHASE 0	BA	AE	FR	RM	1/16
1/1/80	FIRST ISSUE	J.H.	AE	FR	RM	
NO.	DATE	REVISIONS	BY	CHKD	SRV.	ENGR.
		DESIGNED A. Edmiston	DRAWN SHALOM			
ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.						
BRECKINRIDGE PROJECT AREA 15 3-1670 T/D AIR SEPARATION UNITS P & I FLOW DIAGRAM CYCLE NITROGEN COMPRESSOR						
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717						
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY						
AIRCO Corporation HOUSTON						
JOB NO.		DRAWING NO.		REV.		
14222		O-251-4Y-17		1		

2-27-81
ORIGINAL
DUPLICATE



15-K-63
(CP-63)
HIGH STAGE
COMPRESSOR

15-K-64
(CP-64)
LOW STAGE
COMPRESSOR

15-E-62
(EV-62)
LOW LEVEL
EVAPORATOR

15-E-642
(HE-642)
CONDENSER

15-E-61
(EV-61)
MEDIUM LEVEL
EVAPORATOR

15-E-671
(HE-671)
OIL
CONDENSER

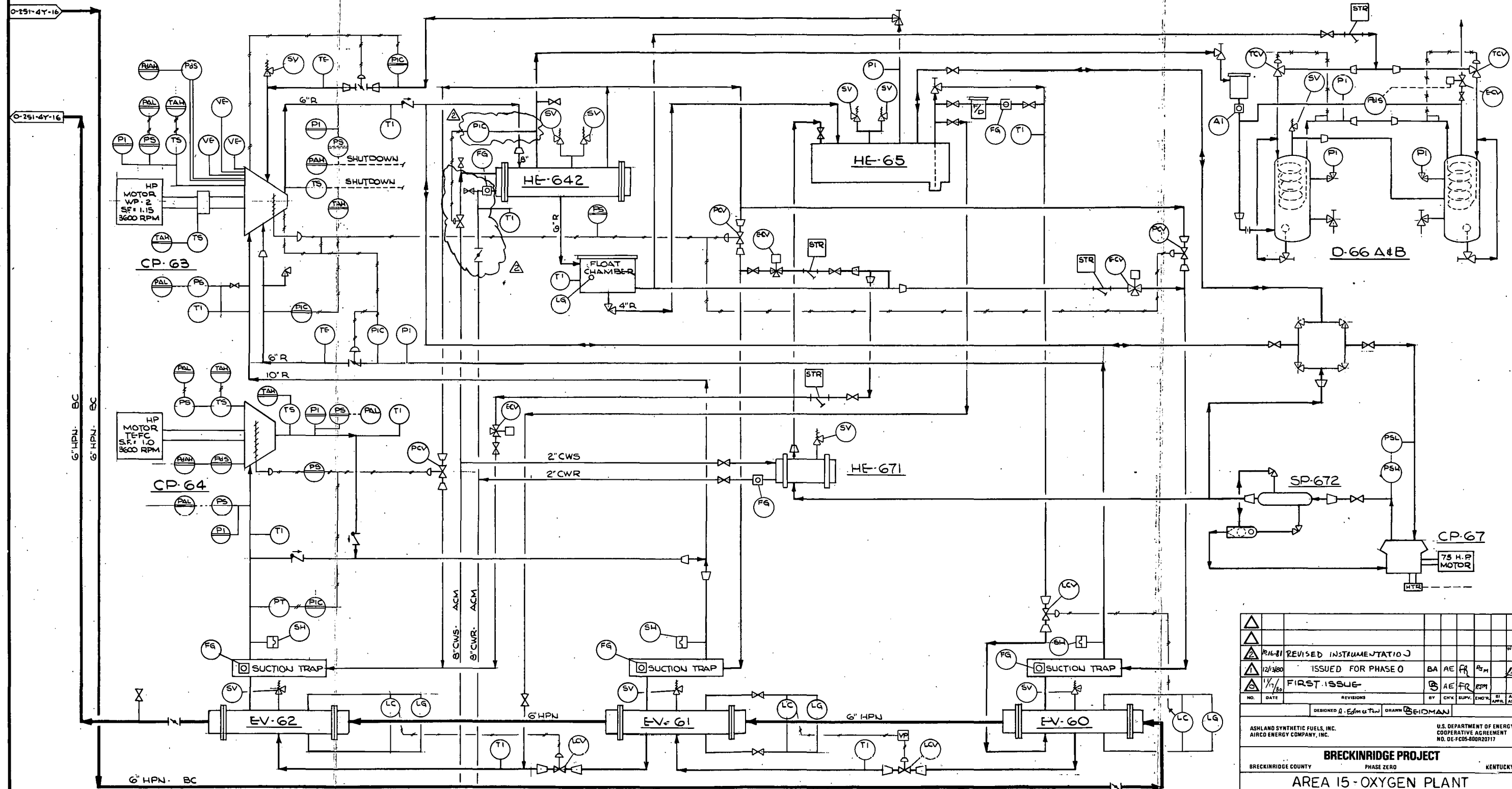
15-E-65
(HE-65)
RECEIVER

15-E-60
(EV-60)
HIGH LEVEL
EVAPORATOR

15-Y-672
(SP-672)
OIL
SEPARATOR

15-Y-66 A#B
(D-66 A#B)
PURGE DRUM

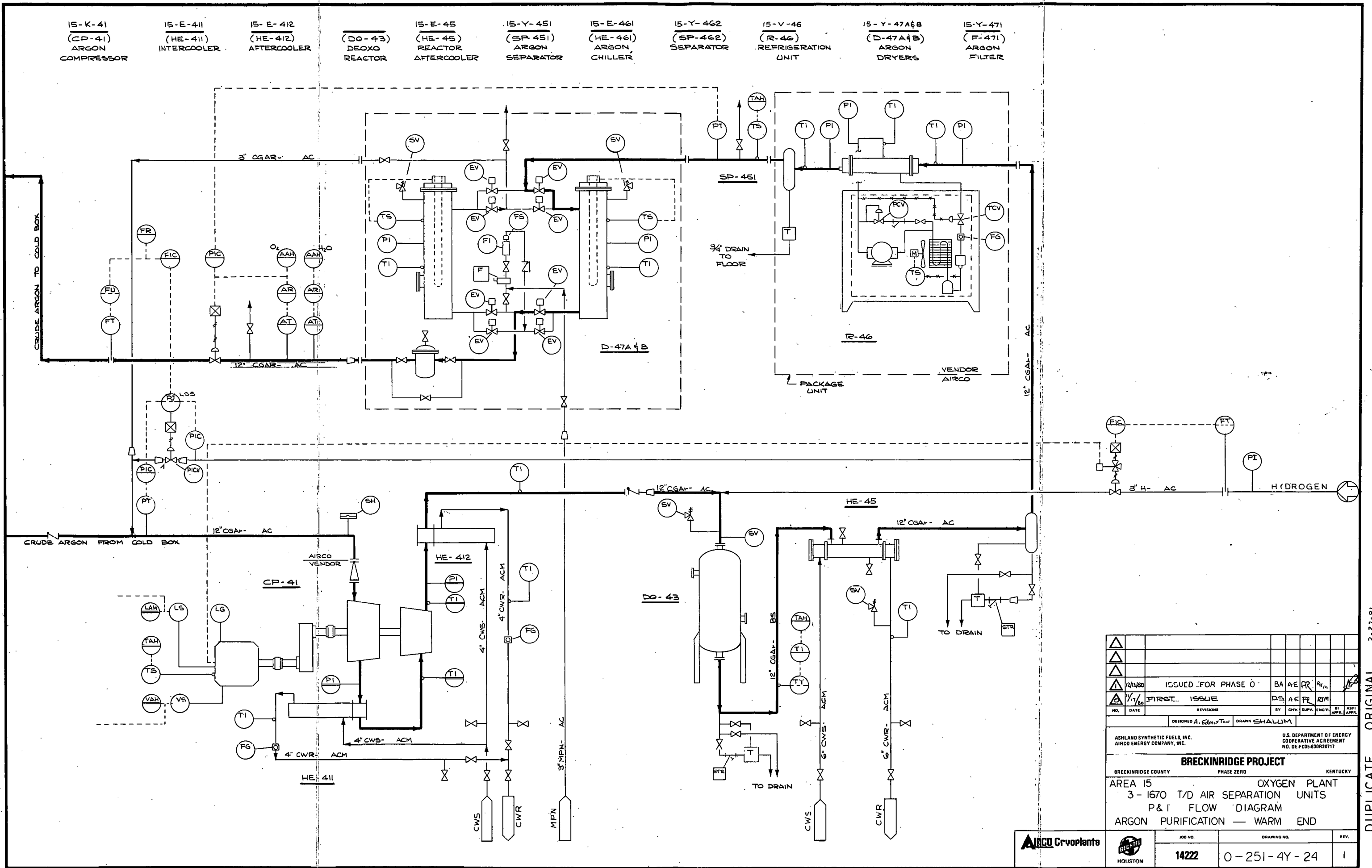
15-K-67
(CP-67)
TRANSFER
COMPRESSOR



REVISION	DATE	BY	CHK	APPV	REASON
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2	1/1/81	BA	AE	FR	FIRST ISSUE
DESIGNED BY: Edm & T... DRAWN BY: Edm & T...					
ASHLAND SYNTHETIC FUELS, INC. AIRCO ENERGY COMPANY, INC.					
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-80OR23717					
BRECKINRIDGE PROJECT					
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY					
AREA 15-OXYGEN PLANT 3-1670 AIR SEPARATION UNITS P&I FLOW DIAGRAM NLW FREON UNIT					
JOB NO.		DRAWING NO.		REV.	
14222		0-251-4Y-22		2	

AIRCO Cryoplants





12/13/80	ISSUED FOR PHASE 0	BA	AE	RR	RM	APPL
11/17/80	FIRST ISSUE	DS	AE	FL	RM	APPL
NO.	DATE	REVISIONS	BY	CHK	SUPV.	ENGR.
DESIGNED	A. Edm. Tow	DRAWN	SHALUM			
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						
AREA 15 OXYGEN PLANT						
3-1670 T/D AIR SEPARATION UNITS						
P&I FLOW DIAGRAM						
ARGON PURIFICATION — WARM END						
JOB NO.	DRAWING NO.	REV.				
14222	0-251-4Y-24	1				

