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The BRECKINRIDGE PROJECT

Initial Effort

REPORT III

VOLUME 1

MASTER

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

PREPARED FOR
UNITED STATES DEPARTMENT OF ENERGY
UNDER COOPERATIVE AGREEMENT
NO. DE-FC05-80OR20717

DISCLAIMER

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

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Volume Introduction and
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REPORT III
VOLUME I

INTRODUCTION

Report III, Volume 1 contains those specifications numbered A through J, as follows:

- General Specifications (A)
- Specifications for Pressure Vessels (C)
- Specifications for Tanks (D)
- Specifications for Exchangers (E)
- Specifications for Fired Heaters (F)
- Specifications for Pumps and Drivers (G)
- Specifications for Instrumentation (J)

The standard specifications of Bechtel Petroleum Incorporated have been amended as necessary to reflect the specific requirements of the Breckinridge Project, and the more stringent specifications of Ashland Synthetic Fuels, Inc. These standard specifications are available to the Initial Effort (Phase Zero) work performed by all contractors and subcontractors.

Report III, Volume 1 also contains the unique specifications prepared for Plants 8, 15, and 27. These specifications will be substantially reviewed during Phase I of the project, and modified as necessary for use during the engineering, procurement, and construction of this project.

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 III
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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
BASIC INSTRUCTION FOR P&ID DEVELOPMENT

JOB NO 14222
SPECIFICATION 14222-A-1
REV 3

1.0 GENERAL INFORMATION

1.10 Scope

⚠ This instruction defines the basic criteria for P&ID development and engineering for the Breckinridge Project to be located in Western Kentucky. This document shall be used as a guide for the engineering work on this project if called for in the subcontractors contract. It is to be applied generally, except when process constraints or conditions require or permit deviations. Paragraphs marked with ⊕ are not mandatory in "Phase Zero" design effort.

1.20 Design Calculations

Calculations performed on the job, whether they are performed on regular calculation sheets or special forms, shall be individually numbered and indexed.

⚠ The Index Sheet shall be prepared and kept current for each plant by the design group supervisors. Refer to specification 14222-A-21 cedure for calculation sheet numbering system. Assignment and control of calculation numbers will be by the Project Engineering Supervisors and Discipline Supervisors as applicable.

2.0 P&ID PRESENTATION

2.10 Size

Use 34-inch high mylar transparent film up to a maximum length of 10 feet for each P&ID. Reproductions of the P&ID's reduced to 11 inches will be required. P&ID's may be produced by either Computer-Aided Drafting (CAD) or normal methods and shall be of a quality which is legible on the reduced prints.

2.20 Format

2.21 Layout

2.21.1 Equipment and piping symbols shall conform to the following Standard Drawings:

(a) A-507 - Mechanical Flow Diagrams
(b) A-510 - P&ID's
(c) B-507 - Process Flow Diagrams

2.21.2 Instrument symbols and identification shall conform to Standard Drawings J-G-0101, J-G-0103 and J-G-0104.

2.21.3 All flow lines shall be spaced 3/8-inch or multiples of 3/8-inch apart, at least on the first issue. Where horizontal and vertical lines cross, the horizontal line shall be broken. Break instrument lines crossing all flow lines. ⚠ Spacing may be 0.40 inches on CAD drawn P&ID's.

2.21.4 All lettering shall be vertical upper case. Letters and numbers should be a minimum of 1/8-inch high to assure legibility when drawings are reduced.

2.21.5 A legend giving the description of symbols, specifications, line and instrument identification, commodity designations, etc., shall be shown on the right-hand side of all diagrams, with the exception of process flow diagrams. Preprinted decals will be available for this purpose.
△ Legend drawings may be referenced as an alternate.

2.21.6 A vertical and horizontal grid reference system shall be used on all P&ID's using numerals in the horizontal and letters in the vertical. See Standard Drawing A-515.

2.22 Process Flow Diagrams

The process flow diagram is a simplified diagram showing only features significant to the overall process system; i.e., pressure, temperature, flow quantities, characteristics, heat balances, equipment sizes and duties, and primary controls. See example, Drawing B-506.

2.22.1 Use simplified equipment symbols in accordance with Standard Drawing B-507, indicating only general types.

2.22.2 Identify flow streams, utilities and services with numbers keyed to commodity and flow data which shall be tabulated along the lower portion of the drawing or on a separate sheet.

2.22.3 General flow pattern shall be from left to right.

2.23 Process Piping & Instrument Diagrams

The P&ID is developed from the Process Flow Diagram and shows considerably more detail. For conventional fluid-flow process, arrange process piping and instrument diagrams as follows: See Standard Drawing A-514.

2.23.1 Arrange equipment, vessels, drums, exchangers, heaters, etc., along top of diagram in sequence consistent with principal functions and flows, so overall flow pattern progresses from left to right. Leave room at top for equipment titles, number and other data.

2.23.2 Draw equipment somewhat in proportion to indicate relative sizes, except where standard sizes are established. See Standard Drawings A-507 and A-514. Simplify equipment shapes.

2.23.3 Arrange pumps, compressors and similar machinery along bottom part of diagram; if possible, directly below associated equipment. Leave room at bottom for equipment titles, numbers and other data.

2.23.4 Use space between equipment and pump rows for lines connecting between equipment and pumps.

2.23.5 Process lines shall have a general flow pattern from left to right. Lines entering or leaving the diagram shall show a continuation line and drawing number.
△ Off-plot lines shall be identified by a "Bull's Eye". Process lines continuing to P&ID's of the same plant shall terminate to the side, permitting a "Butting Up" to the next P&ID.

2.23.6 Avoid repeating unnecessary details for a group of functionally identical units; show details for one, marked typical for total number required.

△ 2.23.7 All flow lines shall show the direction of flow and ⊕ be identified by plant number (for multi-unit projects), commodity symbol, line number, size and service specification. Cancelled line numbers shall not be reused.

△ ⊕ 2.23.8 At junctions of lines carrying different piping specifications, indicate clearly the point at which the higher specification commences.

△ ⊕ 2.23.9 A piping specification shall be shown on all vessels for miscellaneous piping connections. On vertical vessels, where more than one pipe specification applies, the location of the specification change should be indicated.

△ ⊕ 2.23.10 Lines requiring insulation, steam or electric tracing shall carry the appropriate symbol per Standard Drawing A-510. Type and thickness of insulation shall not be shown.

⊕ 2.23.11 All special valves shall be identified by an item code number. Size shall be shown only if valve is not line size.

△ ⊕ 2.23.12 A minimum dimension from grade to tangent line of all vertical vessels shall be shown.

△ ⊕ 2.23.13 Minimum dimensions from grade or related equipment to bottom of all horizontal drums shall be shown.

2.23.14 Main flow streams shall be shown in a heavy line.

△ ⊕ 2.24 Utility Distribution Piping & Instrument Diagrams

Utility distribution piping and instrument diagrams are to show service systems such as steam, condensate, water, air, fuel, pumpout and blowdown, etc. See Standard Drawing A-514.

2.24.1 Utility distribution diagrams are normally developed after the plot plan has been established in order to geographically locate headers and branches in their true relationship to the equipment.

2.24.2 Utility distribution diagrams shall not show equipment outlines, unless the equipment is a functional part of a utility system. Water treating units, boiler plants, effluent plants, etc., should be handled similarly to process P&ID's.

2.24.3 Valving and control for utilities to individual process equipment shall be shown on the process P&ID. Do not duplicate this information on the distribution P&ID.

2.25 Equipment Numbers

Each piece of equipment shown on Process Flow Diagrams and P&ID's is to be identified by number and description.

2.25.1 Numbers shall be recorded on appropriate Status of Equipment forms.

2.25.2 All equipment shall be classified under the applicable alphabetical group letter, as shown on Standard Drawing A-501. Equipment numbers are assigned separately for each plant number prefix for further identification.

2.25.3 Refer to Specification 14222-A-20 for equipment numbering system.

2.25.4 If a piece of equipment has been deleted from the project or from a plant, the equipment number shall not be reused.

2.26 Equipment Headings

Write equipment titles as shown on process flow diagrams. Add the following information under titles:

2.26.1 Columns, Pressure Vessels & Reactors

(a) Item Number
(b) Service
(c) Internal diameter and tangent line to tangent line height

(d) Design pressures and temperatures
⚠ ⊕ (e) Insulation thickness
⊕ (f) If stress relieved, it should be so indicated

2.26.2 Atmospheric Tanks

(a) Item Number
(b) Service
(c) Tank Capacity
⚠ ⊕ (d) Insulation Thickness

2.26.3 Shell & Tube Heat Exchangers

(a) Item Number
(b) Service
(c) Design Duty
(d) Design Pressure and Temperature for each of the tube side and shell side
⚠ ⊕ (e) Insulation Thickness for both sides
*(f) Total Heat Exchange Area
⊕ (g) If shell and/or channel heads are stress relieved, it should be so indicated.

2.26.4 Air-Cooled Exchangers

(a) Item Number
(b) Service
(c) Design Thermal Duty
(d) Design Pressure and Temperature
⊕ (e) Induced Draft or Forced Draft Fans
(f) If variable Pitch Fans; it should be so indicated
*(g) Fan Driver Brake Horsepower
⊕ (h) Winterization Requirement, if any
⊕ (i) If header boxes are stress relieved, it should be so indicated
*(j) Total heat exchange area

2.26.5 Compressor, Blowers, Fans & Drivers

(a) Item Number
(b) Service
(c) Rated Capacity (ACFM)
(d) Rated Differential Pressure (at operating conditions)
*(e) Specific Gravity & Temperature of operating conditions
(f) Driver BHP

2.26.6 Pumps & Drivers

(a) Item Number
(b) Service
(c) Rated Capacity
(d) Rated Differential Pressure (of operating conditions)
(e) Specific Gravity & Temperature of operating conditions
(f) Driver BHP

*For "Phase Zero" use estimated values if design values are not available.

2.26.7 Furnaces

(a) Item Number
(b) Service
(c) Process Absorbed Duty
(d) Steam Generation Duty
*(e) Total Heat Release

2.26.8 Ejectors, Filters & Special Equipment

(a) Item Number
(b) Service
(c) Design Capacity or other appropriate data

*For "Phase Zero" use estimated values if design values are not available.

2.27 P&ID Development Guidelines

2.27.1 Equipment (General)

△1 ⊕ Show all flanges on equipment flanged nozzles. Indicate size and rating if blinded or different from connecting line.

2.27.2 Vessels

1. Draw vessels outlines somewhat in proportion to indicate relative sizes.

△1 ⊕ 2. Show schematically (in dotted line) vessels internals, such as:

   (a) Trays, types & numbers
   (b) Demister pads
   (c) Steam coils or spiders
   (d) Vortex breakers
   (e) Reactor beds
   Etc.

△1 ⊕ 3. Show liquid levels (normal, high, low, alarm and shutdown levels).

2.27.3 Fired Heaters

1. Draw heater outline on the basis of general concept illustrated on Process Flow Diagram.

2. Show schematic arrangement of convection and radiant sections coils as described in the heater specification (if the heater has been selected, you may be guided by the Supplier's outline drawing enclosed with the bid). It is necessary to show all the parallel passes in the heater (at least at the terminals) because they connect to the piping and manifolds.

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* For "Phase Zero" use estimated values if design values are not available.

3. Draw schematically all equipment and components related to the heater (e.g., air prehater, draft fans, flow dampers, etc.). If not defined, allow empty space for future addition.

4. Show complete detail of one burner and write number of burners (if available).

5. Some heaters, particularly those equipped with draft fans, are heavily instrumented, so allow for generous space around the heater to accommodate the required instrumentation.

2.27.4 Air-Cooled Exchangers

Draw all sections of air coolers and show inlet and outlet manifolds. If not defined during initial drafting, consult with Mechanical Group about the expected number for specified duty.

△1 ⊕ 2.27.5 Special Systems

Show necessary information on the P&ID to alert the design groups of certain specific requirements which must be considered during the early design stages. For example, show:

(a) Elevation of thermosyphon reboilers.

(b) Requirement for symmetrical piping connecting to parallel heat exchangers, air coolers, etc.

(c) Elevation of equipment connecting to very low Delta P the feasibility of the hydraulic balance in this particular system.

(d) Requirement of restriction on lengths and layout for some two-phase flow lines.

⊕ 2.27.6 Lines

1. Instrument supply air lines connecting to various instruments shall not be shown on P&ID's.

2. Operating vents and drains shall be shown.

3. High point vents and low point drains (normally determined by design) shall not be shown.

4. Show and indicate sizes of reducers.

5. Identify sloped lines, showing rate and direction.

2.27.7 Valves

1. All valves, regardless of size, shall be shown on the P&ID, except those listed in Paragraph 2, below. These valves shall include:

   ⊕ (a) Valves on operating vents and drains and on drains on control valve manifolds. Note that vents and drains on equipment are considered operating connections.

   ⊕ (b) Header root valves.