AIRCO Cryoplants

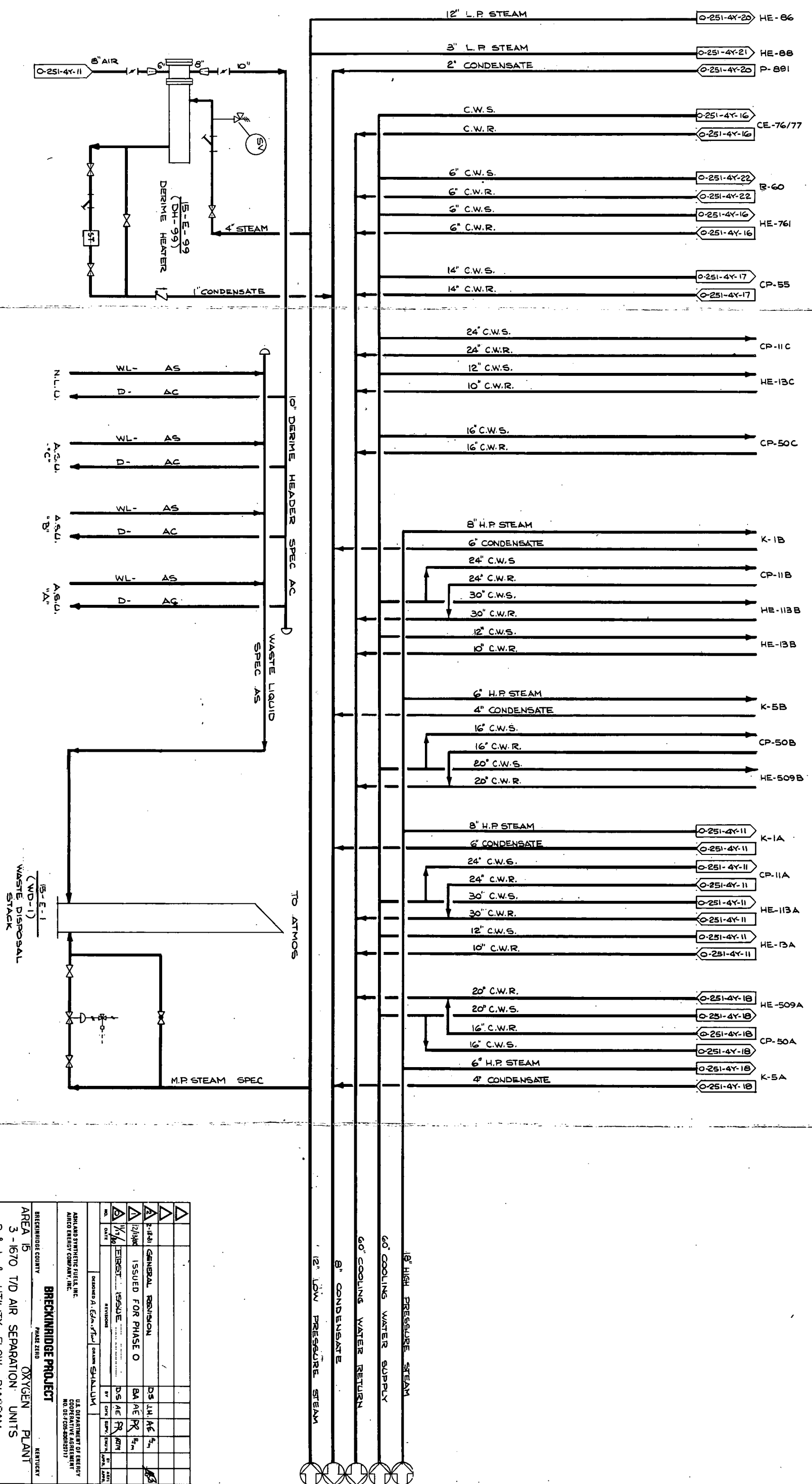


14222

0-251-4Y-24

1

2-27-81
ORIGINAL
DUPLICATE



NO.	DATE	BY	CHKD	REVISION	DESCRIPTION
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AREA 15

3-1670 T/D AIR SEPARATION UNITS

P & I & UTILITY FLOW DIAGRAM

14222

0-251-4Y-25

2

PLANT 18 NAPHTHA HYDROTREATING AND REFORMING

1.0 INTRODUCTION

Raw H-Coal[®] naphtha is upgraded using hydrotreating and Continuous Catalyst Regeneration (CCR) Platforming processes licensed by UPO Process Division. Technical and economic data are provided by UOP based upon an Ashland Oil Co. H-Coal[®] naphtha sample. A complete analysis of this sample is presented in this section.

Approximately 13,000 BPSD are processed in two-stage hydrotreater to provide an acceptable platformer chargestock.

The reformer operation produces a 105 RON clear reformate product.

Plant 18 facilities have been sized for 20,000 BPSD of fresh feed even though the single point design basis is only 13,000 BPSD. Higher feedstock naphtha end points and/or higher naphtha yields on coal are the most significant H-Coal[®] process improvement opportunities. Various data with improved catalysts suggest that 20,000 BPSD of Plant 18 feedstock could be produced at higher H-Coal[®] catalyst addition rates or with improved catalysts. Final sizing of the plant facilities will be an important activity in the next phase of the work.

PLANT 18 NAPHTHA HYDROTREATING AND REFORMING

2.0 PROCESS DESIGN

2.1 Design Basis

The H-Coal[®] product used for the Plant 18 design basis was a full boiling range H-Coal[®] naphtha from PDU Run No. 9 (Kentucky No. 11 coal). The full boiling range naphtha sample was designated as Sample No. 9-HC-210. This sample was rerun to obtain a chargestock that included all fractions from the initial boiling point to an end point of no greater than 355°F (IBP - 355°F). This chargestock was used as the basis for the yield estimates. Analytical data for the naphtha and estimated yields are given in the six tables which appear at the end of this subsection.

- Table 1 - Feedstock Inspections
- Table 2 - UOP Laboratory Analysis - Complete Analysis
- Table 3 - UOP Laboratory Analysis - GC Analysis
- Table 4 - UOP Laboratory Analysis - MS Analysis of Depentanized Olefinic Gasoline
- Table 5 - Estimated Hydrotreating Yields and Product Properties
- Table 6 - Estimated Platforming Yields and Product Properties

The following operations are included in Plant 18:

- Hydrotreating of the raw H-Coal[®] naphtha to provide an acceptable reformer feedstock
- Reforming of the hydrotreated H-Coal[®] naphtha to provide a 105 RON clear reformate product

2.2 Hydrotreater Processing Requirements

Due to the rather unusual composition of the H-Coal[®] naphtha, the feedstock properties were carefully analyzed before selecting processing conditions. The feedstock properties which are most critical are as follows:

- Nitrogen - The full boiling range H-Coal[®] naphtha contains large quantities of nitrogen (500-3,000 ppm depending on boiling range). This level must be reduced to less than 0.5 ppm in order to meet reformer chargestock requirements. The nitrogen is present primarily in the form of pyridines and anilines. The chemical properties of these compounds can significantly distort the validity of analyses, such as Bromine number, which are used for evaluating olefin content
- Oxygen - The oxygen compounds present in the H-Coal[®] naphtha are essentially all phenols. While the severity of the hydrotreatment required for nitrogen removal is also quite adequate for oxygen removal, a small quantity (about 100-200 ppm) of the oxygenates is converted to stable compounds, probably benzofurans, and is not removed during hydrotreating. These compounds appear to have a hydrogen structure which envelopes the oxygen atom present. Even the severe reducing environment of the catalytic reformer seems to have little effect on these compounds
- Olefins - The 7.5 LV% olefins plus significant diolefins, together with the reactive heteroatomic compounds which exist in the raw naphtha, serve to make it unstable both in storage and at normal hydrotreating temperatures. Care must be taken to remove the diolefins by low-temperature saturation before severe hydrotreating for heteroatomic compounds can be commenced. Exposure of the diolefins to excessive temperatures in the hydrotreater will result in fouling of the heater and heat exchange equipment, as well as excessive polymer formation in the catalyst bed

- Sulfur - While the sulfur present in the H-Coal[®] naphtha is significant (approximately .2 wt%), its removal at the processing conditions required for nitrogen and oxygen removal is readily achieved
- Hydrogen Content - The H-Coal[®] naphtha contains about 3 wt% less hydrogen than most straight-run naphthas. This is readily evident when the analyses of this material are reviewed. The hydrogen content increases significantly due to the olefin and aromatic compound saturation which occurs during severe hydrotreating

To provide for the processing conditions necessary to obtain an acceptable reformer chargestock from raw H-Coal[®] naphtha, two-stage hydrotreating is required. The first stage operates at approximately 350°F and is used for olefin saturation. The second stage runs at typical hydrotreating temperatures and removes the heteroatomic compounds present in the naphtha. The overall system operates at a separator pressure of 750 psig, and the chemical hydrogen consumption is about 400 scf per barrel of charge.

The feedstock to the hydrotreater is freshly fractionated. Intermediate storage of the feedstock is minimized and is gas blanketed, due to the tendency for rapid gum formation. Also, the temperature of the exchange medium used to heat the hydrotreater first stage feed cannot exceed 500°F.

2.3 Reformer Processing Requirements

Evaluation of the platformer chargestock shows it to be exceptionally rich in cyclic compounds. The RON clear of this material is in the range of 80 even before reforming. This chargestock can easily be reformed to a product in excess of 100 RON clear. To this end, yield estimates for 105 RON clear operations have been completed (see Table 6 for estimated reforming yields and product properties).

TABLE 1
 FEEDSTOCK INSPECTIONS
 IBP - 355°F RAW H-COAL[®] NAPHTHA

<u>Property</u>	
API Gravity	44.1
Sulfur, wt%	0.226
Total nitrogen, wt ppm	1,600
Bromine number	21.3
Oxygen, wt%	1.04
Paraffins, LV%	16.9
Naphthenes, LV%	50.8
Olefins, LV%	7.5
Aromatics, LV%	18.7
Oxygenates, LV%	6.1
Distillation (ASTM D-86)	
IBP	174°F
50%	264°F
EP	352°F

TABLE 2
UOP LABORATORY ANALYSIS
COMPLETE ANALYSIS

Sample Identification		H-Coal [®] Naphtha	
Sample Number		9-HC-210	
UOP Number		50-2019	
	<u>Total Sample</u>	<u>Naphtha</u>	<u>Bottoms</u>
Fraction Analyzed		IBP - 355°F	355°F+
LV% of Total Sample		88.4	11.6
Position in Sample, LV%		0.0 - 88.4	88.4 - 100.0
Sulfur, Lamp, wt%		0.266	
Oxygen, wt%		1.04	
Total Nitrogen, ppm		1,600	
Phenols by UV, wt%		2.68	
Triphenols by UV, wt%		0.19	
Carbon, wt%		85.23	
Hydrogen, wt%		12.59	
FIA Analysis, LV%			
Oxygenates		6.1	
Paraffins + Naphthenes		67.7	
Olefins		7.5	
Aromatics		18.7	
Bromine Number (ASTM D-1159)		21.3	
API Gravity at 60°F	41.6	44.1	
Specific Gravity at 60°F	0.8174	0.8058	
Distillation (ASTM D-86)			
IBP	174°F	174°F	
10%	205	210	
30%	236	234	
50%	272	264	
70%	310	300	
90%	342	327	
95%	358	336	
EP	369	352	
% Recovered	99.0	99.0	
% Bottoms	1.0	1.0	

TABLE 2 (Continued)

Emission Spectrographic Analysis of Wet Ash

<u>Elements</u>	<u>Reported as ppm metal in the oil</u>
Fe	0.34
Ni	0.04
V	0.04
Pb	< 0.05
Cu	0.07
Na	< 0.05

50-2019 Ashland H - Coal[®] Naphtha
IBP - 335°F Oxygenates Fraction

<u>z No.</u>	<u>Aromatic Hydrocarbon Compound Types, C_nH_{2n} - z*</u>	<u>wt%</u>
z = 6*	Alkyl Benzenes	2.8
z = 8*	Indans/Tetralins	0.2
z = 10*	Dinaphthene Benzenes	1.1
	<u>Aromatic Oxygenates Compound Types, C_nH_{2n} - zO**</u>	
z = 6**	Phenols	95.9
	<u>Aromatic Nitrogens Compound Types, C_nH_{2n} - zN***</u>	
z = 3***	Pyrroles	<u>Trace</u>
	Total	100.0

* These are the more probable compound types. Other compounds may be included.