   ⊕ (c) All valves on level instruments including vents and drains. For in-line valves, indicate size only if other than line size.

2. The following valves shall not be shown on the P&ID:

   (a) Valves connecting to:

      (1) Pressure instruments and pressure points
      (2) Orifice flanges
      (3) Analyzers and sample installations
      (4) Steam traps
      (5) High point vents and low point drains

   (b) Valves on assemblies to be covered by standard drawings (e.g., steam trap assemblies, sampling stations and analyzers, utility stations, steam tracing, etc.), except those listed in Paragraph 1.

   (c) Valves on pump trim drawings.

⊕ 3. It is essential to follow the foregoing instructions in order to provide firm basis for valve takeoff.

⊕ 4. Valve coding on P&ID's shall be as follows:

   (a) When using Standard Piping Specifications, which provide only one type of valve for each piping class, it is not necessary to code the valves.

   (b) Special valves or other items which are not in accordance with the piping class must be coded.

   (c) When using specifications which permit more than one type of valve for each piping class, then all valves must be coded.

⊕ 2.27.8 Miscellaneous

1. Show all steam traps required for equipment operation.

2. Steam traps connected to low point drains on steam headers and branches shall not be shown.

3. Show all sample point connections.

△ ⊕ 2.30 Line Designation Tables (LDT's)

LDT's shall be prepared using Bechtel Form 18. One set of line tables shall be prepared for each commodity in each plant. Within each plant, number the lines consecutively for each commodity.

2.30.1 Line Numbering

Refer to Project Scope and Procedures for line numbering system. Do not reuse line numbers once they are deleted.

2.30.2 Line Table Numbering

LDT's shall normally consist of two data sheets for each process plant; one for process LDT and the other for utility LDT. Each set of line tables (process or utility) shall consist of an 8½"x11" index sheet (Form 1) sheet 1 and subsequent 11"x17" sheets (Form 18) numbered consecutively starting with sheet 2. For numbering system, refer to the Project Scope and Procedures.

2.40 Commodity Symbols

Use commodity symbols listed below for piping designation and flow diagrams development:

PROCESS

B - Catalyst
C - Coal
H - Hydrogen
K - Chemicals
N - Nitrogen
O - Oxygen
P - Process Lines (Hydrocarbons, Ammonia, etc.)
BD - Relief & Blowdown - Process
CS - Coal Slurry
PA - Liquification Product & Ash

WATER

BFW - Boiler Feed Water
CW - Cooling Water
DW - Drinking Water
FW - Fire Water
PW - Process Water
RW - Raw Water
TW - Treated Water (other than BFW)
UW - Utility Water

△1 See specification 14222-A-11 "Abbreviations" for expansion of this list.

STEAM

LS - Low Pressure Steam
MS - Medium Pressure Steam
HS - High Pressure Steam
BDS - Relief & Blowdown - Steam

FUEL

FG - Fuel Gas
FO - Fuel Oil
NG - Natural Gas
PG - Purge Gas (Purge, Inert, etc.)

CONDENSATE

LC - Low Pressure Condensate
MC - Medium Pressure Condensate
HC - High Pressure Condensate

MISCELLANEOUS

LO - Lube Oil
SO - Seal or Gland Oil
M - Miscellaneous

AIR

AI - Instrument Air
AP - Process Air
AU - Utility Air

SEWERS & DRAINS

OWS - Oily Water Sewer
CWS - Clean Water Sewer
SWS - Sanitary Sewer

NOTE: OTHER SYMBOLS WILL BE DEVELOPED AS NECESSARY

2.50 Process Stream Glossary

Use the stream designations listed below in naming equipment, and listing process streams entering or leaving process flow diagrams.

STREAM DESIGNATION	MATERIAL
Run of Mine Coal	As received coal
Clean Coal	-1.40 Sp. Gravity Fraction (nominal)
Middlings Coal	+1.40-1.70 Sp. Gravity Fraction (nominal)
Tailings	+1.70 Sp. Gravity Fraction Plus Froth Flotation Sinks
Clean Dry Coal	2% Moisture x -28 Mesh H-Coal Feed
Hydrogen	All kinds
Sour Water	All Kinds
Feed Slurry	H-Coal Reactor Feed Slurry
Process Water	For NH_4HS Knockdown

STREAM DESIGNATION	MATERIAL
Heavy Flash Distillate	Heavy Flash Distillate from Primary Separation
Stripping Steam	All Kinds
Flash Gas	Various Pressures
Lean Oil	Lean Oil to H.P. Absorber
Recycle Slurry	
Vacuum Distillate	
Vacuum Bottoms	
Atmospheric Stripper Distillate	
Atmospheric Stripper Side Draw	
Rich Oil Stripper Distillate	
Middle Distillate	
Heavy Distillate	
Stabilized Naphtha	
Light Hydrocarbon Liquids	C_4 180°F Material
Main Fractionator Gas	
Light Flash Distillate	Light Flash Distillate from Primary Separation
Acid Gas	All Kinds
Sour Gas	All Kinds
Pipeline Gas	
Propane	Nominal Propane Product
Butane	Nominal Butane Product
Light Straight Run	Nominal C_5 180°F Material
Rich Oil	Rich Oil from High Pressure Absorber
Mix Tank Vapor	Mix Gas from Slurry Mix Tank

STREAM DESIGNATION	MATERIAL
Hydrotreated Naphtha	Nominal S/N Free Naphtha
Reformate	Stabilized Reformate
Oxygen	Oxygen Plant Product
Nitrogen	
Sulfur Dioxide	FGD Unit Product SO_2
Salt Cake	Na_2SO_4 Product from FGD Unit
Sulfur	Claus Product
Claus Tail Gas	Recycle to Incinerator & FGD Unit
Medium BTU Gas	Sweetened, nominal 300 BTU/CF Fuel gas from hydrogen plant
Ammonia	
Phenol	Nominal cresylic product

The streams above are likely intercontractor flows and are designated to avoid multiple designations for common streams. Other designations will be developed, as necessary, in the course of preparation of process flow diagrams.

3.0 P&ID ENGINEERING

⊕ 3.10 System Hydraulics

3.10.1 General Design Criteria

The following tables may be used as a general guide of friction losses, linear velocities, and other criteria. These criteria apply only if fixed pressures or other special process conditions do not control.

1. Process Liquid Lines

a) Pressure & Pump Discharge Lines

TABLE 1 - PRESSURE LINES

Nominal Pipe Size (Inches)	Recommended Max △P PSI/1000 Ft	Velocity, fps Carbon Steel
1½-3	30	3.5-8
4-6	30	6-12
8 & larger	22	8-15

Note: For Carbon Steel lines, the upper end of the velocity ranges should be used with caution. Alloy lines, because of their high cost, have economic velocities in the upper end of these ranges.

b) Pump Suction Lines

In pump suction lines, the static head must always exceed the fluid vapor pressure plus the pump NPSH requirement. Pump suction lines for liquids near the boiling point are sized so that the pressure drop through the line and fittings is 0.5 psi total or less. (On a short suction line, this means that a pressure drop in the range of 0.5 to 2.5 psi per 1000 feet and a maximum velocity of about 5 feet per second).

For liquids below the boiling point or very viscous liquids, the pressure drop allowed may be higher. Pump suction line loss will generally be in the range of 1 to 4 psi per 1000 ft. Pump NPSH requirements must be checked. The design NPSH required by the pump should generally be at least 2 feet less than that available. Be careful in selecting the elevation datum for NPSH. Minimum NPSH to be 7 feet.
Limiting velocities for pump suction lines are given in Table 2 below:

TABLE 2 - PUMP SUCTION LINES

Line Size (Inches)	Limiting Velocity (FPS)
1-4	1-3
6-8	4.5-5
10 & Up	6-7

2. Process Vapor Lines

TABLE 3 - VAPOR LINES

	Maximum Recommended Pressure Drop	Recommend Velocity Ft/Sec
Operating Pressure		
above 50 psig	5 psi Total*	40-60
1 atm to 50 psig	7% of Tower Top Pres.*	70-80
Above 50mm Hg abs.	10-20% Tower Top Pres.*	125-200
Compressor Discharge (above 100 psig)	10-15 psi/1000 ft.	70-100
Compressor Discharge (below 100 psig)	10% Discharge Pres.*	70-100
High Pressure Suction & Recycle Suction (above 100 psig)	10-15 psi/1000 ft.	70-100
Low Pressure Suction (1 atm to 50 psig)	1-3 psi/1000 ft.	70-100
Transfer Lines from High Pressure to Low Pressure Equipment	Size usually not limited by Δ P	Below 100

*This is total allowable line loss

3. Steam Lines

Steam lines are sized on the basis of pressure drop considerations, but for larger sizes (12" and over), velocity is usually the controlling factor.

Recommended design velocities are shown on Table 4.

TABLE 4 - RECOMMENDED MAXIMUM VELOCITIES FOR STEAM LINES (FT/SEC)

Size	Schedule	(A)	(B)	(C)
1"	80	25	40	50
1½"	80	30	58	70
2"	40	44	71	88
3"	40	58	98	120
4"	40	70	120	140
6"	40	90	160	190
8"	40	110	200	230
10"	40	130	200	250
12"	Std.	150	200	250
14"	Std.	150	200	250
16"	Std.	150	200	250
18"	Std.	150	200	250
20"	Std.	150	200	250
24"	XS	150	200	250

(A) Saturated Steam (All Pressures) - Headers & Long Lines

(B) Saturated Steam (5 to 200 psig) - Short Lines & Branches

(C) Superheated Steam Lines (All Pressures) & Saturated Steam (250-600 psig) - Short Lines & Branches

4. Vapor Liquid Mixtures (Two-Phase Flow)

Lines containing 2-phase mixtures shall be designed to prevent surging and slug flow.

5. Underground Lines

Lines running underground shall have minimum sizes as follows:

Process Lines	1½ inches
Sewer Lines	4 inches
Drain Lines	2 inches

⊕ 3.10.2 Line Pressure & Drop Calculations

When determining firm line sizes for the design issue of the P&ID flow diagrams, make a complete hydraulic system analysis to calculate line pressure drop. Be sure to properly identify and record all pressure drop calculations. Make calculations for a complete hydraulic system, say, from the outlet of an accumulator through a pump, exchanger, control valve and into a fractionator tower. Obtain an estimate of equipment locations from Plant Design and roughly sketch the piping system in three dimensions. Show item numbers for each piece of equipment. Be sure to include all twists and turns the piping takes into and out of the pipeway and to and from equipment.

Code the various sections of line between each piece of equipment. Use these codes to identify the pressure drop calculations for each section. List the approximate total length of pipe between each piece of equipment, and the approximate elevation of the pipe at the inlet and outlet of each piece of equipment. Line pressure drops should be calculated at 100% design process flow. After completing the calculations, summarize the overall system hydraulics by listing the calculated operating pressure at the inlet and outlet of each piece of equipment or control valve on the sketch. Be sure to include the effect of elevation (static head) on the operating pressure.

△1 ⊕ 3.10.3 Equipment Pressure Drop Calculation

See the appropriate specialty group leader to obtain design pressure drop for equipment. Be sure a realistic pressure drop is assigned for each exchanger service. Use the value recommended by the exchanger rating after they rough-rate the exchanger. They include inlet and outlet pressure drop in the exchanger rating. For columns, we must include the inlet and outlet nozzle losses as these are not included as part of the column pressure drop.

△1 ⊕ 3.10.4 Control Valve Pressure Drop Calculations

A good working rule is that, at maximum flow, at least one-third of the total friction drop of the system should be absorbed by the control valve. This rule may be relaxed for extremely long or high-pressure-drop systems. Reasonably good control can then be attained in these systems with not less than 15% of the total system drop taken across the valve. This relatively low percentage drop is permissible only when the variation in flow is small.

△1 ⊕ 3.10.5 Pump Head Calculations

Use Pump Head Form 62, or equivalent, to summarize the calculated pressure drops for the system components.

1. Rated GPM

Use the following table, as a guide, for determining rated guarantee-point gpm:

Service	% Normal Process Flow @ Operating Temperature
Feed Pumps	105-110*
Reflux Pumps	110-120*
Reboiler Circ. Pumps	110-120*
Tankage Transfer Pumps	105-110*

*For economic reasons, lower capacity ranges shall be used for high capacity, high differential pressure pumps (400 gpm & 200 psi ΔP).

⊕ 2. Pump Valving

Usually, the sizes of the nozzles on centrifugal pumps are less than those of the suction and discharge piping. In many cases, the block valve on the pump suction piping and the block and check valves on the discharge piping can be smaller than line size.

After vendor information on pumps is available, adjust sizes of pump valving according to the following general rules:

(a) If pump connection is one size smaller than line size, suction valves should be line size and discharge valves should be pump flange size.

(b) If pump connection is two sizes smaller than line size, suction valves should be one size less than line size and discharge valves should be pump flange size.

3. Pump Differential Head

The rated differential head for the pump as calculated on Form 62 equals the difference between the required pump discharge pressure and the pump suction pressure. Rated differential head should be calculated at 100% of normal process flow.

4. Available NPSH

The NPSH available is equal to the static head of liquid, plus equivalent feet of head due to the difference between the operating pressure and vapor pressure in the suction drum, minus the suction line friction loss converted to feet. For computing the available NPSH, the vessel from which the pump takes suction shall be considered empty. Therefore, for horizontal drums, the level is considered to be flush with the bottom of the tank and for vertical vessels, with the bottom tangent line.

5. Also make sure static head is sufficient to prevent vaporization (when actual vessel pressure is vapor pressure) in horizontal piping run to suction of pump, or for orifice meters, even though static head is sufficient for the system.

△1 ⊕ 3.11 Vents, Drains & Utility Connections

A flanged utility connection is located a minimum distance above the bottom head seam in vertical vessels and the head knuckle in horizontal vessels. Nitrogen or another inert gas will be used if steam or water is detrimental to the equipment or internal process material. Utility connections shall not be permanently piped. All utility connections shall be valved and blinded.

Each vessel shall be equipped with a drain normally located in the bottom liquid effluent nozzle. The drain is piped to an oily water sewer hub with spectacle blind located between the valve and piping run to the sewer. If the bottoms line has an internal extension, the drain is located on the vessel and piped to the bottoms liquid effluent line, as well as the oily water sewer.

Each vessel shall be equipped with a valved and blinded vent connection. Vents are located in the top head to towers and vertical vessels. They are located on top of horizontal vessels at the same end as the drain and the opposite end from the utility connection.

Vent, drain and utility connections for columns and vessels shall be sized as follows:

EQUIPMENT VOLUME FT^3	VENT	DRAIN	UTILITY
to 1,000	1½"	2"	1½"
1,000 to 5,000	2"	3"	2"
5,000 to 10,000	2"	3"	2"
10,000 to 25,000	3"	4"	2"
Above 25,000	3"	4"-6"	3"

⊕ 3.12 Flushing & Pumpout Connections

To clear equipment for maintenance, the liquid is transferred to product storage using process pressure or pumps. Liquids that cannot be transferred to product storage tanks are transferred to slop or untreated feed tanks through pumpout headers. Jumper lines with double block and bleed valves connect process or product lines to the pumpout headers.

With the major portion of the liquid removed, the system is depressurized to the flare system. Atmospheric vents and drain lines to the oily water sewer are then opened and the equipment is purged with steam until the system is free of hydrocarbon.

⊕ 3.13 Blinds

We use three types of blinds: (1) Slip blinds, (2) Line blinds, and (3) Spectacle blinds. Slip blinds are thin plates that can be inserted between standard piping flanges by springing the pipe. These are used during shutdowns to isolate equipment or groups of equipment that require maintenance or inspection. They are also used to isolate a unit from other operating units and from hazardous utility sources during shutdown.

Line blinds are used for the same purpose as slip blinds, but are designed for the full pressure rating of the flanges that hold them. They are used where high pressure may be in contact with one side of the blind. Spacer rings, the same thickness as the blind, may be provided where it is impractical to spring the pipe enough to accommodate the line blind.

Spectacle blinds provide a line blind and a spacer ring fabricated into a Figure 8 assembly. They are used as operating blinds to protect process fluids and utilities from contamination during startup, shutdown, and normal operations, and during regeneration cycles.

⊕ 3.14 Strainers

Strainers shall be provided as follows:

STEAM	ON P&ID		SOURCE
Steam Inlet to Turbines	No	Manuf. Stand	w/Turbine
Steam Inlet to Ejectors	Yes	Line Size Y-Type (0.020 Screen)	By Piping
Condensate to Line Traps	No	Line Size Y-Type (100 Mesh Screen)	By Piping
Condensate to Process Traps	Yes	Line Size Y-Type (100 Mesh Screen)	By Piping
Air Inlet to Pneumatic Operated Equipment	Yes	Line Size Y-Type (100 Mesh Screen)	By Piping
Air Inlet to Instrmts.	No	Fisher 67 FR (or equal)	Instr. Engr.
Atm. Inlet Filter to Air Blower	Yes △1	Special or Mfg. Standard: Furnished with Blower	Process
Inlet to Positive Displacement Meter, Mass Flow Meter & Turbine Meters	Yes	Mfg. Stand	w/Meter
Suction Line to Compressors, Temporary	Yes	cone or truncated cone pointed upstream.	By Piping
Suction Line to Pumps, Temporary	No	Basket (Cone Pointed Downstream)	By Piping

3.15 Battery Limit & Header Block Valves

Each unit leader is responsible for coordinating all lines leaving or entering his unit with the Plant Design Group to determine where sub-headers are advantageous. He determines where battery limit block valves and header block valves are required to prevent stream contamination, provide isolation for installing blinds, or ensure safety.

All lines entering or leaving a process unit require a battery limit block valve with valved vent and drain connections located inside the battery limit, unless special considerations dictate otherwise. Use slide gates for flare system battery limit block valves. All lines carrying steam or combustible materials must have flanges at the battery limit for installing isolation blinds.

Use the following general rules to determine the location of header block valves:

⊕ 1. All takeoffs from headers or subheaders 1½-inch or smaller must have header block valves.

⊕ 2. All intermittent utility connections where service is permanently connected must have header block valves.

⊕ 3. Continuous utility connections from headers to equipment do not require header block valves.

⊕ 3.16 Chemical Cleaning of Exchangers

Provide a 2-inch chemical cleaning connection on exchanger's cooling water return piping to enable connection of chemical cleaning facilities.

3.17 Pressure Relief Facilities

The basis for the pressure relief system design are ASME Code Section VIII, API-RP-520 and API-RP-521. Safety facilities shall comply with all local, state and federal regulations.

3.17.1 Relief Valve Discharge

All relief valves on process equipment shall discharge into a closed blowdown system, unless the material handled can be safely and legally discharged to atmosphere.

Relief valves venting to atmosphere must discharge through a vertical tail pipe. The outlet of the tail pipe must not be less than 10 feet above the highest operating platform within a horizontal radius of 25 feet. Check all relief valves discharging hydrocarbon vapor to atmosphere to insure that flammable mixtures do not occur at grade level or on elevated structures and be sure that condensation of hydrocarbon discharge vapor does not occur at minimum atmospheric temperature.

Relief valves which cannot be vented to the atmosphere shall discharge into a closed flare system or into a lower pressure portion of the process system whenever possible. No relief valves shall be set at less than 10% above normal operating pressure without ASFI approval.

Relief valves discharging water and non-flammable non-toxic chemical liquid shall relieve visibly to sewer.

3.17.2 Special Relief Requirements

The following considerations shall be followed when designing the relief system:

EQUIPMENT	CONSIDERATION
Vessels, Exchangers, Furnace Coils	No relief valve required if equipment is interconnected by piping to other equipment protected with relief valves. Maintenance block valves in interconnecting piping must be locked open during operation. If interconnecting piping contains operating valves, both items of equipment must be protected with relief valves.
Exchangers	Provide thermal relief on cold side of heat exchangers equipped with maintenance block valves.
Positive Displacement Pumps & Compressors	Provide relief valves to protect against operation with a blocked discharge.
Noncondensing Steam Turbines	Relief valves shall be installed with the exhaust piping of turbines to provide full flow relief if the inlet steam pressure is over 150 psig, or if the turbine is an automatic or remote start turbine.
Condensing Steam Turbine	Provide relief valve on turbine outlet piping or condenser.
Piping	Provide thermal relief on liquid hydrocarbon piping systems which can be blocked in and are heat traced.

3.17.3 Relief System Analysis

The capacity requirement for the relief system shall be limited to the largest emergency caused by a single operational difficulty or fire exposure related to an individual fire area (the unit area will be divided into probable fire areas, normally not to exceed 2,500 square feet ground space). The principle operational difficulties to be considered are listed below:

- Localized failure (blocked outlets on vessel, machinery breakdown, instrument failures)
- Steam failure
- Power failure
- Compressor failure
- Instrument Air Failure
- Cooling water failure
- Exchanger tube rupture, if low pressure side design pressure is less than 2/3 of the high pressure side operating pressure

When determining heat input, consider all equipment in an individual fire area, all wetted surface below 25-foot elevation and take full credit for environmental factors listed in Table 3, API-RP-520. Storage vessels or other vessels where liquid level is independent of operation shall be considered as liquid full for purposes of determining wetted surface.

⊕ 3.17.4 Relief System Details

All branch connections from relief valves should enter relief headers from the top. If possible, all relief valves should be located above the header into which they discharge. If not practical to install relief valves at an elevation where the lateral will drain to the flare header, a low point drain should be provided and the low point shall be heat traced. All relief valves shall be accessible from platform or ladders. Preferred location for relief valve is directly on the equipment protected. Other design details and considerations are given below.

- Provide steam purge with RO sized to inject steam at rate sufficient to maintain 5 ft/sec blowback through PSV inlet nozzle in plugging service if steam is not detrimental to the process.
- No provision shall be made for removing relief valves from the piping during operation.
- Manual bypasses around relief valves shall be provided only for the purpose of depressuring the system on shutdown.

- Minimum discharge line size is PSV outlet size. Tie into header at 45° angle in direction of header flow. Outlet line back pressure should not exceed 10% of set pressure for conventional PSV or 50% of set pressure for bellows PSV. This applies to both the superimposed back pressure from other relieving valves before the PSV opens, and the combination of superimposed plus created back pressure after the PSV opens.

- Minimum inlet line size is PSV inlet size. If more than one PSV is mounted and a manifold, the minimum area of the manifold is the sum of the inlet areas of the PSV's. However, the total inlet line friction pressure drop to the PSV at full open flow should not be more than 3% of the set pressure.

- Relief valves which discharge to atmosphere require snuffing steam, unless vapor vented is non-combustible. Provide weep hole in discharge line if no snuffing steam is required.

- Use a rupture disc to protect the PSV from coking fluids, solids ladened vapor or condensing tar-like components that might plug or seal the plug of the PSV to the seat where a steam purge would be detrimental to the process. The unit must be shut down, the PSV and piping cleaned, and the rupture disc replaced if it ever ruptures or springs a leak. Provide corrosion resistant vent, pressure gauge, excess flow valve and try-cock assembly between rupture disc and relief valve.

3.18 Exchanger Block Valves

Provide block valves in inlet and outlet water piping to water coolers.

3.20 Equipment Soaring

Provide spare equipment to insure against mechanical failure. Provide spare equipment to insure against interruption of production only when justified and approved. For example, large compressors are not normally spared. Most small pumps are spared. Where spare equipment is required, optimize the use of common spares.

3.21 Turbine Drivers

Electrical service is assumed to be highly reliable. For this reason, turbine drivers on spare equipment are not required to insure against interruption of production during power failure.

Provide other turbine drivers as necessary only to satisfy the plant steam balance. Review selection of all turbine drivers with ASFI.

△1 ⊕

3.30 Winterizing

Process and utility lines may require winterizing under the following conditions:

- The fluid pour point or freezing point is above the design minimum for ambient temperature.
- The viscosity is increased to the point where flow is reduced below an acceptable limits.
- Ice formation occurs in lines carrying water vapor.
- Corrosive compounds or hydrates will form if condensation occurs.

Heat tracing of vessels and lines shall be kept to a minimum. Where flows are intermittent, or a problem exists only during shutdowns, the system shall be drained or flushed. Places where water could collect, such as dead legs or low points in vapor lines, are avoided where possible by careful planning of the piping layout. Where electric tracing is used, set points shall be standardized at 50°F, 75°F, 100°F, 125°F, 150°F, 175°F and 200°F. The selected set point temperature shall be at least 10°F above the liquid pour point or freezing point, but below the bubble point.

Where winterizing is required for standby pumps, a bypass line and globe valve for 2%-5% pump capacity may be provided around the discharge shut-off valve or check valve to allow a continuous backflow through either pump while the other is pumping.

Cooling water supply and return lines shall have a bypass from supply header to return header immediately adjacent to isolation valves. The isolated sections of cooling water lines shall be drained during shutdowns in cold weather.

Steam condensate lines that are in continuous service shall be insulated. Steam condensate lines that are in intermittent service shall be insulated and traced.

Field-mounted instruments shall be located and piped so as to minimize winterizing requirements. Large case instruments are housed in heated enclosures. The tubing or pipe that connects the instrument to the process is heat traced as required.

3.40 Instruments & Control Valves

Float-type level switches are mounted directly on the vessel. Displacement level transmitters or controllers and gage glasses are mounted either directly on the vessel or on a bridle, depending on the number of connections involved and whether the vessel is horizontal or vertical. For horizontal vessels, a bridle is used if the total number of connections is four or more. For vertical vessels, a bridle is used if the total number of connections is more than six. Isolation valves shall be used at the vessel connections to a bridle. All level connections shall be on the side of the vessel. Do not use vessel bottom or line connections, unless approved by ASFI.