** The z number refers to aromatic oxygen compounds.

*** The z number refers to aromatic nitrogen compounds.

TABLE 3
UOP LABORATORY ANALYSIS
GC ANALYSIS
(On Oxygenate-Free Basis)

Sample Identification	H-Coal [®] Naphtha
UOP Number	50-2019
Fraction Analyzed	IBP - 355°F
Aromatics	<u>wt%</u>
Benzene	.5
Toluene	3.4
Ethylbenzene	1.9
<u>p</u> -Xylene	.7
<u>m</u> -Xylene	2.0
<u>o</u> -Xylene	1.3
C ₉ + Aromatics	<u>8.9</u>
Total Aromatics	18.7
Olefins	
C ₈ -	2.6
C ₉ +	<u>4.1</u>
Total Olefins	6.7
Paraffins + Naphthenes	
Propane	-
Isobutane	-
<u>n</u> -Butane	.1
Isopentane	.2
<u>n</u> -Pentane	.6
2, 2-Dimethylbutane	-
Cyclopentane	-
2, 3-Dimethylbutane	.06
2-Methylpentane	.68
3-Methylpentane	.44
<u>n</u> -Hexane	2.13
Methylcyclopentane	3.02

TABLE 3 (Continued)

2, 2-Dimethylpentane	-
2, 4-Dimethylpentane	.03
2, 2, 3-Trimethylbutane	-
Cyclohexane	9.02
3, 3-Dimethylpentane	-
1, 1-Dimethylcyclopentane	.06
2-Methylhexane	.66
2, 3-Dimethylpentane	.24
1-cis-3-Dimethylcyclopentane	.50
3-Methylhexane	.82
1-trans-3-Dimethylcyclopentane	.54
1-trans-2-Dimethylcyclopentane	.78
3-Ethylpentane	.11
2, 2, 4-Trimethylpentane	-
n-Heptane	1.89
1-cis-2-Dimethylcyclopentane	.33
Methylcyclohexane	11.90
1, 1, 3-Trimethylcyclopentane	.03
2, 2-Dimethylhexane	-
Ethylcyclopentane	1.35
2, 5-Dimethylhexane	.02
2, 4-Dimethylhexane	.06
2, 3, 3-Trimethylpentane	-
1-trans-2-cis-4-Trimethylcyclopentane	.19
1-trans-2-cis-3-Trimethylcyclopentane	.14
3, 3-Dimethylhexane	-
2, 3, 4-Trimethylpentane	-
1, 1, 2-Trimethylcyclopentane	.03
2, 3, 3-Trimethylpentane	-
2-Methyl-3-ethylpentane	
2, 3-Dimethylhexane	.12
1-cis-2-trans-4-Trimethylcyclopentane	.02
1-cis-2-trans-3-Trimethylcyclopentane	.03
2-Methylheptane	}
3-Methyl-3-ethylpentane	
1-cis-2-cis-4-Trimethylcyclopentane	}
4-Methylheptane	
3, 4-Dimethylhexane	.39

TABLE 3 (Continued)

3-Ethylhexane	}	.60
3-Methylheptane		
1, 1-Dimethylcyclohexane	}	1.76
1-trans-4-Dimethylcyclohexane		
1-cis-3-Dimethylcyclohexane		.35
1-Methyl-cis-3-ethylcyclopentane		
1-Methyl-trans-3-ethylcyclopentane	}	.92
1-Methyl-trans-2-ethylcyclopentane		
1-Methyl-1-ethylcyclopentane	}	.72
1-cis-2-cis-3-Trimethylcyclopentane		
1-trans-2-Dimethylcyclohexane		
1-trans-3-Dimethylcyclohexane	}	1.06
1-cis-4-Dimethylcyclohexane		
Isopropylcyclopentane		.18
n-Octane		1.45
1-Methyl-cis-2-ethylcyclopentane		.21
1-cis-2-Dimethylcyclohexane		.36
Ethylcyclohexane	}	5.35
n-Propylcyclopentane		
C ₉ Naphthenes		11.28
C ₉ Paraffins		3.83
C ₁₀ Naphthenes		7.08
C ₁₀ Paraffins		2.43
C ₁₁ Naphthenes		Trace
C ₁₁ Paraffins		Trace
C ₁₂ Paraffins and Napthenes		-
Total Paraffins and Napthenes		<u>74.6</u>
Totals		100.0

TABLE 4

UOP LABORATORY ANALYSIS

MS ANALYSIS OF DEPENTANIZED
OLEFINIC GASOLINE
(On Oxygenate-Free Basis)Sample Identification
UOP Number
Fraction AnalyzedH-Coal[®] Naphtha
50-2019
Naphtha, IBP - 355°FComposition of Olefinic Gasoline
(95% Distillation Temperature 411°F)

		<u>LV%</u>
Paraffins	16.61	16.61
Naphthenes		45.35
Monocycloparaffins	44.74	
Bi, Dicycloparaffins	0.61	
Tricycloparaffins	0.0	
Olefins	15.97	
Mono-Olefins	6.05	
Coda	9.86	
CDO, Tricyclo-Olefins	0.06	
Aromatics		22.07
Alkylbenzenes	20.78	
Indans, Tetralins	1.29	
Naphthalenes	<u>0.0</u>	
Total	100.00	<u>100.00</u>

TABLE 4 (Continued)

Carbon Number Distribution in Liquid Volume Percent
(Result of Combined Analytical Methods)

Carbon Number	Paraffins	Monocyclo- Paraffins	Mono- Olefins	Aromatics		
				J = 6	J = 8	J = 12
6	6.81	7.70	2.09	0.79		
7	7.19	15.56	1.68	6.20		
8	2.34	10.75	1.12	7.50	0.0	
9	0.01	7.07	0.71	5.08	1.25	
10	0.26	3.66	0.39	1.20	0.04	0.0
11	0.0	0.0	0.06	0.01	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Total	16.61	44.74	6.05	20.78	1.29	0.0

Cyclopentanes 0.83

Cyclohexanes 43.91

TABLE 5

ESTIMATED HYDROTREATING YIELDS AND PRODUCT PROPERTIES
(Basis: Rerun C₆-355°F H-Coal Naphtha).

<u>Charge</u>	<u>Wt%</u>	<u>Vol%</u>	<u>(scfd) BPSD</u>	<u>Specific Gravity</u>
Raw Oil	100.00	100.00	13,000	.8058
Hydrogen (Chemical)	0.78	-	(412)	-
<u>Products</u>				
H ₂ S	0.24			
H ₂ O	1.17			
NH ₃	0.19			
C ₁	0.04			
C ₂	0.15			
C ₃	0.28			
C ₄	0.45	0.63	82	.5792
C ₅	0.56	0.72	94	.6286
C ₆₊	<u>97.70</u>	99.47	12,931	.7901
	100.00			

Product Properties

API Gravity	47.6
P, LV%	21.6
N, LV%	54.6
A, LV%	23.8
Distillation (ASTM D-86)	
IBP	174°F
50%	264
EP	352
Sulfur, ppmw	0.5
Total Nitrogen, ppmw	< 1

TABLE 6

ESTIMATED PLATFORMING YIELDS AND PRODUCT PROPERTIES
(Basis: Continuous Platforming Unit 105 RON Clear)

<u>Charge</u>	<u>Wt%</u>	<u>Vol%</u>	<u>(scfd) BPSD</u>
Hydrotreated H-Coal [®] Naphtha	100.00	100.00	13,000
<u>Products</u>			
H ₂	3.40		
C ₁	0.67		
C ₂	0.63		
C ₃	0.87		
i-C ₄	0.42	0.59	
n-C ₄	0.64	0.87	
i-C ₅	0.77	0.97	126
n-C ₅	0.51	0.64	83
C ₆ ⁺	<u>92.09</u>	83.89	10,906
	100.00		

<u>Product Properties</u>	<u>Debutanizer Bottoms</u>
API Gravity	31.4
RVP	2.62
RON Clear	105.0
MON Clear	92.6
Distillation (ASTM D-86)	
IBP	150 °F
10%	193
30%	235
50%	265
70%	293
90%	330
EP	398

2.4 Process Description - Hydrotreating

2.4.1 General

Hydrotreating removes objectionable materials from petroleum distillates by selectively reacting sulfur-, nitrogen-, and oxygen-containing compounds with hydrogen and by saturating olefinic hydrocarbons. Naphtha generally is purified for subsequent processing in catalytic reforming operations. Heavier distillates, ranging from jet fuels and kerosene through heavy vacuum gas oils, are treated for sulfur/nitrogen removal to meet specifications associated with emission standards and/or for odor and color improvement.

The chemistry of the hydrotreating process is essentially that of selective hydrogenation. It involves the controlled breaking of the molecular chain or ring at the point where the sulfur, nitrogen or oxygen atom is joined to carbon atoms. This breaking is accomplished by the introduction of hydrogen with production of hydrogen sulfide, ammonia or water, respectively. The resultant hydrocarbon reaction product usually remains either as one or more aliphatic hydrocarbons or as an alkyl group on an aromatic or naphthenic hydrocarbon. These hydrocarbon reaction products usually have larger liquid molecular volumes than do the parent sulfur, nitrogen or oxygen containing reactants. Only a small amount of cracking of the carbon-to-carbon bonds occurs and olefins and some aromatics are hydrogenated. The yields of liquids are usually in excess of 100 volume percent of the charge stock.

The specific reactions shown below have been listed in increasing order of difficulty. These reactions do not proceed to completion exclusively. Considerable overlapping occurs and, in some cases, it may be necessary to limit severity on heavier stocks to avoid excessive hydrogen consumption and to suppress unwanted hydrocracking.

- Saturation of Acetylenes
- Saturation of Dienes
- Saturation of Olefins
- Desulfurization
- Removal of Chlorides
- Removal of Oxygen
- Removal of Nitrogen
- Saturation of Aromatics
- Removal of Metals

2.4.2 Process Flow

The process flow is illustrated in Figure 1. The charge stock, together with the makeup hydrogen and recycle gas, are heated to reaction temperature in exchangers and a fired heater. In the reactor, the contained sulfur, nitrogen, halogen and oxygen impurities, together with olefinic hydrocarbons, are converted over catalysts, with metallic compounds being removed by a decomposition/adsorption mechanism. All the above reactions are exothermic, although the exothermic heat is relatively small when minimal quantities of these impurities are present. The reaction product is cooled through exchangers and a cooler enroute to the product separator. Net separator gas is recycled and combined with hydrogen-rich makeup gas while the separator liquid, after heat exchange, is stripped in the stripper column to remove H_2S and undesired light ends. The stripper column bottoms product, after exchange and cooling, is sent directly to the platforming unit.

Since the hydrotreating unit pretreats platforming feed, erection and operating costs are reduced by combining the design of the two units. All the net hydrogen make from the platformer is compressed in two compressors in parallel. Only part of this hydrogen feeds naphtha hydrotreater, the rest going to other hydrogen users in the liquefaction complex.

2.5 Catalytic Reforming

The catalytic reforming used for processing hydrotreated H-Coal[®] naphtha is the UOP continuous platforming process as shown in Figure 2. The regenerating section of the UOP continuous platforming process is presented in Figure 3. Because of the higher proportions of indans, decalins and other coke precursors present in the H-Coal[®] naphtha relative to straight-run petroleum naphtha, continuous catalyst regeneration is a significant advantage. This is true not only because of the potential for high coke make during normal operation, but also because of the need to protect the platforming catalyst from possible H-Coal[®] plant upsets upstream of the hydrotreater.

The basic flow pattern through the UOP continuous platformer is essentially the same as with conventional fixed-bed units. Feed to the platformer is combined with recycle hydrogen, raised to the reaction temperature by heat exchange and a fired heater and charged to the reactor section. Temperature is maintained across the reaction section by interheaters. Effluent from the reactors is cooled by heat exchange and subsequent air and/or water cooling and is charged to the separation section. Separator gas is recycled to the reactors with the net hydrogen make sent to hydrogen users or to fuel. Separator liquid is directed to product stabilization facilities.