The minimum pipe size for orifice meter runs shall be 2 inches. The preferred differential pressure range for orifice plates is 100 inches of water. The use of other ranges must be approved by ASFI.

In general, all control valves are to have double blocks and bypasses, except control valves in intermittent service or those which for other reasons can be removed for maintenance while the unit remains on stream. Control valve blocks and bypass valves shall be sized in accordance with ISA RP4.2 and API RP550, Table 6.1.

3.60 Surge Capacities

Liquid surge time is the controllable residence time between the high and low liquid levels.

For water separation from liquid HC, the required residence time is that needed for water settling. When there is no water in the drum feed, the following liquid residence time shall apply, except where process restraints or conditions require or permit deviations:

		Surge, Minutes
1.	Feed Drums	
	Feed received from within the unit	15
2.	Separators, Drums, Bottoms of Columns	
	Feed to Column	7
	Product to off-plot tankage	
	With pump	5
	Without pump	2
	Product to off-plot tankage via feed bottoms exhange	3-5
	Feed to fired heater	10
	High pressure separator followed by low pressure separator	4

3. Overhead Accumulators

For reflux only, provide 5 minutes surge time (vapor distillate). For accumulators which also serve as product receivers, provide 3 minutes surge for reflux portion and product surge time as specified in Item 2 above; the volumes are additive and should not be less than 5 minutes based on reflux plus product rates.

4. Fired Reboilers

For fired reboilers, provide 5 minutes surge based on the liquid vaporized in the reboiler plus product surge specified in Item 2 above.

3.61 Shop Fabrication Limitation

If possible, limit vessel diameters to less than 13 feet. Diameters 13-14 feet require special consideration for shipping purposes. Diameters greater than 14 feet may require field fabrication or barge shipment.

⊕ 3.90 Equipment Connections

Connections on fabricated vessels, tanks and exchangers shall comply with the following rules:

1. Size and Use Limitations - The minimum size connection shall be 3/4-inch. Clad or overlay nozzles shall not be less than 4 inches.

2. Couplings - In general, all connections on fabricated equipment will be flanges. Exceptions are certain instrument connections as specified below, and small connections on the manufacturer's standard equipment not available with flanged connections.

3. Sizing - Exchanger shellside nozzles shall be sized for $V^2\rho$ = 4500, maximum for liquids and 2500 maximum for vapors. Size reboiler return nozzles on columns to limit $V^2\rho$ = 1500.

4. All vessel nozzles 3" and under shall be 300 pound rating.

5. Minimum flanged nozzle size shall be 1" .

6. Instrument Connections	Number/Size/Type
Pressure	
Pressure gage or transmitter	1" flanged
Diaphragm sealed gage or transmitter	To match diaphragm-flanged
Level	
Bridle	Two-2" flanged
Gage Glass	Two-1" flanged
Level Transmitter, Displacement Type	Two-2" flanged
Level Transmitter, dP Type	Two-1" flanged
Level Switch for Level Alarm	Two-1" flanged
Internal Ball Float	To match float-flanged
Diaphragm Type Level Transmitter	To match diaphragm-flanged
Temperature	
Thermowell	1½" flanged

7. Handholes & Manholes

VESSEL ID	MINIMUM INSPECTION OPENINGS
Under 12"	Two - 1" (May be process connection with removable spool)
Over 12"-16"	Two - 1½" (May be process connection with removable spool)
Over 16"-36"	Two - 2" with blind flange
Over 36"	One - 20" nominal pipe size with blind flange

TOWER ID	MINIMUM INSPECTION OPENINGS
Under 36"	Normally set by extent of removable internals, packing or catalyst, but not less than for vessels.
36" & Larger	20" nominal pipe size or larger - set by economics. Located in bottom surge section, above top tray, above main feed tray and above special trays. In addition, approximately 25 trays apart for clean service and 10 trays apart for dirty.

4.0 EQUIPMENT DESIGN

General Specifications & Codes

Unless otherwise specified, all equipment shall be designed, fabricated, inspected and tested in accordance with the applicable specifications and referenced codes. Refer to the attached Bechtel Standard Specification Index.

All fired boilers shall be code stamped. All equipment must also conform with governing local rules and regulations.

Process design requirements shall be listed on the equipment specifications and/or data sheets. Mechanical design requirements are defined by the equipment specifications in conjunction with general project specifications, Bechtel specifications, or both. In case of conflict, the equipment specification governs.

4.10 Pressure Vessels

The design pressure for vessels that are protected by relief valves located so that there is no other equipment between the vessel and the relief valve shall be 10% (but not less than 25 psi) above the maximum pressure attained in normal operation. Vessels in high-pressure service may be designed for pressures less than 10% above maximum operating pressure, but not less than 6%, if the operating conditions are stable and savings in fabrication costs are significant.

Design pressures set at less than 10% above normal operation pressure require ASFI approval.

All vessels subject to steam out will be designed for at least 50 psig or full vacuum, whichever is more severe.

The design pressure for vessels that can be blocked against full centrifugal pump discharge pressure shall be the larger of the normal suction pressure plus 120% of the normal differential pressure, or the maximum suction pressure plus the normal differential pressure. After vendor information on pumps is available, check all pumps to be sure that maximum discharge conditions do not exceed downstream vessel design pressures.

The design pressure for vessels that are remote from the relief valve for the system shall be the larger of either 10% (but not less than 25 psi) above the maximum pressure attained in normal operation, including startup, shutdown, and turndown conditions, or the highest actual pressure obtained during an upset condition such as maloperation, power failure, instrument air failure or cooling water failure.

For vessels operating above 30°F, the design temperature shall be 50°F above the maximum temperature attained in normal operation. However, vessels made from carbon and low alloy steels with operating temperatures below 600°F shall have a design temperature of 650°F, unless limited to a lower temperature by the flange pressure temperature ratings or by service conditions such as hydrogen, hydrogen sulfide, caustic, sulfur content or other aggressive environments. For vessels operating above 600°F, the design temperature may be reduced to the maximum normal operating temperature, if necessary, to avoid undue fabrication costs with ASFI approval. For vessels operating below 30°F, the design temperature shall be the lowest expected operating temperature.

4.20 Shell & Tube Exchangers

The design pressure for the process side of exchangers shall follow the same criteria as for pressure vessels.

The design pressure for carbon steel exchangers shall not be less than 75 psig.

The design temperatures for the shell and the tube sides of exchangers shall be based on the inlet temperature for the hot side and the outlet temperature for the cold side. From this basis, the same rules apply as for pressure vessels.

Obtain ASFI review and approval on the fouling factor used for each service. In general, fouling factors less than .001 shall be considered as a clean service. Cooling tower water is assumed to have a fouling factor of .002 on the basis of maintaining a minimum velocity of 4 feet per second through the exchanger. The tubeside shall be used for cooling water, unless process conditions dictate otherwise. Coolers shall be designed to limit the temperature of cooling tower water return to 110°F. In general, use standard tube lengths of 20 feet, maximum length of 30 feet. Use of bundles larger than 48-inch diameter require ASFI approval.

4.30 Fired Heaters

△1 The design absorbed duty shall be the maximum duty expected during normal operation. No overage is added to heater duties, unless approved specifically by ASFI.

In general, two design pressure conditions are involved in heater tube design.

1. Normal Operating Condition. The normal operating design pressure is the maximum pressure expected at the inlet to the tubes during normal operation.

2. Excess Pressure Condition. Excess pressure condition design pressure is the maximum pressure that can occur during an upset condition either upstream or downstream of the heater.

A required wall thickness is calculated for both the normal operating and the excess pressure condition by different formulas. The larger required wall thickness governs. Refer to API RP 350 Latest Edition for details.

The design tube wall temperature shall be the calculated maximum tube wall temperature plus 50°F.

Burners shall be capable of operating at 125% of design heat release with 30% excess air.

The stack design shall be based on 125% of design duty at 30% excess air. Exit velocity shall be greater than 25 feet/sec at normal firing. The heater shall be provided with smothering steam connections suitably located to purge entire firebox.

4.40 Air-Cooled Exchangers

The rules for establishing design pressures are the same as those that apply to shell and tube exchangers. The design temperature of the exchanger shall be the maximum normal operating temperature at the inlet to the exchanger, plus 50°F. This margin may be reduced if undue fabrication costs can be avoided. Tube lengths shall be limited to 36 feet maximum, unless careful consideration has been given to plot layout and maintenance facilities.

Inlet and outlet piping on air coolers shall be arranged symetrically and designed to avoid differential expansion within a common bay as a result of unequal flows.

The control of outlet temperature shall be by auto-variable-pitch fans. Where close control is not necessary, 50% of the fans may have fixed blades and 50% may have variable pitch blades. The maximum capacity of the variable pitch fans should be 5% to 10% greater than the capacity of the fixed blade fans to avoid hunting if all fixed blade fans are automatically shut down when the variable pitch fans reach minimum capacity.

A single variable pitch fan may be used on multi-bay units, if unequal cooling through the different bays can be tolerated and if close temperature control is not required. When equal cooling through different bays is required and temperature control is not critical, 2-speed motors may be considered.

Louvers shall be provided when required to compensate for seasonal changes in air temperature and sudden rainstorms, or to protect the fin-tubes against snow or hail.

The controls used shall be reviewed and approved by ASFI on an individual basis.

Induced draft fans are preferred to forced draft fans (if pourpoint is lower than minimum ambient temperature) for the following services:

- Where close temperature control is required.
- Where noise is a problem.
- Where approach temperature is critical (from 10°F to 25°F).

4.50 Centrifugal Pumps

Rated capacity shall be as specified in Section 3.10.5 of this instruction. The specified differential head for pumps shall be the calculated head required based on process design (normal) △1 flow rate. There is no overage on the pump head.

For motor driven pumps, impellers shall not exceed 95% of the maximum impeller size.

Steam turbine drivers shall in general be in accordance with API-611. Occasionally, when the pump is in extremely critical service unspared, or when turbine inlet conditions exceed 600 psig or 750°F, the steam turbine driver shall be in accordance with API-612.

4.60 Centrifugal Compressors

Except as modified by job specifications, centrifugal compressors shall be in accordance with API-617 criteria. The normal operating point shall conform to process conditions expected during normal operation. This will correspond to middle of run conditions where fouling of exchangers and fired heaters or deterioration of catalyst activity occurs. The compressor must also be capable of operating (non-surge) throughout the range of operating cases identified in the equipment specification and/or data sheets.

Driver horsepower requirements shall be rated in accordance with API-617 criteria.

Steam turbine drivers for compressors shall be in accordance with API-612. Steam turbine drivers for lube and seal oil pumps shall be per API-611.

Special purpose gear units shall be in accordance with API-613 criteria.

4.70 Reciprocating Compressors

Except as modified by the job specification, reciprocating compressors shall be in accordance with API-618 criteria. The design capacity of reciprocating compressors shall correspond with the design conditions. The compressor must also be capable of operating throughout the range of operating cases identified in the equipment specification and on data sheets.

5.0

5.0 ATTACHMENTS

5.10 Bechtel Standard Drawings

Dwg Number	Title
A-501	Group Letters for Drawing Indices & M/R's
A-507	Equipment Symbols for Mechanical Flow Diagrams
A-510	Symbols for Piping & Instrument Flow Diagrams
A-514	Drafting Standards for P&ID's
B-506	Typical Process Flow Diagrams
B-507	Flow Diagrams Equipment Symbols
J-G-0101	Instrument Identification
J-G-0103	Instrumentation P&ID Symbols
J-G-0104	Instrumentation P&ID Symbols

5.20 Bechtel Standard Forms

Form #	Title
1	Index Line Designation Tables
18	Line Designation Tables
62	Pump Calculation Sheet

5.30 Bechtel Standard Specification Index

GROUP LETTER	GROUP	DESCRIPTION
A	GENERAL	Plot Plans, P&I Diagrams, Maps, Basic Engineering Design Data Sheets, Indexes.
B	PROCESS	Process Design, Flow Diagrams, Data Sheets, etc.
C	COLUMNS AND PRESSURE VESSELS	All pressure vessels of any pressure designed in accordance with the ASME code. This includes towers columns, reactors, regenerators, spheres, drums, etc., including trays, liners, lining, packing, internals and appurtenances.
D	TANKS	All storage vessels other than ASME code vessels. Includes API atmospheric or low pressure storage tanks, bins, spheroids, hoppers, silos, etc., including internals and appurtenances.
E	EXCHANGERS	Heat transfer equipment such as tubular exchangers, condensers, evaporators, reboilers, coolers, fin-fan coolers and cooling towers; excludes fired heaters.
F	FIRED HEATERS	Fired heaters, furnaces, ovens, boilers, fired kilns and driers, including superheaters, air preheaters, tubes, headers, settings, burners, stacks, flues, draft fans and drivers associated with heaters, Includes flare stacks and framework, Incinerators.
G	PUMPS AND DRIVERS	Includes all pumps and their drivers.
H	VACUUM EQUIPMENT	Vacuum pumps, ejectors and other vacuum producing apparatus. Includes drivers and integral auxiliary equipment.
J	INSTRUMENTS	All instruments and control equipment (except electric power switchboards, controls and meters), including safety (relief) valves, measuring devices, controllers, control valves, indicators, sight glasses, alarms, instrument panels, fittings, control signal pneumatic tubing, air piping and filters, and winterization of instrumentation.
K	COMPRESSORS & DRIVERS	Compressors, blowers, fans and their drivers.
L	PIPING	All process and utility piping(except the following covered elsewhere: sewer and drainage piping(S Group); building plumbing, heating, ventilating and air conditioning(R Group); instrument piping and tubing(J Group); column and vessel internals(C or D Group); and integral piping on pumps or compressors, etc., (G or K Group)
M	STRUCTURES	All steel, concrete, masonry, wood or other structures except buildings. Includes bridges, pipe stanchions, platforms, stairs, ladders, conduit racks.
N	INSULATION	Thermal insulation of piping, vessels, tanks and equipment, also fireproofing of vessel skirts, legs, supports and structures.
P	ELECTRICAL	All electrical equipment and material(except process instrumentation covered under J Group). Includes generators and drivers, motor controls, switchgear, transformers, converters, rectifiers, transmission and distribution, communication systems, lighting, grounding, all necessary wire and conduit, cathodic protection. For equipment numbering refer to Std. Dwg. P-A101.
Q	FOUNDATIONS	All foundations for buildings, structures or equipment. Includes piling, ground floor slabs, trenches, pits, basins and associated earthwork, soils surveys.
R	BUILDINGS	All permanent buildings above their foundations and floorslab. Includes all integral permanently installed equipment, elevators, plumbing, piping, heating, ventilating and air conditioning and painting.
S.	SITE IMPROVEMENTS	Includes clearing, grubbing, grading, fencing, signs, railroads, roads, walks, paving, parking areas, landscaping, sewers and drainage systems, topographic surveys.
T	MATERIAL HANDLING EQUIPMENT	Bucket elevator, conveyors, cranes, hoists, chutes, feeders, weighing devices and hoppers, scales, packaging devices.
U	EXPENDABLES	Chemicals, catalysts, refrigerants, etc.
V	PACKAGE UNITS	Includes integral "package" units, such as air-driers, refrigeration systems, etc., where applicable.
W	WELDING & METAL PROCESSING	Welding, casting and other metal processing specifications.
X	PAINTING	All paint and thinner for plant with exception of buildings.
Y	PROCESSING	Crushers, pulverizers, blenders, screens, separators, cyclones, filters, centrifuges, mixers, grinders, dryers, extruders and similar machinery including drivers.
Z	WATER & WASTE TREATMENT	All equipment intended specifically for treatment of water for general supply, cooling water, boiler feed water, etc., or for treatment of waste water for pollution control. Includes clarifiers, reactors, ion exchange equipment, chemical feeders, mixers, agitators, storage hoppers, liquid filters, settlers, cycle timer and specialty controls.

Note: For a more detailed description, refer to the Refinery and Chemical Standard Code of Accounts.

Reference: Standard Drawing A-506 Numbering Drawings and Documents.

△1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

No.	DATE	REVISIONS	BY	CHKD		ENGR		APPD
△	1/74	ADDED OWNERSHIP CLAUSE TO DWG.	L.S.	G.F	[illegible]	[illegible]	[illegible]	
△	4/71	Addition: Z	WPG	[illegible]			[illegible]	[illegible]

SCALE | DESIGNED | DRAWN | CHIEF ENGR

BECHTEL
SAN FRANCISCO

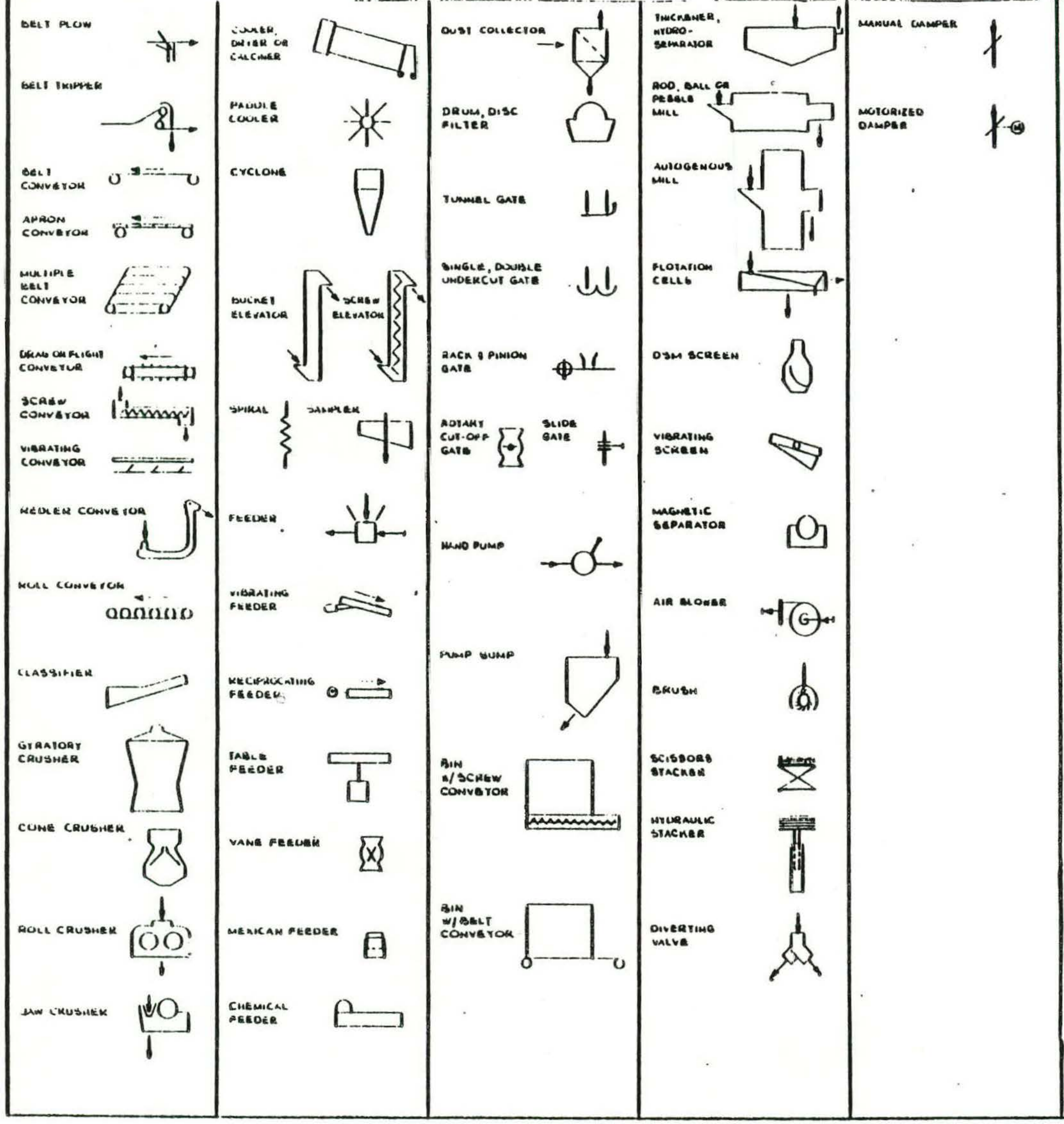
ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

GROUP LETTERS FOR DRAWING INDEXES AND MATERIAL REQUISITIONS

JOB No.	DRAWING No.	REV.
STANDARD	A-501	10

SIZE D

GENERAL SYMBOLS



△1

GENERAL NOTES

△1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

REFERENCE DRAWINGS	
FLOW DIAGRAM EQUIPMENT SYMBOLS	B-507
INSTRUMENT IDENTIFICATION	J-6-0101
INSTRUMENTATION P & I D SYMBOLS	J-6-0103
INSTR. P & I D. SYMBOLS - TYP ILLUSTRATION	J-6-0104
EQUIP & PIPING SYMBOLS FOR FLOW & PIPING & INSTRU DIAGS.	A-510

△								
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△0	7/6	ISSUED AS AN ENGINEERING STD.						

NONE

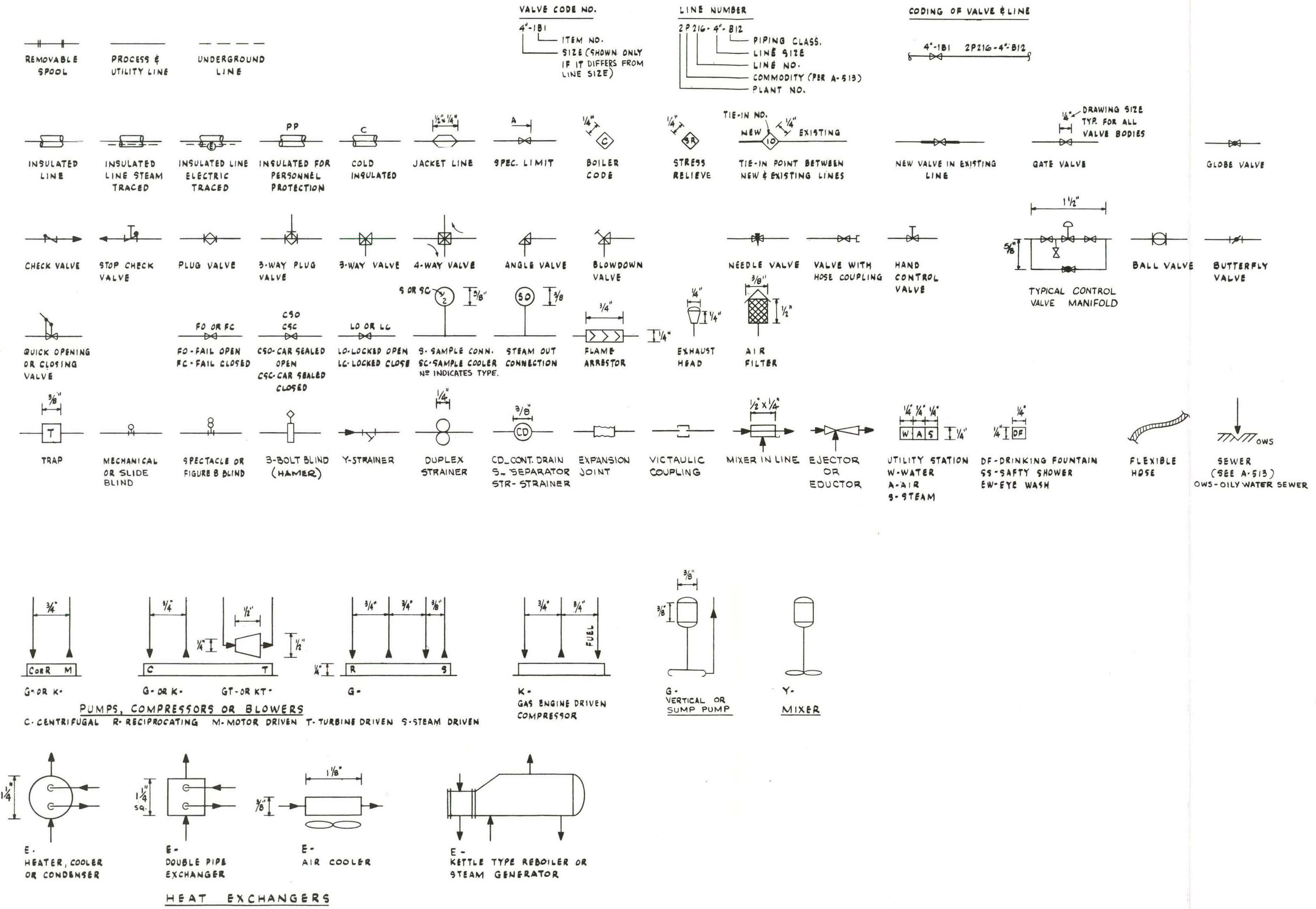
BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

EQUIPMENT SYMBOLS FOR
MECHANICAL FLOW DIAGRAMS

STANDARD A-507 0

22 x 34 'D' SIZE



GENERAL NOTES

1. FOR PROCEDURES IN PREPARING PROCESS FLOW AND PIPING AND INSTRUMENT DIAGRAMS REFER TO REFINERY AND CHEMICAL DIVISION ENG. INSTRUCTION L-20 & PROCESS DESIGN GUIDE A-3.
2. FOR EQUIPMENT NOT SHOWN, SUCH AS FURNACES, VERTICAL AND HORIZONTAL VESSELS AND OTHER SPECIALTY ITEMS, MAKE SYMBOLS TO FIT THE INDIVIDUAL REQUIREMENTS.
3. FOR INSTRUMENT SYMBOLS, SEE INSTRUMENT REFERENCE DWGS. AS LISTED BELOW.