Figure 1

UOP HYDROTREATING PROCESS

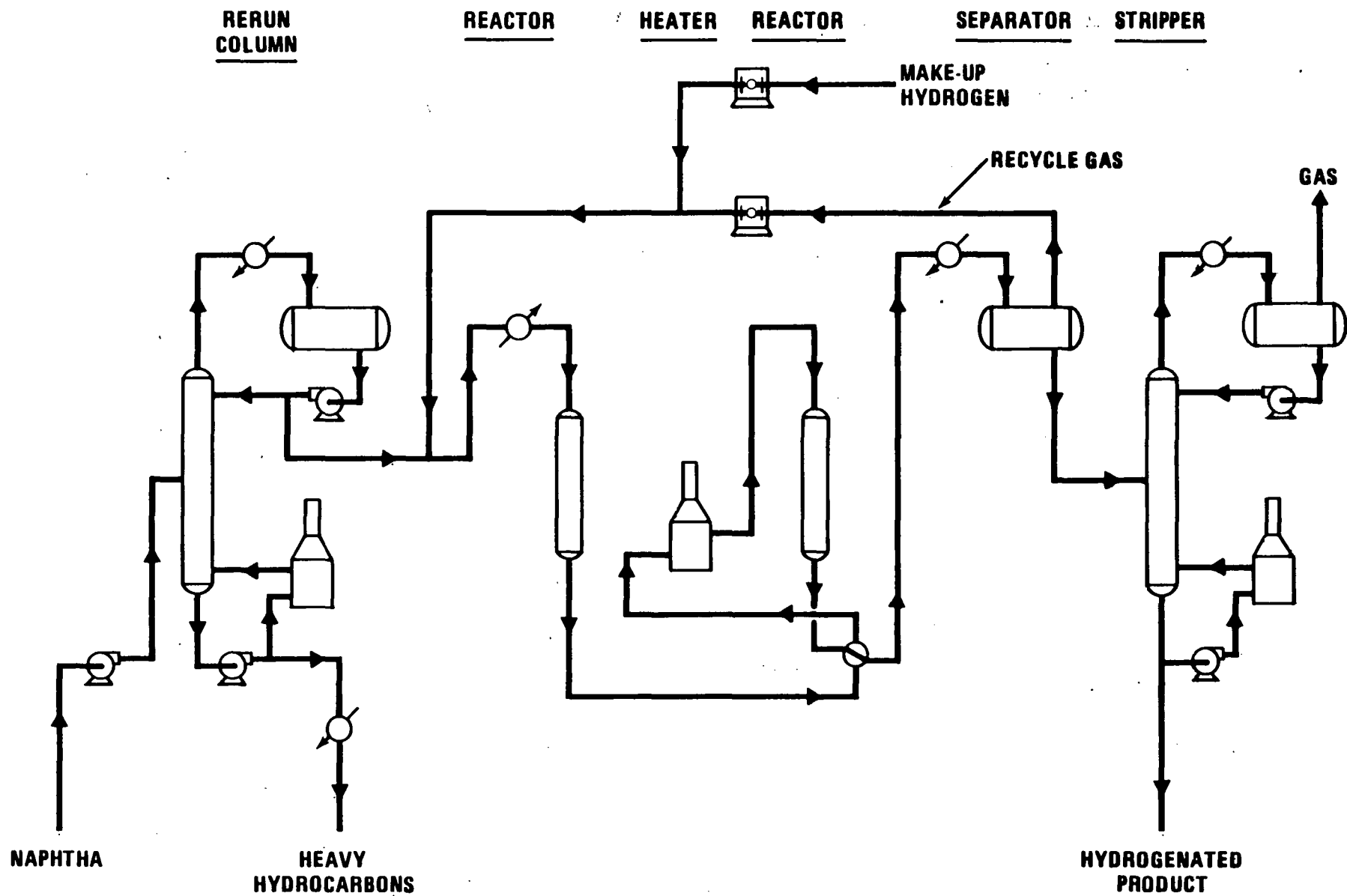


Figure 2

UOP CONTINUOUS PLATFORMING PROCESS

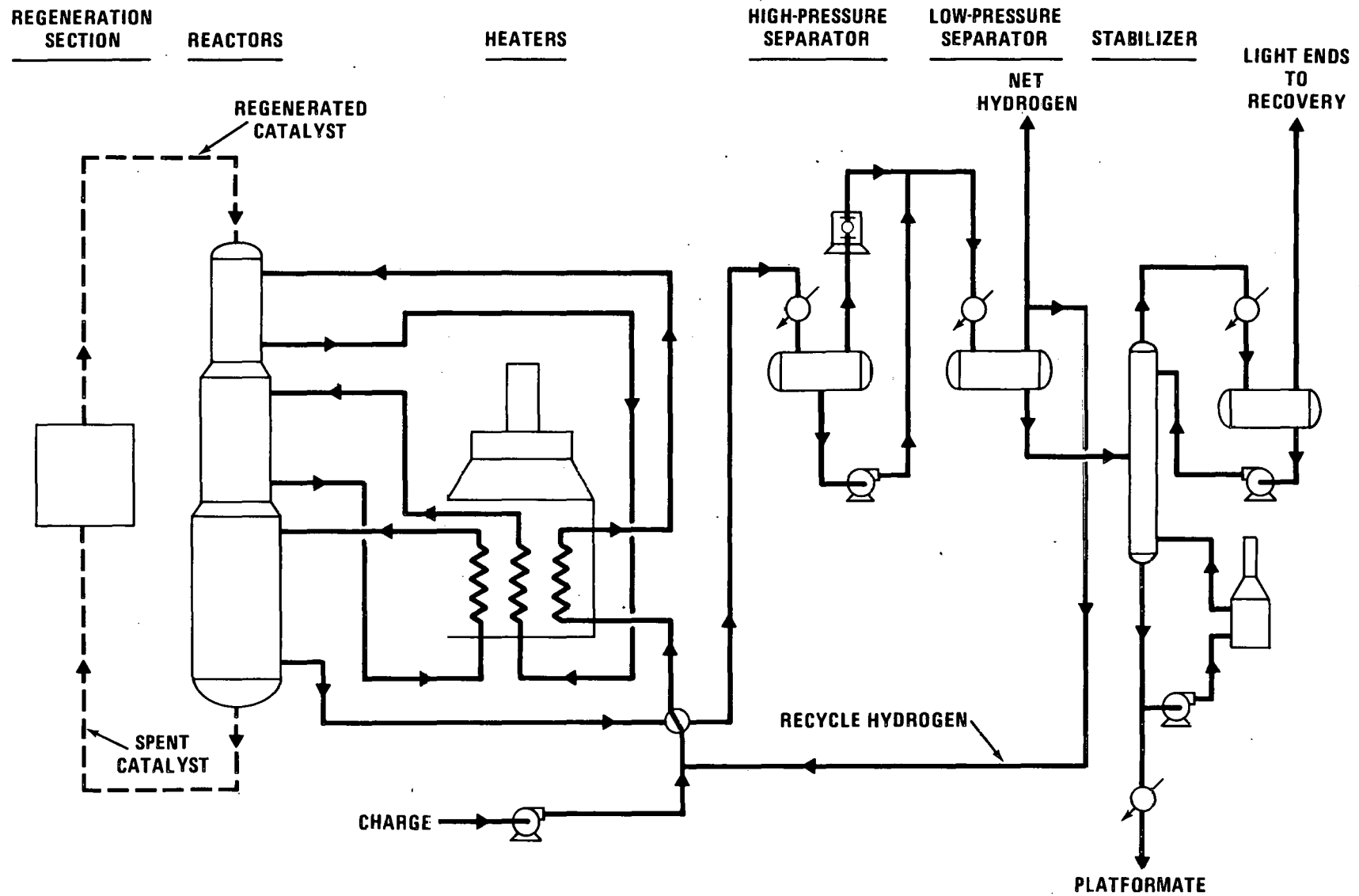
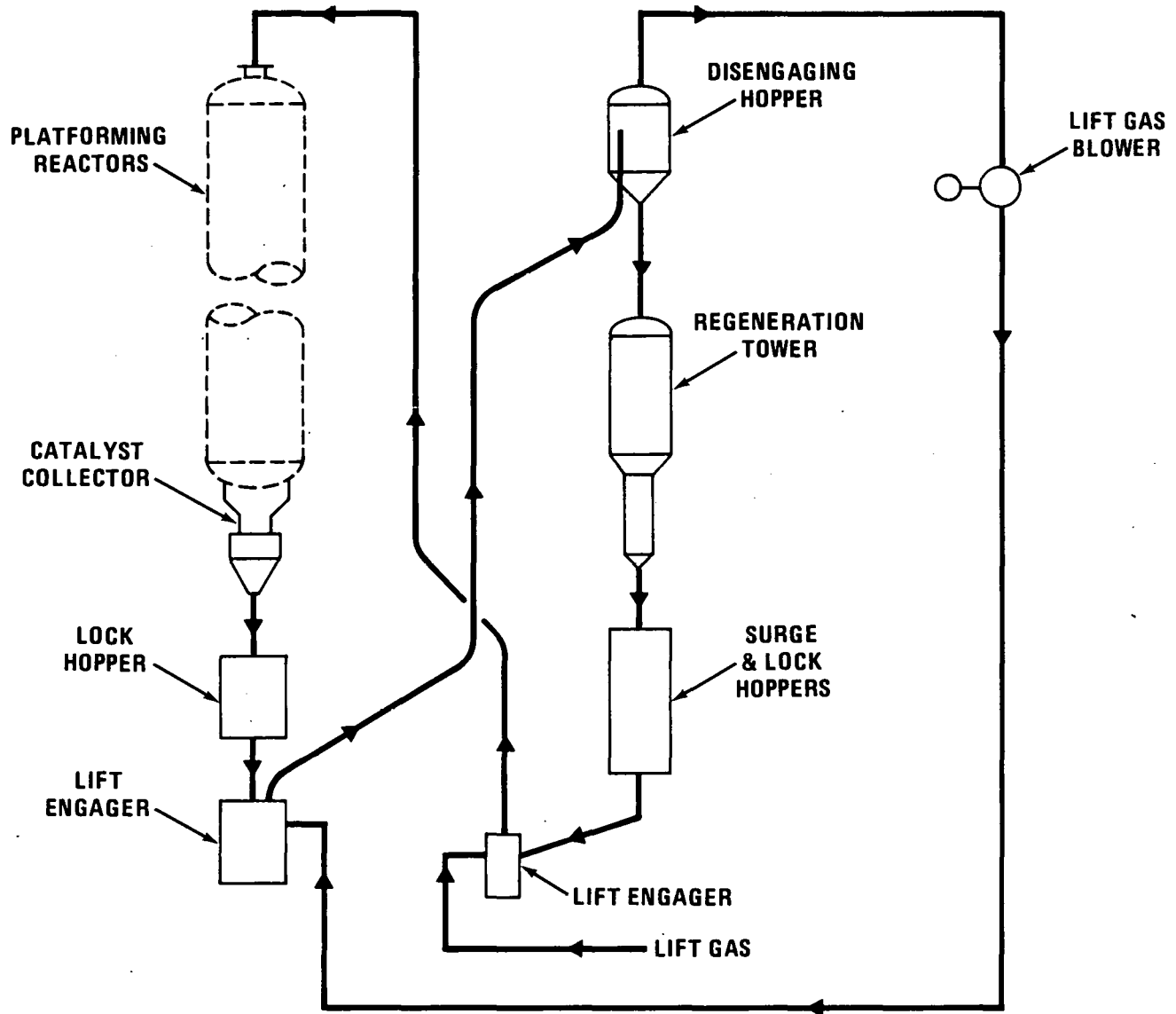


Figure 3

UOP CONTINUOUS PLATFORMING PROCESS
(REGENERATION SECTION)



2.6 Catalysts and Chemicals

Catalyst consumptions are based on estimated lives. They obviously depend on actual plant operation, and substantial saving can be obtained by good operational practice and plant housekeeping. Platformer catalyst consumption figures include cost of the carrier base, noble metals recovery and attrition. No allowance is made for catalyst handling losses or for interest on platinum investment.

The catalyst life utilized in calculating the daily allowance is three years for the naphtha hydrotreater and five years for the platformer.

	<u>Two-Stage Hydrotreater</u>	<u>105 RON Platformer</u>
Catalyst Consumption \$/Calendar Day	861	560

Note: Catalyst consumption is expressed in January 1981 dollars. The particular catalyst used and its consumption rate are proprietary to UOP and are not available for this report.