REFERENCE DRAWINGS

COMMODITY SYMBOLS FOR P.&I.D's	A-513
EQUIP. SYMBOLS FOR PROCESS FLOW DIAGRAMS	B-507
INSTRUMENT IDENTIFICATION	J-G-0101
INSTRUMENTATION P&ID SYMBOLS	J-G-0105
INSTRU. P&ID SYMBOLS TYP. ILLUS.	J-G-0104
STANDARD SAMPLE COOLER	L-514
PIPING DETAILS FOR SAMPLE CONN.	L-515
EQUIP. SYMBOLS FOR MECH. FLOW DIAGS.	A-507

△1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

6	11/[illegible]	ADDED 3-BOLT BLIND REV'D TURBINE FLOW	M H	HS.	[illegible]		[illegible]	RFS
5	9/27/73	REVISED SIZE OF CONTROL VALVE MANIF. FR. 3/8" TO 5/8" AND EXCH. SIZE FR. 3/4" TO 1 1/4"	KMC	HS.	[illegible]	[illegible]		
4	4/30/71	REVISED & ADDED DWG. REF'S DELETED WORD "FLOW" FR. TITLE DELETED ORIGIN BLOCK & INSTRUMENT SYMBOLS. ADDED NOTE-3 & OWNERSHIP CLAUSE	CML	HS.	[illegible]	[illegible]	[illegible]	
3	4/28/69	REDRAWN	CW	HS	[illegible]	[illegible]	[illegible]	
No.	DATE	REVISIONS	BY	CHK'D				APP'D

SCALE NONE | DESIGNED HS. | DRAWN CW/JC

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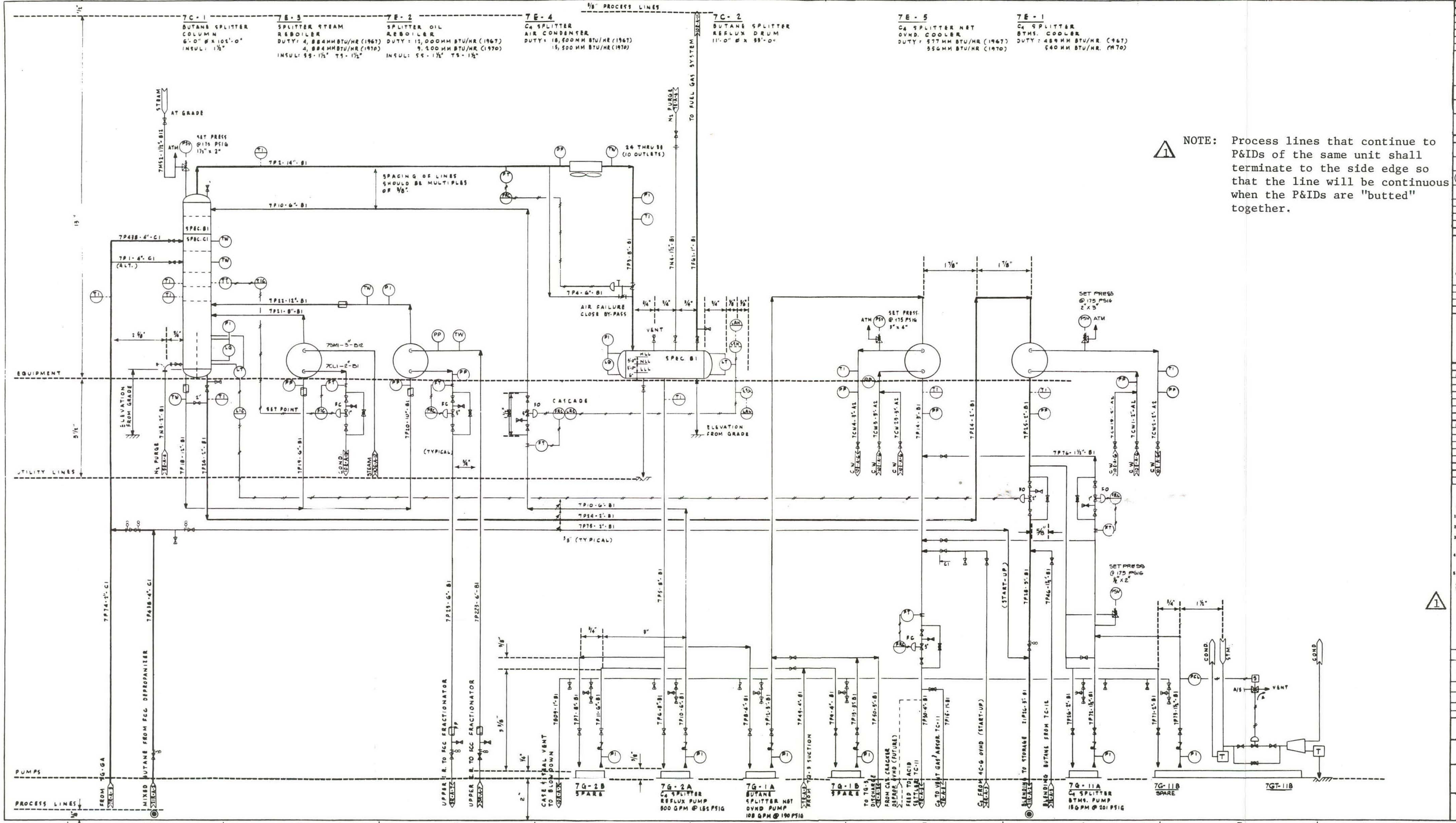
REFINERY AND CHEMICAL DIVISION

EQUIPMENT AND PIPING SYMBOLS FOR
PIPING & INSTRUMENT DIAGRAMS

STANDARD | A-510 | 6



△1 NOTE: Process lines that continue to P&IDs of the same unit shall terminate to the side edge so that the line will be continuous when the P&IDs are "butted" together.

LEGEND

PIPING SYMBOLS

INSTRUMENT SYMBOLS

INSTRUMENT IDENTIFICATION

LINE IDENTIFICATION

COMMODITY DESIGNATION

PIPING SPECIFICATIONS

REFERENCE DRAWINGS

NOTES:

1. DRAFTING STANDARD IS SHOWN IN RED COLOR.
2. FOR DRAFTING PROCEDURE SEE ENGINEERING INSTRUCTION L-20.
3. FOR EQUIPMENT & SYMBOLS SEE ENGINEERING STANDARD DWG. Nº A-510.
4. ALL SPACINGS SHOWN ARE DESIRABLE BUT NOT MANDATORY.
5. FOR TITLE BLOCK FORMAT AND DRAWING SHEET SIZES SEE STD. DWG. A-515

△1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

△					
△2	12/27/73	ADDED NOTE 5 & OWNERSHIP CLAUSE. REVISED TITLE BLOCK & GRID SYST. TO AGREE W/ENG. STD DWG. A-515 REV D DIM. THAT LOCATES PUMPS FROM 1½" TO 2".	FM	MS	HOB
△1	3/4/69	REV TO SHOW NEW STD SYMBOL			
△0		ISSUED AS ENG. STD	JH		

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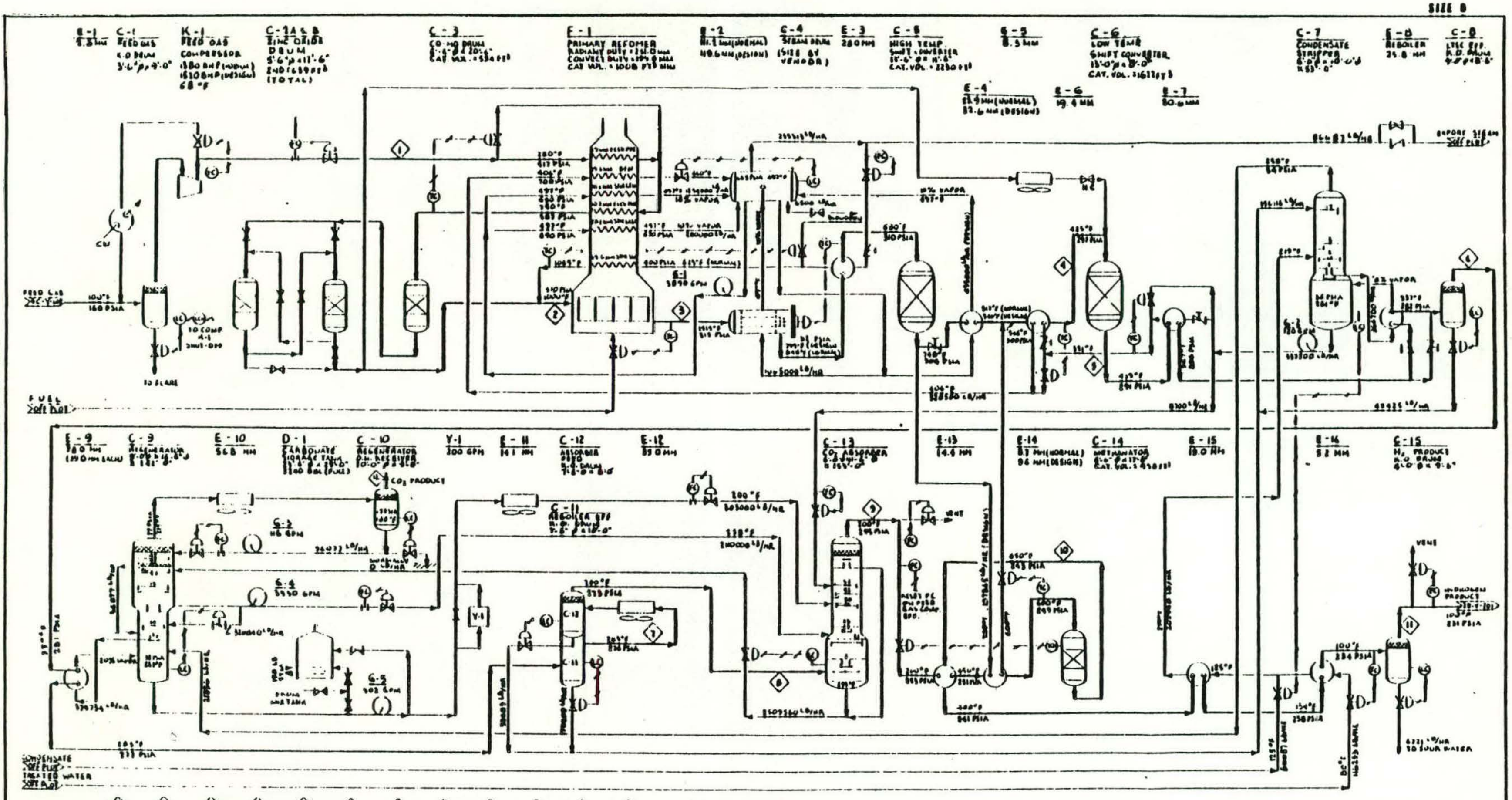
DRAFTING STANDARD FOR PROCESS
PIPING & INSTRUMENT DIAGRAM

STD A-514 2

Specification No. 14222-A-1 Rev. 3 Sheet 38 of 46

SIZE D



DESCRIPTION COMPONENT	① FEED GAS	② PRIMARY REFORMER FEED	③ PRIMARY REFORMER EFFLUENT	④ HIGH TEMP SHIFT EFFL	⑤ LOW TEMP SHIFT EFFL	⑥ LTSC EFFL TO REGEN REBOILER	⑦ REGEN REBOILER EFFL VAPOR	⑧ ABSORBER FEED	⑨ METHANATOR FEED	⑩ METHANATOR EFFLUENT	⑪ HYDROGEN PRODUCT	⑫ CO2 PRODUCT
MMSCFD	14.2	155.3	171.7	171.7	171.7	148.8	109.8	92.3	74.2	73.6	70.8	16.0
MW	19.5	10.8	14.3	14.5	14.3	13.7	12.4	11.2	3.10	3.10	2.92	38.1
LB/HR TOTAL	34337	264710	264710	264710	264710	224285	146077	113553	25705	25705	19184	108241
COMP MOLS/HR												
C_1	552.0	552.6	200.2	200.2	100.2	200.2	200.2	200.2	200.2	232.4	232.4	—
C_2	222.6	222.6	—	—	—	—	—	—	—	—	—	—
C_3	346.6	346.6	—	—	—	—	—	—	—	—	—	—
C_4	26.1	26.1	—	—	—	—	—	—	—	—	—	—
C_5	1.7	1.7	—	—	—	—	—	—	—	—	—	—
C_6	1.2	1.2	—	—	—	—	—	—	—	—	—	—
H_2	522.5	522.5	6745.7	7415.7	7555.5	7555.5	7555.5	7555.5	7555.5	7467.0	7467.0	—
CO	—	—	830.1	162.1	20.5	20.5	20.5	20.5	20.5	—	—	—
CO_2	—	—	1167.6	1835.6	1977.8	1977.8	1977.2	1977.2	11.7	—	—	1765.5
H_2O	—	15076.3	9911.0	9245.0	9101.4	6580.0	2212.9	428.2	361.2	403.1	31.8	1744.6
MPH TOTAL	1185.9	14857.8	18854.6	18854.6	18854.6	16333.8	11906.1	10181.4	8148.9	8089.5	7711.8	3330.1

ENG. STANDARD NOTES:

FOR DRAFTING PROCEDURE SEE ENGINEERING INSTRUCTION L-20.

FOR EQUIPMENT STANDARDS SEE ENGINEERING STD. DRAWING B-507

FOR PIPING SYMBOLS SEE ENGINEERING STD. DRAWING A-510.

△1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

NOTES:

1. MM = 10^6 BTU/HR.
2. PUMP GPM ARE AT NORMAL OPERATING CONDITION.
3. N.C. = NORMALLY CLOSED

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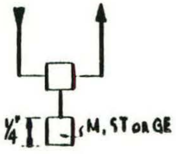
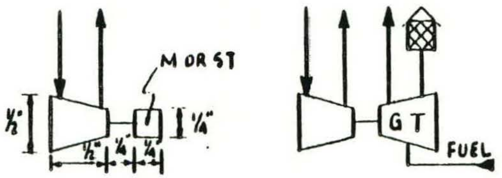
REFINERY & CHEMICAL DIVISION
TYPICAL
PROCESS FLOW DIAGRAM
STD | B-506 | 5

CENTRIFUGAL
PUMP

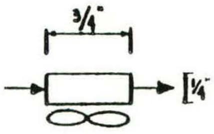


RECIPROCATING
PUMP OR COMPRESSOR

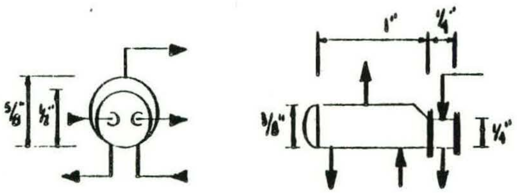


CENTRIFUGAL
COMPRESSOR, BLOWER, OR EXPANDER

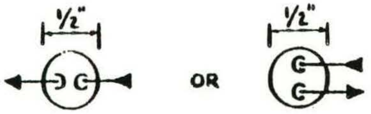
M - MOTOR, ST - STEAM TURBINE, GE - GAS ENGINE
GT - GAS TURBINE.



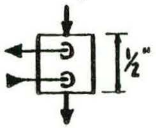
AIR COOLER



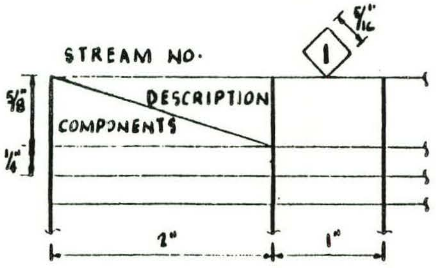
KETTLE TYPE REBOILER OR
STEAM GENERATOR



SHELL AND TUBE
EXCHANGER



DOUBLE PIPE
EXCHANGER



TYPICAL MATERIAL BALANCE
SIZES SHOWN ARE MAX.

GENERAL NOTES

1- EQUIP. & PIPING SYMBOLS FOR P&ID'S SEE STD. DWG. A-510.

2- FOR EQUIPMENT NOT SHOWN, SUCH AS FURNACES, VERTICAL AND HORIZONTAL VESSELS AND OTHER SPECIALTY ITEMS, MAKE SYMBOLS TO FIT THE INDIVIDUAL REQUIREMENTS.

3- EQUIPMENT SYMBOLS FOR MECH. FLOW DIAGRAMS, SEE STD. DWG. A-507.

△1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

No	DATE	REVISIONS	BY	CHKD	PRJ SUPV	ENGR	PROJ ENGR	APPR
△3	4/30/'81	DELETED ORIGIN BLOCK REVD. GEN. NOTE-1 & ADDED GEN. NOTE-3 REVD. TITLE & ADDED OWNERSHIP CLAUSE	GML	H.G				
△2	6/2[illegible]	REVISED DWG. NUMBER	HG					
△1	4/10/[illegible]	ISSUED AS ENG. STD.	CW	HG				

SCALE NONE DESIGNED HG DRAWN CW CHIEF ENGR

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ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

EQUIPMENT SYMBOLS FOR
PROCESS FLOW DIAGRAMS

JOB No	DRAWING No	REV
STANDARD	B-507	2

FIRST LETTER		SECOND & SUCCEEDING LETTERS																			
		DISPLAY DEVICES							CONTROLLING DEVICES								SENSING DEVICES					(See Note 3)
						ALARM (See Note 12)															
MEASURED VARIABLE	SYMBOL FOR MEASURED VARIABLES	INDICATING	RECORDING	INTEGRATING INDICATOR (See Note 5)	SCAN (See Note 7)	LOW	HIGH	LOW HIGH	INDICATING	RECORDING	BLIND	CONTROL VALVE	SELF ACTUATED VALVE	FINAL CONTROL ELEMENT (See Note 11)	SWITCH (See Note 6)	PRIMARY ELEMENT	BLIND TRANSMITTER	INDICATING TRANSMITTER	LOCAL OBSERVATION GLASS	TEST CONNECTION	RELAY OR CONVERTER (BLIND)
Typical Symbol	( )	( )I	( )R	( )QI	( )J( )	( )AL	( )AH	( )AHL	( )IC	( )RC	( )C	( )V	( )CV	( )Z	( )S( )	( )E	( )T	( )IT	( )G	( )P	( )Y
Analysis (See Note 1)	A	AI	AR		AJ( )	AAL	AAH	AAHL	AIC	ARC	AC	AV		AZ	AS( )	AE	AT	AIT		AP	AY
Burner Flame	B	BI	BR		BJ( )	BAL					BC	BV			BS( )	BE	BT		BG	BP	BY
Conductivity	C	CI	CR		CJ( )	CAL	CAH	CAHL	CIC	CRC		CV		CZ	CS( )	CE	CT	CIT		CP	CY
Density	D	DI	DR		DJ( )	DAL	DAH	DAHL	DIC	DRC		DV		DZ	DS( )	DE	DT	DIT		DP	DY
Voltage (EMF)	E	EI	ER		EJ( )	EAL	EAH	EAHL	EIC	ERC	EC			EZ	ES( )	EE	ET	EIT			EY
Flow (See Note 10)	F	FI	FR	FQI	FJ( )	FAL	FAH	FAHL	FIC	FRC	FC	FV	FCV	FZ	FS( )	FE	FT	FIT	FG	FP	FY
Flow Ratio	FF	FFI	FFR		FFJ( )				FFIC	FFRC	FFC	FFV		FFZ							
Gaging (Dimensional)	G	GI	GR		GJ( )	GAL	GAH	GAHL	GIC	GRC	GC	GV		GZ	GS( )	GE	GT	GIT			
Hand	H								HIC		HC	HV	HCV	HZ	HS( )						
Current	I	II	IR	IQI	IJ( )	IAL	IAH	IAHL	IIC	IRC	IC			IZ	IS( )	IE	IT	IIT			IY
Power	J	JI	JR	JQI	JJ( )	JAL	JAH	JAHL	JIC	JRC	JC			JZ	JS( )	JE	JT	JIT			JY
Time	K	KI	KR	KQI	KJ( )	KAL	KAH	KAHL	KIC	KRC	KC			KZ	KS( )		KT	KIT			KY
Level	L	LI	LR		LJ( )	LAL	LAH	LAHL	LIC	LRC	LC	LV	LCV	LZ	LS( )	LE	LT	LIT	LG	LP	LY
Moisture	M	MI	MR		MJ( )	MAL	MAH	MAHL	MIC	MRC	MC	MV		MZ	MS( )	ME	MT	MIT		MP	MY
Users Choice (See Note 2)	N																				
Torque	O	OI	OR		OJ( )	OAL	OAH	OAHL	OIC	ORC	OC	OV	(See Note 9)	OZ	OS( )	OE	OT				OY
Pressure	P	PI	PR		PJ( )	PAL	PAH	PAHL	PIC	PRC	PC	PV	PCV	PZ	PS( )	PE	PT	PIT		PP	PY
Pressure Differential	PD	PDI	PDR			PDAL	PDAH	PDAHL	PDIC	PDRC	PDC	PDV	PDCV	PDZ	PDS( )		PDT	PDIT			
Quantity or Event	Q	QI	QR	QQI	QJ( )	QAL	QAH	QAHL	QIC	QRC	QC	QV		QZ	QS( )		QT	QIT			QY
Radiation	R	RI	RR	RQI	RJ( )	RAL	RAH	RAHL	RIC	RRC	RC			RZ	RS( )	RE	RT	RIT		RP	RY
Speed or Frequency	S	SI	SR	SQI	SJ( )	SAL	SAH	SAHL	SIC	SRC	SC			SZ	SS( )		ST	SIT			SY
Temperature	T	TI	TR		TJ( )	TAL	TAH	TAHL	TIC	TRC	TC	TV	TCV	TZ	TS( )	TE	TT	TIT		TW	TY
Temperature Differential	TD	TDI	TDR			TDAL	TDAH	TDAHL	TDIC	TDRC	TDC	TDV	TDCV	TDZ	TDS( )	(See Note 8)				(See Note 8)	
Multi-Variable	U	UI	UR		UJ( )	UAL	UAH	UAHL	UIC	URC	UC	UV		UZ	US( )						UY
Viscosity	V	VI	VR		VJ( )	VAL	VAH	VAHL	VIC	VRC	VC	VV		VZ	VS( )	VE	VT	VIT			VY
Weight	W	WI	WR	WQI	WJ( )	WAL	WAH	WAHL	WIC	WRC	WC	WV		WZ	WS( )	WE	WT	WIT			WY
Unclassified (See Note 4)	X	XI	XR		XJ( )	XAL	XAH	XAHL	XIC	XRC	XC	XV		XZ	XS( )	XE	XT	XIT			XY
User's Choice (See Note 2)	Y																				YY
Position	Z	ZI	ZR		ZJ( )	ZAL	ZAH	ZAHL	ZIC	ZRC	ZC			ZZ	ZS( )	ZE	ZT	ZIT			ZY

NOTES

(1) "A" is used for all analytical variables: for example: O_2, H_2O, CO_2, pH, octane improvement, chromatograph analyzing one or more streams for one or more compounds, boiling point, freezing point, combustibles etc. The chemical formula recognized symbol (such as pH) or a description denoting the function of the analyzer should be noted on the P&ID outside the instrument symbol.

(2) A user's choice letter is intended to cover a meaning that would be used repetitively in a particular project. When used, the letter may have one meaning as a first letter and another meaning as a succeeding letter. The meanings need be defined only once in a legend, or otherwise for that project. For example, the letter "N" may be defined as turbidity as a first letter and television monitor as a second letter. "BN" would be a burner flame television monitor.

(3) The equation or description denoting the function of the relay "Y" should be shown on the P&ID. For example: A-B+C+K, LP selector, volume booster.

(4) "X" is used to represent any "special" variables and may be defined as required. For example: Mass flow recorders which receive a signal from a multiplying relay which combines the product of density and flow. This item is not to be confused with "U" multi-variable symbol.

(5) When "Q" is used as a second or succeeding letter it denotes an integrating modifier. For example: "FQI" is an indicating flow integrator (or totalizer). Note that the integrating function shall be shown with separate identification. For example: FQI/FRS or FR/FQIS.

(6) Startup and shutdown devices are usually blind, but may be indicating or recording. If so, add "I" or "R" after measured variable. For example: FIS, FRS. If the switch performs an on-off control function, replace "S" by "C". For example: "FS" becomes "FC". Switch functions shall be further modified by "L" for low and "H" for high.

(7) The designation "AJ( )" may denote a scanning analyzer indicator, recorder, transmitter, etc., by using the designation AJI, AJR, AJT, etc., respectively.

(8) "TW" denotes an empty thermowell. "TE" denotes a thermowell with thermocouple or resistance bulb and head suitable for use with a secondary instrument.

(9) Pressure relief valves and rupture disks shall be identified as "PSV" and "PSE" respectively.

(10) "FO" is used to designate a restriction orifice.

(11) For devices other than control valves, such as hydraulic couplings, variable speed drives, etc.

(12) High-high alarms will be designated "( )AHH" and low-low alarms "( )ALL". For example: LAHH denotes "high-high level alarm".

GENERAL NOTES:

(A) All instrument identifications are based upon ISA standard "S5.1 - 1967". For further details refer to ISA standard.

(B) Where special designation is required, pilot lights shall be identified with the particular variable letter, followed by second letter "L".