2.7 Utility Balance

Electricity, kV

<u>Condition</u>	<u>Consumed</u>
Operating:	1,116 ⁽¹⁾
	<u>4,588⁽²⁾</u>
Total	5,704

Steam, lb/hr

<u>Level</u>	<u>Consumed</u>	<u>Generated</u>	<u>Imported (Exported)</u>
600 psig, sat.	3,000 ⁽¹⁾		3,000
600 psig, 750°F		51,200 ⁽²⁾	(51,200)

Condensate Returned: 8,960 lb/hr

Water, GPM

Boiler Feedwater: 114

Cooling Water Circulation: 134⁽¹⁾
(30°F Rise) 435⁽²⁾

Total 569

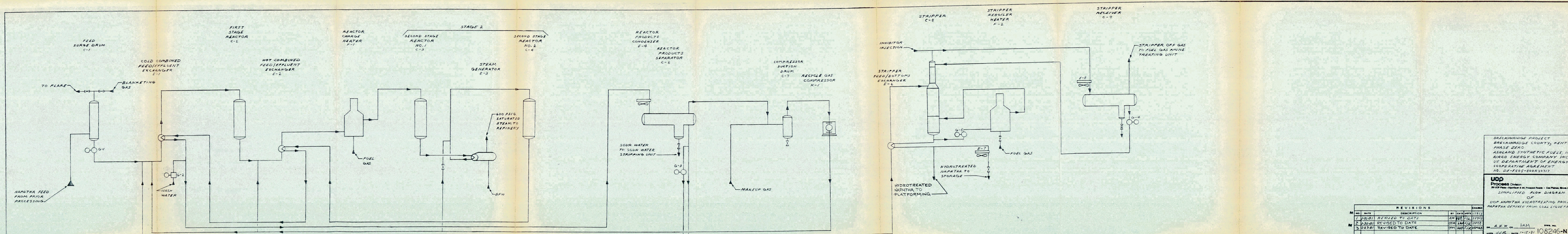
Fuel, MM Btu/hr

Total Fired Duty: 62.0⁽¹⁾
195.0⁽²⁾

Total 257.0

(1) Two-stage hydrotreater unit

(2) 105 RON platformer unit



BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY, KENTUCKY
PHASE ZERO
ASHLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY INC.
US DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

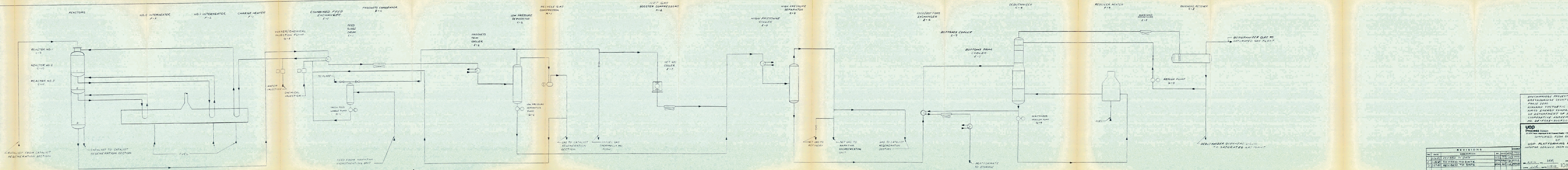
UOP
Process Division
20 UOP Plaza - Alton, IL 61810
SIMPLIFIED FLOW DIAGRAM
OF
UOP NAPHTHA HYDROTREATING PROCESS UNIT
NAPHTHA DERIVED FROM COAL LIQUEFACTION

REVISIONS				CHANGE
NO.	DATE	DESCRIPTION	BY	CHKD
1	1-26-81	REVISED TO DATE	AW	ARM
2	1-30-81	REVISED TO DATE	DTM	ARM
3	2-27-81	REVISED TO DATE	DTM	ARM

DR. A.H.W. CK. ARM
APPR. JLR DATE 1-15-81
DWS. NO. 108246-NX-3
REV.

BIB

108246-NX



BRECKINRIDGE PROJECT
BRECKINRIDGE COUNTY, KENTUCKY
PHASE ZERO
ASLAND SYNTHETIC FUELS, INC.
AIRCO ENERGY COMPANY, INC.
US DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

UOP
Process Division
20 UOP Plaza - Aspen, CO 80516
Simplified Flow Diagram
OF
UOP PLATFORMING PROCESS UNIT
NAPHTHA DERIVED FROM COAL LIQUEFACTION

REVISIONS				CHART
NO.	DATE	DESCRIPTION	BY	CHKD
1	11-28-81	REVISED TO DATE	JJS	ARM
2	1-30-81	REVISED TO DATE	DTM	ARM
3	2-27-81	REVISED TO DATE	DTM	ARM

DR. A.H.W. CR. ARM
APP. JJR DATE 1-15-81
DWS. NO. 108247-NX-3
REV. 3

HYDROTREATER EQUIPMENT LIST

<u>C</u>	<u>Columns and Pressure Vessels</u>	<u>Number Required</u>
C-1	Feed Surge Drum	1
C-2	First-Stage Reactor	1
C-3	Second-Stage Reactor No. 1	1
C-4	Second-Stage Reactor No. 2	1
C-5	Intermittent Blowdown Drum	1
C-6	Reactor Products Separator	1
C-7	Compressor Suction Drum	1
C-8	Stripper Column	1
C-9	Stripper Overhead Receiver	1
<u>D</u>	<u>Tanks</u>	<u>Number Required</u>
D-1	Wash Water Tank	1
<u>E</u>	<u>Exchangers</u>	<u>Number Required</u>
E-1	Cold Combined Feed Reactor/Effluent Exchanger	1
E-2	Hot Combined Feed Reactor/Effluent Exchanger	1
E-3	Second-Stage Reactor Interstage Steam Generator	1
E-4	Reactor Products Condenser	1
E-5	Reactor Products Trim Cooler	1
E-6	Stripper Feed-Bottoms Exchanger	1
E-7	Stripper Bottoms Cooler	1
E-8	Stripper Overhead Condenser	1
<u>F</u>	<u>Fired Heaters</u>	<u>Number Required</u>
F-1	Second-Stage Reactor Charge Heater	1
F-2	Stripper Reboiler Heater	1
<u>G</u>	<u>Pumps and Drivers</u>	<u>Number Required</u>
G-1	Reactor One-Charge Pump	1
G-2	Water Injection Pump	1
G-3	Separator Liquid Products Pumps	2
G-4	Stripper Overhead Recycle Pump	1
G-5	Stripper Reboiler Circulation Pump	1
<u>K</u>	<u>Compressors and Drivers</u>	<u>Number Required</u>
K-1	Recycle Gas Compressors	2

PLATFORMER EQUIPMENT LIST

<u>C</u>	<u>Columns and Pressure Vessels</u>	<u>Number Required</u>
C-1	Feed Surge Drum	1
C-2	Low-Pressure Separator	1
C-3	High-Pressure Separator	1
C-4	Debutanizer	1
C-5	Debutanizer Overhead Receiver	1
C-6	Steam Disengaging Drum	1
C-7	Continuous Blowdown Drum	1
C-8	Intermittent Blowdown Drum	1
C-9	Platforming Reactor No. 1	1
C-10	Platforming Reactor No. 2	1
C-11	Platforming Reactor No. 3	1
C-12	Vent Drums	4
C-13	Regenerator Tower	1
<u>D</u>	<u>Tanks</u>	<u>Number Required</u>
D-1	Condensate Injection Tank	1
D-2	Desuperheater Water Break Tank	1
<u>E</u>	<u>Exchangers</u>	<u>Number Required</u>
E-1	Combined Feed Reactor/Effluent Exchanger	1
E-2	Products Trim Cooler	1
E-3	High-Pressure Cooler	1
E-4	Debutanizer Feed-Bottoms Exchanger	1
E-5	Debutanizer Bottoms Trim Cooler	1
E-6	Products Condenser	1
E-7	Net Gas Cooler	1
E-8	Debutanizer Overhead Condenser	1
E-9	Debutanizer Bottoms Cooler	1
E-10	Steam Surface Condenser	1
E-11	Recycle Gas Cooler	1
E-12	Lift Gas Blower Spillback Cooler	1
E-13	Regeneration Cooler	1
<u>F</u>	<u>Fired Heaters</u>	<u>Number Required</u>
F-1	Platforming Charge Heater	1
F-2	Platforming No. 1 Interheater	1
F-3	Platforming No. 2 Interheater	1
F-4	Debutanizer Reboiler Heater	1

<u>G</u>	<u>Pumps and Drivers</u>	<u>Number Required</u>
G-1	Charge Pump	2
G-2	Low-Pressure Separator Pump	2
G-3	Debutanizer Reflux Pump	2
G-4	Debutanizer Reboiler Pump	2
G-5	Circulating Water Pump	2
G-6	Surface Condenser Condensate	2
G-7	Desuperheater Water Pump	2
G-8	Water/Chemical Injection Pump	1
G-9	Startup Chemical Injection Pump	1
G-10	Organic Chloride Injection Pump	1

<u>K</u>	<u>Compressors and Drivers</u>	<u>Number Required</u>
K-1	Platforming Recycle Gas Compressor	1
K-2	Net Gas Booster	2
K-3	Lift Gas Blower	2
K-4	Chlorination Blower	2
K-5	Regeneration Blower	2
K-6	Regeneration Cooler Blower	2

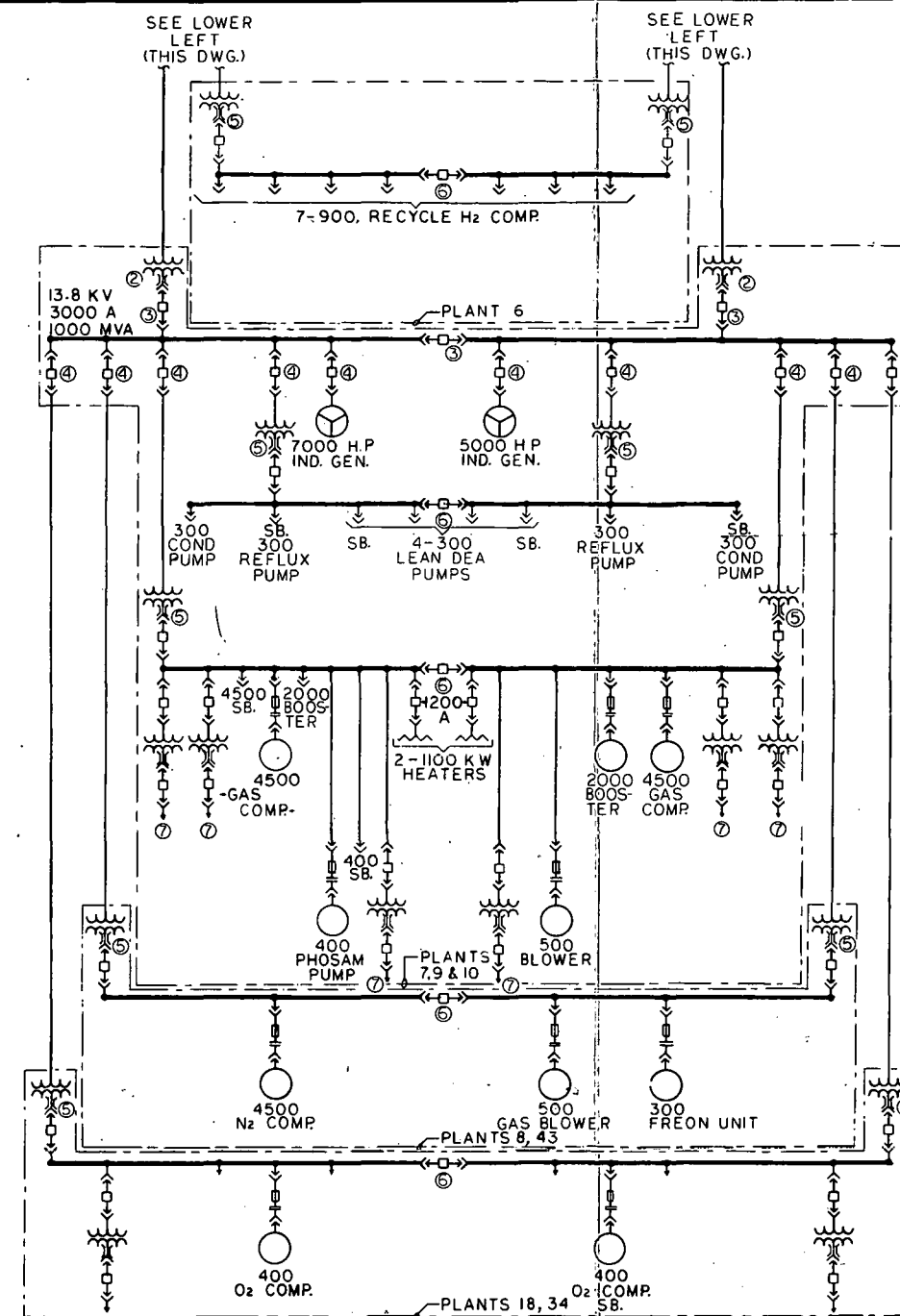
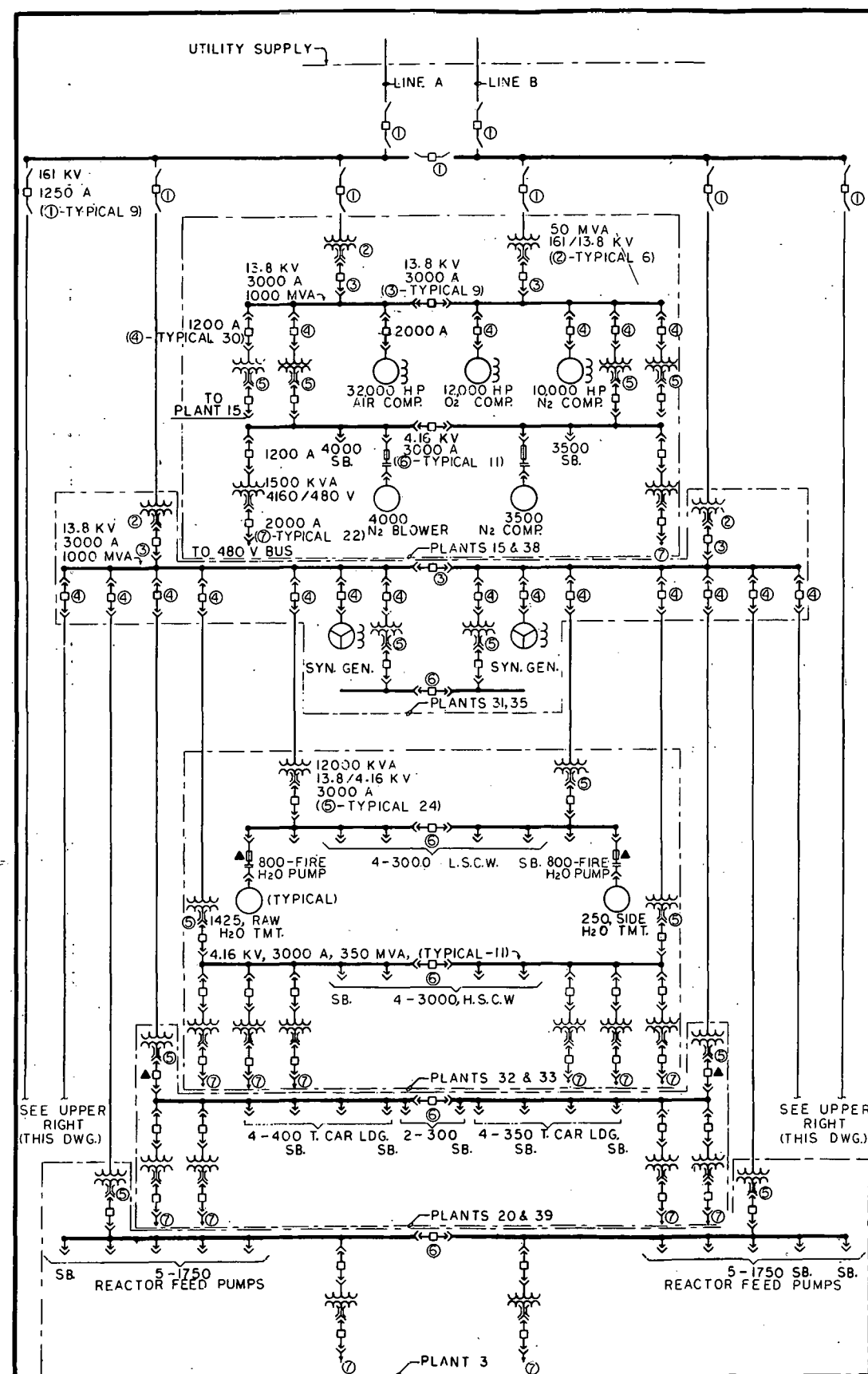
<u>P</u>	<u>Electrical</u>	<u>Number Required</u>
P-1	Chlorination Heater	1
P-2	Regeneration Heater	1
P-3	Air Heater	1

<u>T</u>	<u>Material Handling Equipment</u>	<u>Number Required</u>
T-1	Catalyst Collector	1
T-2	Lock Hopper No. 1	1
T-3	Lift Engager No. 1	1
T-4	Disengaging Hopper	1
T-5	Flow Control Hopper	1
T-6	Surge Hopper	1
T-7	Lock Hopper No. 2	1
T-8	Lift Engager No. 2	1
T-9	Catalyst Addition Lock Hopper	1

<u>Y</u>	<u>Processing</u>	<u>Number Required</u>
Y-1	Platformer Separator Gas Coalescer	1
Y-2	Regenerator Lift Gas Blower	
	Suction Dust Collector	1
Y-3	Air Dryer	1
Y-4	Booster Gas Coalescer	1

4.0 DATA SHEETS AND SKETCHES

Data Sheets for equipment in this plant were not prepared during Phase Zero. The equipment design is proprietary to UOP. Data Sheets will be prepared during the early stages of the EPC phase.



- LEGEND**
- SF₆ BREAKER
 - VACUUM CKT. BKR.
 - E2 CONTROLLER
 - TRANSFORMER
 - MOTOR
 - IND. GENERATOR
 - SYN. GENERATOR
 - SYN. MOTOR
 - HEATER
 - BUS DUCT
 - SB. STANDBY

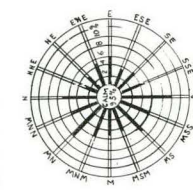
NOTE: ALL TIE BREAKERS ARE N.O. (MANUAL)

WHEN UTILITY SOURCE IS LOST, FEEDER BREAKERS MARRD ▲ WILL OPEN TO NON-ESSENTIAL LOADS

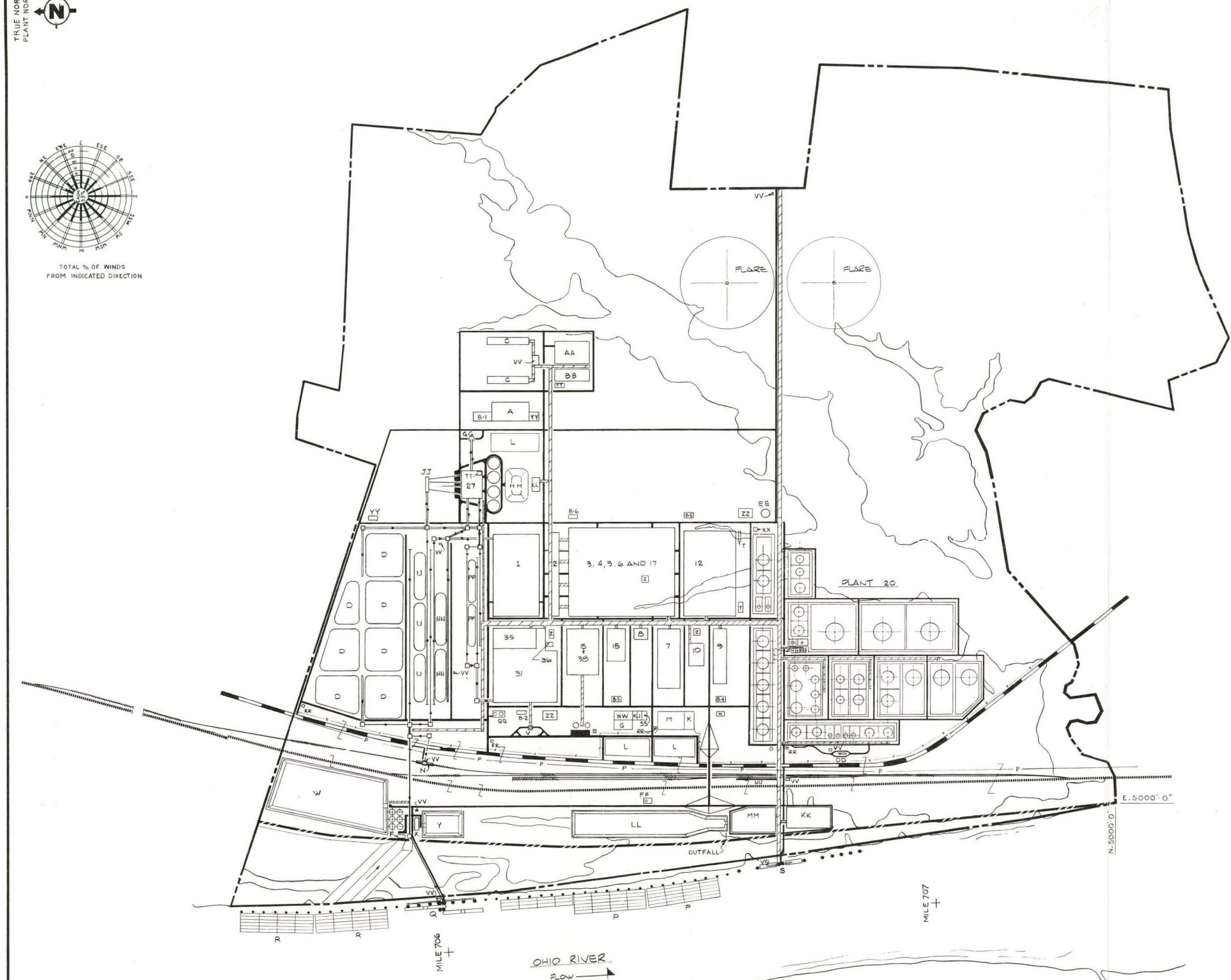
PLANTS: 15,38,31,35,32,33,20,39,3(PART)
6(PART),7,9,10,8,43,18,34

ISSUED FOR PHASE WERD	REV	DATE	BY
ISSUED FOR REVIEW/APPROVAL	REV	DATE	BY
DRAWN BY: T4/RAD CHECKED BY: RAD APPROVED BY: [Signature] PROJECT: ORECKOWIDE PROJECT SHEET: 1 TOTAL SHEETS: 1			
ELECTRICAL ONE LINE DIAGRAM			
1422	30E-P-003	1	

TRUE NORTH 0-0
PLANT NORTH 0-0



TOTAL % OF WINDS
FROM INDICATED DIRECTION



- LEGEND**
1. COAL DRYING AND PULVERIZING
 2. COAL SLURRY PREPARATION
 3. H-COAL PRE-HEATING 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
 11. GASIFICATION AND PURIFICATION
 12. OXYGEN PLANT
 13. DISTILLATE SEPARATION
 14. NAPHTHA TREATING AND REFORMING
 15. TANKAGE
 16. INTERCONNECTING PIPING (PIPERACKS)
 17. RIVER LOADING FACILITIES
 18. RAIL AND TRUCK LOADING
 19. COAL RECEIVING AND STORAGE
 20. COAL WASHING AND SECONDARY CRUSHING
 21. STEAM GENERATION AND B.F.W. TREATING
 22. WATER SYSTEM
 23. FIRE SYSTEM
 24. WASTE WATER TREATMENT PLANTS
 25. STACK GAS SCRUBBING
 26. INSTRUMENT AIR AND PLANT AIR SYSTEM
 27. INERT GAS SYSTEM
 28. PURGE AND FLUSH OIL SYSTEM
 29. WASTE SLUDGE INCINERATOR

- LEGEND**
- A. WAREHOUSE
B-1. THERM 8-6 MAINTENANCE BUILDINGS
C. COOLING TOWERS (PLT. 32)
D. DEAD COAL (PLT. 26)
E. LIQUID OXYGEN AND NITROGEN UNLOADING
F. WATER INTAKE
G. CHANGING HOUSE
H. FIRE STATION
J. FIRST AID STATION
K. CAFETERIA
L. PARKING
M. ADMINISTRATION
N. RAILROAD COAL UNLOADING (PLT. 26)
O. FULL BARGES, 24 BARGE TOW (PLT. 22)
P. COAL UNLOADING DOCK (PLT. 22)
R. EMPTY BARGES, 24 BARGE TOW (PLT. 22)
S. LIQUID LOADING DOCK (PLT. 22)
T. SWITCHGEAR
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. GUARDED 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 N 5000' 0" E 5000' 0" ARE ESTABLISHED AT THE MOUTH OF TOWN CREEK AT THE INTERSECTION OF THE WATER LINE OF THE OHIO RIVER.
 2. REFERENCE: COMMONWEALTH LAND TITLE INSURANCE COMPANY PHILADELPHIA, PENNSYLVANIA FILE NO. L-055292.
 3. HIGH POINT OF FINISHED GRADE ELEVATION 100' 0" EQUALS ELEVATION 415' 0" ABOVE M.S.L.
 4. NORMAL WATER ELEVATION OF OHIO RIVER IS EL. 382.3' AT RIVER MILE 706.
 5. MEAN HIGHWAY ELEVATION IS EL. 415' 0".
 6. 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

1	ISSUED FOR PHASE ZERO	R	P	J	K	J	K	H	S
2	ISSUED FOR REVIEW AND APPROVAL	R	J	K	J	K	H	S	
NO.	DATE	DESIGNED	BY	CHEK	REVIEW	BY	CHEK	REVIEW	BY
SCALE	1"=400'	DESIGNED	J. KUTLIK	BY		REVIEW			

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

U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT
NO. DE-FC05-80OR2177

BRECKINRIDGE PROJECT

BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY

OVERALL SITE PLAN

JOB NO.	DRAWING NO.	REV.
14222	50E-A-1	1

HOUSTON

BOUNDARY LINE
EXISTING ROAD
NEW ROAD
EXISTING RAILROAD
NEW RAILROAD
PREDACK
FLOODWAY FRINGE
CONVEYOR
EXISTING POWER LINE
FENCE

		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 & SAFETY 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	0.1" DIA. ARCS AT 0.6" SPACING
F.	OTHER SYSTEMS, BLOC. OUTLINES & EQUIPMENT	0.5" (NOTE 1) 0.3" LINE, 0.1" SPACE
G.	CENTER LINE	0.5" (NOTE 1) 0.3" + 0.1" LINES, 0.1" SPACE
H.	FURNISHED BY OTHERS	0.6" (NOTE 1) 0.3" + 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	

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		0.50" X 0.25"
7. FURNISHED WITH EQUIPMENT		0.2" LINES

1.		OPEN DURING NORMAL OPERATION (ALL VALVES EXCEPT BUTTERFLY)
2.		CLOSED DURING NORMAL OPERATION
3.		OPEN DURING NORMAL OPERATION (BUTTERFLY ONLY)
4.		CLOSED DURING NORMAL OPERATION (BUTTERFLY ONLY)
5.		LO - LOCKED OPEN
		LC - LOCKED CLOSED
		CSO - CAR SEALED OPEN
		CSC - CAR SEALED CLOSED

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)

13.		BREATHER CAP
14.		LOOP SEAL
15.		DOWNWARD SLOPE (1" PER 8' SHOWN)
16.		UPWARD SLOPE (1" PER 5' SHOWN)
17.		ATMOSPHERIC VENT
18.		HEAT CONSERVATION
19.		PROCESS CONTROL
20.		COLD INSULATION
21.		STEAM TRACING
22.		ELECTRIC TRACING
23.		PERSONAL PROTECTION INSULATION
24.		JACKETED
25.		STRESS RELIEVE

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.		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.		ACTUATOR G - GEAR (SHOWN) H - AIR WRENCH C - CHAIN E - EXTENSION STEM S - SPECIAL TYPE

1.		SPECTACLE BLIND
2.		CIRCULAR OR HAMER BLIND
3.		SIMPLEX BASKET STRAINER
4.		DUPLEX BASKET STRAINER
5.		Y-TYPE STRAINER (SHOWN WITHOUT BLOWOFF VALVE)
6.		TEMPORARY STARTUP STRAINER
7.		SCREEN TYPE STRAINER
8.		FILTER
9.		EXPANSION JOINT
10.		FLAME ARRESTER
11.		TRAP ST - STEAM TRAP (SHOWN) AT - AIR TRAP DT - DRAIN TRAP
12.		PIPE SPEC. CHANGE
13.		EJECTOR OR EDUCTOR
14.		EXHAUST HEAD
15.		SPRAY NOZZLE OR SPARGER (SHOWN WITH UPWARD FLOW)
16.		DESUPERHEATER
17.		SAMPLING CONNECTION (NO. INDICATES TYPE)
18.		SAMPLE COOLER (NO. INDICATES TYPE)
19.		STEAM OUT
20.		UTILITY STATION WATER, AIR, STEAM SHOWN
21.		DRINKING FOUNTAIN
22.		HEATING COIL

22.		IN-LINE MIXER	23.		COL
24.		MODULATING-TYPE BY-PASS RECIRCULATING VALVE (YARWAY)			
25.		ASME BOILER PRESSURE VESSEL CODE LIMITS			
26.		DRAIN TO SEWER DWS = DILY WATER SEWER (SHOWN) SWS = SANITARY WATER SEWER CS = CHEMICAL SEWER WS = WATER SEWER (STORM DRAIN)			
27.		AIR FILTER			

1. TWO-WAY (TYPICAL, GLOBE SHOWN)
 FO - INDICATES FAIL OPEN
 FC - INDICATES FAIL CLOSED
 FL - INDICATES FAIL LOCKED
 FN - INDICATES FAIL (POSITION DOES NOT CHANGE)
 FI - INDICATES FAIL INDETERMINATE

2. 3-WAY

3. 4-WAY

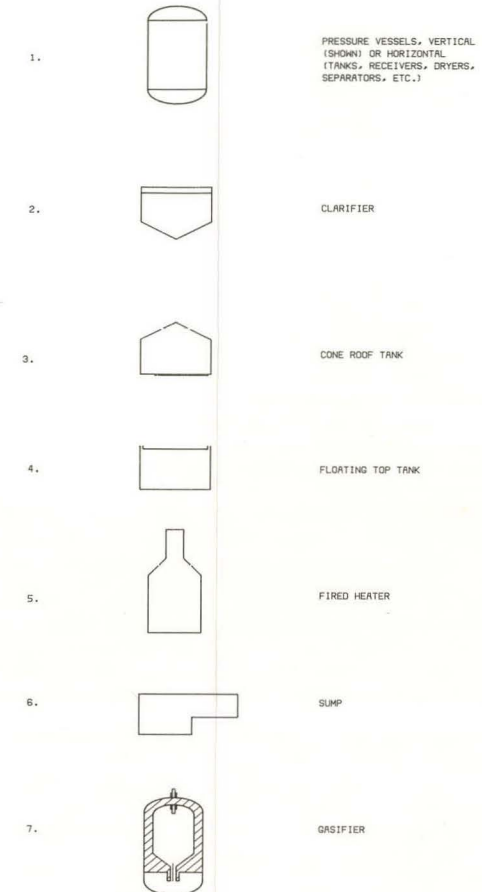
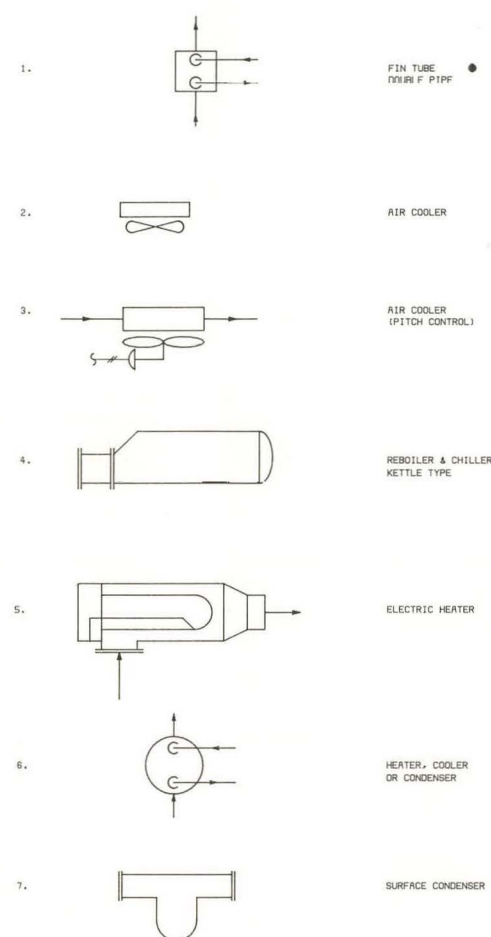
1.		FIRE HYDRANT
2.		FIRE HYDRANT WITH PUMPER CONNECTION
3.		FIRE HYDRANT WITH MONITOR (PUMP CONNECTION SHOWN)
4.		ELEVATED MONITOR
5.		HOSE AND STAND PIPE SYSTEM PER NFPA-14
6.		FIXED SPRAY SYSTEM PER NFPA-15
7.		SPRINKLER SYSTEM PER NFPA-13
8.		HALON 1301 SYSTEM PER NFPA-12A
9.		CO ₂ SYSTEM PER NFPA-12
10.		HOSE HOUSE
11.		DELUGE VALVE
12.		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 CURVES, SYMBOLS & EQUIPMENT LINES MAY NOT START WITH A SPACE.

VESSELS, TANKS, ETC.



DESIGNATIONS
INSTRUMENT TAGGING

```

COMPLETE TAG NUMBER

PV 12 3 4 5 6
| | | | |
| | | | | --- MODIFIER, A, B, C ETC.
| | | | | --- LOOP NUMBER
| | | | | --- TRAIN NUMBER (SINGLE TRAIN IS 1)
| | | | | --- PLANT NUMBER
| | | | | --- ISA FUNCTION

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 NAME AS THE DRAWING.

```

PV
348A FOR EXAMPLE

	2-26-78	ISSUED FOR PHASE 0		LOC	ADJ	H5	H5	
		ISSUED FOR REVIEW / APPROVAL		APP	ADJ	H5	H5	
NO.	DATE	REVISIONS	BY	CHK	SUPV.	ENGR.	SL	INSP.
		DESIGNED	DRAWN					
ASHLAND SYNTHETIC FUELS, INC. AIRCRO ENERGY COMPANY, INC.			U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FG00-80ORCITY					
BRECKINRIDGE PROJECT								
DRECKINRIDGE COUNTY			PHASE ZERO				KENTUCKY	
SYMBOLS & LEGEND								
PIPING & INSTRUMENT DIAGRAMS								
	JOB NO.		DRAWING NO.				REV.	
HOUSTON	14222		OE-A-12				1	

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. 0-EA-4)

1.		FE - ORIFICE PLATE FO - 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, DWP, O-EA-4)
11.		FLOW STRAIGHTENING DEVICE

1.		GAUGE GLASS OR FLOAT OR DISPLACEMENT TYPE LEVEL INSTRUMENT
2.		DIFFERENTIAL PRESSURE TYPE (NOTE 3, DWG. 0-EA-4)
3.		(NOTE 3, DWG. 0-EA-4) TANK-MOUNTED DIFFERENTIAL PRESSURE TYPE
4.		INTERNAL BALL-FLOAT TYPE
5.		GAUGE BOARD TYPE

1.  DIRECT CONNECTED

2.  WITH DIAPHRAGM SEAL, PIPED

SENSOR - ANALYSIS

1.  THROUGH-FLOW TYPE

2.  NON THROUGH-FLOW TYPE

1. THROUGH-FLOW TYPE

2. NON THROUGH-FLOW TYPE

1. TI = BIMETALLIC THERMOMETER
TM = THERMOMILL
TE = SINGLE SENSOR

2. DUAL SENSOR
(SHOWN WHEN BOTH ARE USED)

3. FILLED SENSOR

SFF DWG. O-FA-1
(NOTE 4, DWG. O-EA-4)

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 PNEUMO-HYDRAULIC (SYMBOL P/H)
10. UNCLASSIFIED (TYPE OF ACTUATOR TO BE WRITTEN ADJACENT TO THE SYMBOL)

(NOTE 4, DWG. O-EA-4)

1. FLOW REGULATOR
(NOTE 5, DWG. 0-EA-4)
2. SIGHT FLOW GLASS

1. LEVEL REGULATOR WITH MECHANICAL LINKAGE

1.		PRESSURE REDUCING REGULATOR SELF-CONTAINED
2.		PRESSURE REDUCING REGULATOR WITH EXTERNAL PRESSURE TAP
3.		DIFFERENTIAL PRESSURE REDUCING REGULATOR WITH INTERNAL AND EXTERNAL PRESSURE TAPS
4.		BACKPRESSURE REGULATOR SELF-CONTAINED
5.		BACKPRESSURE REGULATOR WITH EXTERNAL PRESSURE TAP
6.		PRESSURE RELIEF OR SAFETY VALVE, ANGLE PATTERN SPRING OR WEIGHT LOADED, OR WITH INTEGRAL PILOT
7.		VACUUM RELIEF VALVE, ANGLE PATTERN SPRING OR WEIGHT LOADED, OR WITH INTEGRAL PILOT
8.		PRESSURE AND VACUUM RELIEF VALVE
9.		RUPTURE DISK OR SAFETY HEAD, FOR VACUUM RELIEF
10.		RUPTURE DISK OR SAFETY HEAD, FOR PRESSURE RELIEF

1. TEMPERATURE REGULATOR,
FILLED SYSTEM TYPE

1.

TWO-WAY HAND CONTROL VALVE
IN PROCESS LINE
(NOTE: S, DMG, G-EAR)
2.

MANUALLY ADJUSTABLE
RESTRICTION ORIFICE
IN SIGNAL LINE
3.

TWO-WAY HAND ACTUATED
SWITCHING VALVE
IN PNEUMATIC SIGNAL LINE

(NOTE 7, DWG. O-ER-4)

1. SIGNAL RELAY
(NOTE 8, DWG. 0-EA-4)

2. $\sqrt{\quad}$ SQUARE ROOT EXTRACTOR

3. $\frac{E}{P}$ VOLTAGE TO PNEUMATIC
CONVERTER

6. Σ ADD AND SUBTRACT

FOR ADDITIONAL RELAY SYMBOLS

FOR ADDITIONAL RELAY SYMBOLS,
SEE ISA S5.1, TABLE 2

12. 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

100

ONLY IF ALL INPUT EXIST

10. *Chlorophyll a* (mg/g dry weight) = $\frac{12.7}{2300} \times \text{Absorbance at } 663 \text{ nm}$

[illegible]

FIRST LETTER (NOTE 9)		SUCCEEDING LETTER(S) (NOTE 9)																			
MEASURED OR INITIATING VARIABLE (NOTE 10)	SYMBOL	SENSING DEVICE (NOTE 5)		DISPLAY DEVICE						CONTROL DEVICE (NOTE 5)						MISCELLANEOUS DEVICE					
		PRIMARY ELEMENT	TRANSMITTER	INDICATOR	RECORDER	INTEGRATING INDICATOR	ALARM ANNUNCIATOR (NOTE 15)			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)	
							LOW	HIGH	HIGH & LOW												
TYPICAL SYMBOL	()	()E	()T	()I	()R	()G	()AL	()AH	()AHL	()K	()C	()V	()CV	()Z	()S	()G	()P	()Y	()B	()N	()X
ANALYSIS (NOTE 11)	A	AE	AT	AI	AR		AL	AH	AHL	AK	AC	AV		AZ	AS		AP	AY	AB	AN	AX
BURNER FLAME	B	BE	BT	BI	BR		BL	BH	BHL	BC	BC	BV		BS	BS	BG	BP	BY	BB	BN	BX
CONDUCTIVITY	C	CE	CT	CI	CR		CL	CH	CHL	CK		CV		CZ	CS		CP	CY	CB	CN	CX
DENSITY (MASS) OR WEIGHT	D	DE	DT	DI	DR		DL	DH	DHL	DK	DC	DV		DZ	DS		DP	DY	DB	DN	DX
VOLTAGE (EMF)	E	EE	ET	EI	ER		EL	EH	EHL	EK	EC			EZ	ES			EY	EB	EN	EX
FLOW (NOTE 12)	F	FE	FT	FI	FR	FG	FL	FH	FHL	FK	FC	FV	FCV	FZ	FS	FG	FP	FY	FB	FN	FX
GAGING (DIMENSIONAL)	G	GE	GT	GI	GR		GL	GH	GHL	GK	GC			GZ	GS			GY	GB	GN	GX
HAND (MANUAL)	H										HC	HV	HCV	HZ	HS		HP	HY			
CURRENT	I	IE	IT	II	IR	IG	IL	IH	IHL	IK	IC			IZ	IS			IY	IB	IN	IX
POWER	J	JE	JT	JI	JR		JL	JH	JHL	JK	JC			JZ	JS			JY	JB	JN	JX
TIME	K		KT	KI		KG	KL	KH	KHL	KK	KC	KV		KZ	KS			KY	KB	KN	KX
LEVEL	L	LE	LT	LI	LR		LL	LH	LHL	LK	LC	LV	LCV	LZ	LS	LG	LP	LY	LB	LN	LX
MOISTURE	M	ME	MT	MI	MR		ML	MH	MHL	MK	MC	MV		MZ	MS		MP	MY	MB	MN	MX
USER'S CHOICE	O																				
PRESSURE	P	PE	PT	PI	PR		PL	PH	PHL	PK	PC	PV	PCV	PZ	PS		PP	PY	PB	PN	PX
PRESSURE DIFFERENTIAL	PD		PDT	POI	POR		PDL	PDH	PDLH	PDK	PDC	PDV	PCV	PZ	PDS						
QUANTITY OR EVENT	Q		QT	QI	QR	QG	QL	QH	QHL	QK	QC	QV		QZ	QS			QY	QB	QN	QX
SPEED OR FREQUENCY	S		ST	SI	SR	SG	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	TB	TN	TX
MULTIVARIABLE	U			UI			UL	UH	UHL		UC	UV		UZ	US		UP	UY	UB	UN	UX
VISCOSITY	V		VT	VI	VR		VL	VH	VHL	VK	VC	VV		VZ	VS		VP	VY	VB	VN	VX
WEIGHT	W	WE	WT	WI	WR	WG	WL	WH	WHL	WK	WC	WV		WZ	WS			WY	WB	WN	WX
UNCLASSIFIED (NOTE 14)	X																				
VIBRATION	Y	YE	YT	YI	YR			YH							YS		YP	YY	YB	YN	YX
POSITION	Z	ZE	ZT	ZI	ZR		ZL	ZH	ZHL	ZC				ZZ	ZS		ZP	ZY	ZB	ZN	ZX

GENERAL NOTES

- EXAMPLES OF THE USE OF TANGENTIAL INSTRUMENT CIRCLES TO DENOTE A SINGLE INSTRUMENT WITH TWO VARIABLES AND/OR TWO FUNCTIONS.
TWO VARIABLES: FR/PD, A 2 PEN RECORDER, ONE FOR FLOW ONE FOR PRESSURE.
TWO FUNCTIONS: L/LC, A DUAL-PILOT LEVEL INSTRUMENT, ONE TRANSMITTER AND ONE CONTROLLER.
HCV/ZSH, MANUAL CONTROL VALVE WITH POSITION SWITCH.
- THE TYPE OF FLOW INSTRUMENT MAY BE NAMED OUTSIDE THE INSTRUMENT CIRCLE, E.G., MAGNETIC FLOW METER, DISPLACEMENT METER, MASS FLOW METER, ETC.
- THE UPPER INSTRUMENT LEAD LINE IS OMITTED IF LEVEL IS MEASURED BY PRESSURE INSTEAD OF DIFFERENTIAL PRESSURE.
- VALVE BODY PORTS THAT ARE CLOSED IN NORMAL OPERATION ARE BLACKENED. THE OPERATING CONDITION SHOWN FOR ALL VALVE BODIES CORRESPONDS 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 CLOSURES DURING UPSETS CONTAINS A DOT.
- 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., DIC DESIGNATES ANALYSIS INDICATING CONTROL STATION.
- A HAND CONTROL VALVE HCV IS A HAND-ACTUATED VALVE THAT EITHER MODULATES A PROCESS STREAM OR IS USED AS AN INSTRUMENT DEVICE.
- FOR ROOT AND OTHER INSTRUMENT VALVES, SEE INSTRUMENT INSTALLATION DETAILS.
- THE DESCRIPTION DENOTING A RELAY FUNCTION SHOULD BE SHOWN ON THE PAID EXCEPT WHEN USED WITH DISTINCTIVE SYMBOLS SUCH AS A SOLENOID VALVE.
A DOUBLE SOLENOID VALVE IS DRAWN WITH TWO SINGLE SOLENOIDS.
- THE INSTRUMENT LEGEND IS BASED ON ISA STANDARD 5.1-1973 FOR FURTHER DETAILS AND CLARIFICATION, REFER TO ISA STANDARD.
- 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 (QI - FLOW INTEGRATING INDICATOR)
- 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
CL - CHLORINE
CO - CARBON MONOXIDE
COMB - COMBUSTIBLE
COND - CONDUCTIVITY
H - DISSOLVED HYDROGEN
HS - DENSED HYDROGEN
H2S - HYDROGEN SULFIDE
M - MOISTURE
N - NITROGEN
NOX - NITROGEN OXIDES
O - DISSOLVED OXYGEN
O2 - GASEOUS OXYGEN
ORP - OXIDATION REDUCTION
PH - PH
SI02 - SILICA
SO2 - SULFUR DIOXIDE
TSS - TURBIDITY
VIS - VISCOSITY
- PD - DESIGNATES FLOW RESTRICTION ORIFICE
PF - DESIGNATES FLOW RATIO
FFC - DESIGNATES FLOW RATIO CONTROLLER
- 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.
- 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.
- HIGH-HIGH ALARMS HAVE ()HH, LOW-LOW ALARMS HAVE ()LL, AND HIGH-LOW ALARMS HAVE ()HL IN INSTRUMENT CIRCLE, E.G., LAHH - DESIGNATES HIGH-HIGH LEVEL ALARM
LALL - DESIGNATES LOW-LOW LEVEL ALARM
LAHL - DESIGNATES HIGH-LOW LEVEL ALARM
- THE LETTER Z WHICH FOLLOWS A MEASURED VARIABLE REPRESENTS FINAL DEVICES OTHER THAN CONTROL VALVES SUCH AS HYDRAULIC COUPLINGS, VARIABLE SPEED DRIVE, ACTUATOR, ETC.
- 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.
- 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
- TEXT LOCATIONS AROUND INSTRUMENT "BALLOONS" SHALL BE STANDARDIZED AS SHOWN IN THE SKETCH BELOW.
J3 - J4
J1 - ISA CODE (INSTRUMENT TYPE)
J2 - LOOP NUMBER
J3 - VENDOR DESIGNATION (E.G., #)
J4 - FUNCTION (E.G., V)

ISSUED FOR PHASE 0	10/10/73	1/5	1/5
ISSUED FOR REVIEW / APPROVAL	10/10/73	1/5	1/5
NO.	DATE	REVISIONS	BY
1	10/10/73	1	1/5
DESIGNED			
DRAWN			
ARS AND SYNTHETIC FUELS, INC. ARCO ENERGY COMPANY, INC.			
U.S. DEPARTMENT OF ENERGY COOPERATIVE AGREEMENT NO. DE-FC05-60OR20717			
BRECKINRIDGE PROJECT			
BRECKINRIDGE COUNTY PHASE ZERO KENTUCKY			
SYMBOLS & LEGEND PIPING & INSTRUMENT DIAGRAMS			
	JOB NO.	DRAWING NO.	REV.
	14222	0E-A-4	1

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34X44 "E" SIZE