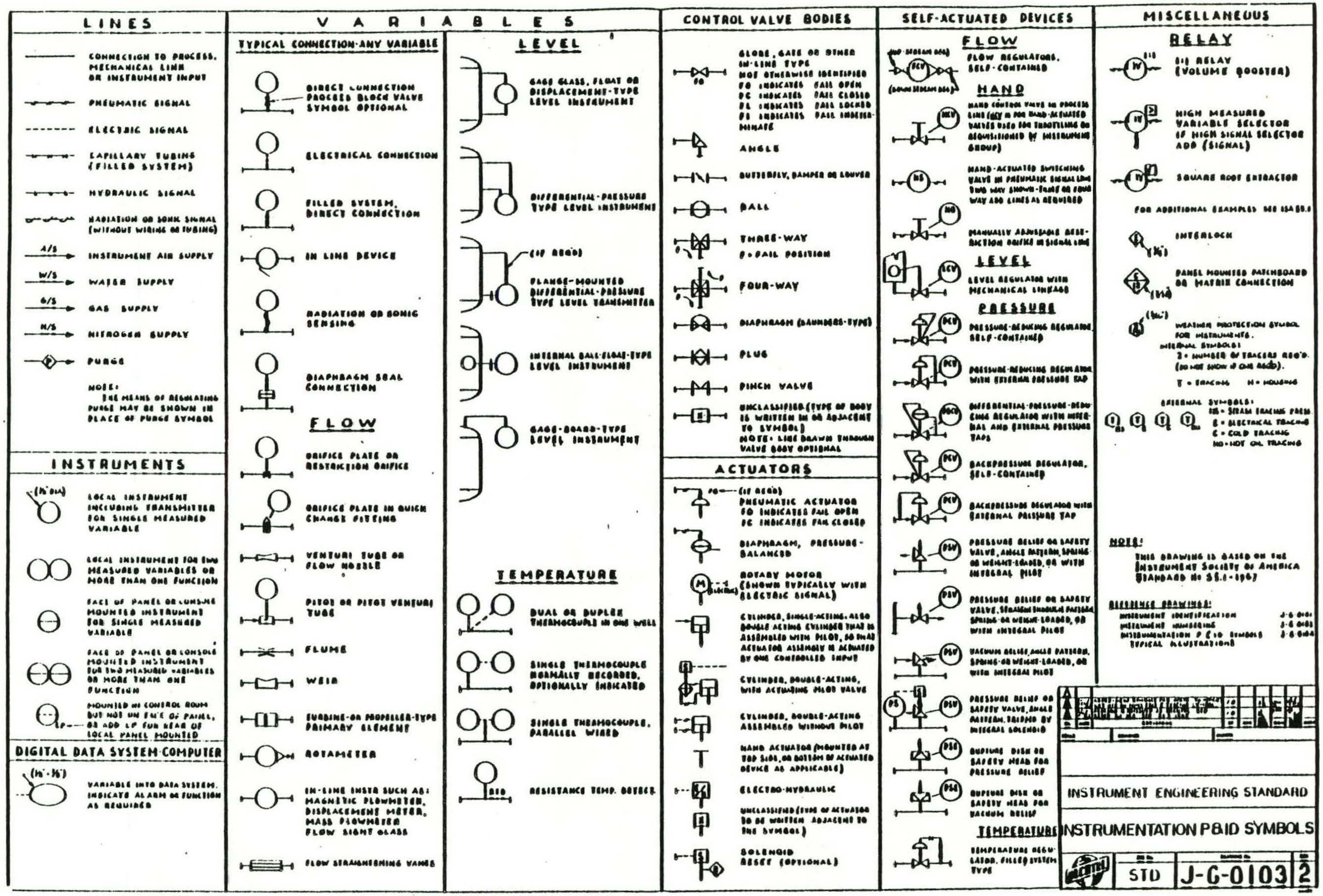
⚠1 "See 14222-A-10 for title block to be used for the Breckinridge Project"

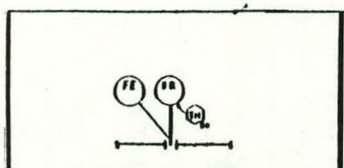
REVISIONS

INSTRUMENT ENGINEERING STANDARD

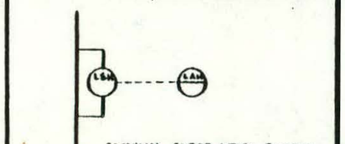
INSTRUMENT IDENTIFICATION

STD
J-G-0101
3

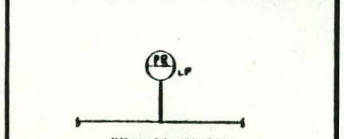

LINES
CONNECTION TO PROCESS, MECHANICAL LINK OR INSTRUMENT INPUT
PNEUMATIC SIGNAL
ELECTRIC SIGNAL
CAPILLARY TUBING (FILLED SYSTEM)
HYDRAULIC SIGNAL
RADIATION OR SONIC SIGNAL (WITHOUT WIRING OR TUBING)
A/S
INSTRUMENT AIR SUPPLY
W/S
WATER SUPPLY
G/S
GAS SUPPLY
N/S
NITROGEN SUPPLY
P
PURGE
NOTE: THE MEANS OF REGULATING PURGE MAY BE SHOWN IN PLACE OF PURGE SYMBOL
INSTRUMENTS
LOCAL INSTRUMENT INCLUDING TRANSMITTER FOR SINGLE MEASURED VARIABLE
LOCAL INSTRUMENT FOR TWO MEASURED VARIABLES OR MORE THAN ONE FUNCTION
FACE OF PANEL OR CONSOLE MOUNTED INSTRUMENT FOR SINGLE MEASURED VARIABLE
FACE OF PANEL OR CONSOLE MOUNTED INSTRUMENT FOR TWO MEASURED VARIABLES OR MORE THAN ONE FUNCTION
LP
MOUNTED IN CONTROL ROOM BUT NOT ON FACE OF PANEL, OR ADD LP FOR REAR OF LOCAL PANEL MOUNTED
DIGITAL DATA SYSTEM-COMPUTER
VARIABLE INTO DATA SYSTEM. INDICATE ALARM OR FUNCTION AS REQUIRED
VARIABLES
TYPICAL CONNECTION-ANY VARIABLE
DIRECT CONNECTION PROCESS BLOCK VALVE SYMBOL OPTIONAL
ELECTRICAL CONNECTION
FILLED SYSTEM, DIRECT CONNECTION
IN LINE DEVICE
RADIATION OR SONIC SENSING
DIAPHRAGM SEAL CONNECTION
FLOW
ORIFICE PLATE OR RESTRICTION ORIFICE
ORIFICE PLATE IN QUICK CHANGE FITTING
VENTURI TUBE OR FLOW NOZZLE
PITOT OR PITOT VENTURI TUBE
FLUME
WEIR
TURBINE-OR PROPELLER-TYPE PRIMARY ELEMENT
ROTAMETER
IN-LINE INSTR SUCH AS: MAGNETIC FLOWMETER, DISPLACEMENT METER, MASS FLOWMETER FLOW SIGHT GLASS
FLOW STRAIGHTENING VANES
LEVEL
GAGE GLASS, FLOAT OR DISPLACEMENT-TYPE LEVEL INSTRUMENT
DIFFERENTIAL-PRESSURE TYPE LEVEL INSTRUMENT
(IF REQ'D)
FLANGE-MOUNTED DIFFERENTIAL-PRESSURE TYPE LEVEL TRANSMITTER
INTERNAL BALL-FLOAT-TYPE LEVEL INSTRUMENT
GAGE-BOARD-TYPE LEVEL INSTRUMENT
TEMPERATURE
DUAL OR DUPLEX THERMOCOUPLE IN ONE WELL
SINGLE THERMOCOUPLE NORMALLY RECORDED, OPTIONALLY INDICATED
SINGLE THERMOCOUPLE, PARALLEL WIRED
RTD
RESISTANCE TEMP. DETECT.
CONTROL VALVE BODIES
FO
GLOBE, GATE OR OTHER IN-LINE TYPE NOT OTHERWISE IDENTIFIED
FO INDICATES FAIL OPEN
FC INDICATES FAIL CLOSED
FL INDICATES FAIL LOCKED
FI INDICATES FAIL INDETERMINATE
ANGLE
BUTTERFLY, DAMPER OR LOUVER
BALL
THREE-WAY
F = FAIL POSITION
FOUR-WAY
DIAPHRAGM (SAUNDERS-TYPE)
PLUG
PINCH VALVE
X
UNCLASSIFIED (TYPE OF BODY IS WRITTEN IN OR ADJACENT TO SYMBOL)
NOTE: LINE DRAWN THROUGH VALVE BODY OPTIONAL
ACTUATORS
FO
(IF REQ'D)
PNEUMATIC ACTUATOR
FO INDICATES FAIL OPEN
FC INDICATES FAIL CLOSED
DIAPHRAGM, PRESSURE-BALANCED
M
ROTARY MOTOR (SHOWN TYPICALLY WITH ELECTRIC SIGNAL)
CYLINDER, SINGLE-ACTING. ALSO DOUBLE ACTING CYLINDER THAT IS ASSEMBLED WITH PILOT, SO THAT ACTUATOR ASSEMBLY IS ACTUATED BY ONE CONTROLLED INPUT
S
CYLINDER, DOUBLE-ACTING, WITH ACTUATING PILOT VALVE
CYLINDER, DOUBLE-ACTING ASSEMBLED WITHOUT PILOT
HAND ACTUATOR (MOUNTED AT TOP SIDE, OR BOTTOM OF ACTUATED DEVICE AS APPLICABLE)
EH
ELECTRO-HYDRAULIC
X
UNCLASSIFIED (TYPE OF ACTUATOR TO BE WRITTEN ADJACENT TO THE SYMBOL)
S
R
SOLENOID
RESET (OPTIONAL)
SELF-ACTUATED DEVICES
FLOW
(UP-STREAM REQ)
FCV
(DOWN-STREAM REQ)
FLOW REGULATORS, SELF-CONTAINED
HAND
HCV
HAND CONTROL VALVE IN PROCESS LINE (HCV IS FOR HAND-ACTUATED VALVES USED FOR THROTTLING OR REQUISITIONED BY INSTRUMENT GROUP)
HS
HAND-ACTUATED SWITCHING VALVE IN PNEUMATIC SIGNAL LINE TWO WAY SHOWN-THREE OR FOUR WAY ADD LINES AS REQUIRED
HO
MANUALLY ADJUSTABLE RESTRICTION ORIFICE IN SIGNAL LINE
LEVEL
LCV
LEVEL REGULATOR WITH MECHANICAL LINKAGE
PRESSURE
PCV
PRESSURE-REDUCING REGULATOR, SELF-CONTAINED
PCV
PRESSURE-REDUCING REGULATOR WITH EXTERNAL PRESSURE TAP
PDCV
DIFFERENTIAL-PRESSURE-REDUCING REGULATOR WITH INTERNAL AND EXTERNAL PRESSURE TAPS
PCV
BACKPRESSURE REGULATOR, SELF-CONTAINED
PCV
BACKPRESSURE REGULATOR WITH EXTERNAL PRESSURE TAP
PSV
PRESSURE RELIEF OR SAFETY VALVE, ANGLE PATTERN, SPRING OR WEIGHT-LOADED, OR WITH INTEGRAL PILOT
PSV
PRESSURE RELIEF OR SAFETY VALVE, STRAIGHT THROUGH PATTERN SPRING OR WEIGHT-LOADED, OR WITH INTEGRAL PILOT
PSV
VACUUM RELIEF, ANGLE PATTERN, SPRING OR WEIGHT-LOADED, OR WITH INTEGRAL PILOT
PS
PSV
PRESSURE RELIEF OR SAFETY VALVE, ANGLE PATTERN, TRIPPED BY INTEGRAL SOLENOID
PSE
RUPTURE DISK OR SAFETY HEAD FOR PRESSURE RELIEF
PSE
RUPTURE DISK OR SAFETY HEAD FOR VACUUM RELIEF
TEMPERATURE
TEMPERATURE REGULATOR, FILLED SYSTEM TYPE
MISCELLANEOUS
RELAY
1:1
1:1 RELAY (VOLUME BOOSTER)
HIGH MEASURED VARIABLE SELECTOR IF HIGH SIGNAL SELECTOR ADD (SIGNAL)
SQUARE ROOT EXTRACTOR
FOR ADDITIONAL EXAMPLES SEE ISA S5.1
I
INTERLOCK
PANEL MOUNTED PATCHBOARD OR MATRIX CONNECTION
WEATHER PROTECTION SYMBOL FOR INSTRUMENTS.
INTERNAL SYMBOLS:
2 = NUMBER OF TRACERS REQ'D. (DO NOT SHOW IF ONE REQ'D).
T = TRACING H = HOUSING
EXTERNAL SYMBOLS:
ST = STEAM TRACING PRIM.
E = ELECTRICAL TRACING
C = COLD TRACING
HO = HOT OIL TRACING
NOTE:
THIS DRAWING IS BASED ON THE INSTRUMENT SOCIETY OF AMERICA STANDARD No S5.1-1967
REFERENCE DRAWINGS:
INSTRUMENT IDENTIFICATION J-G-0101
INSTRUMENT NUMBERING J-G-0102
INSTRUMENTATION P&ID SYMBOLS TYPICAL ILLUSTRATIONS J-G-0104
INSTRUMENT ENGINEERING STANDARD
INSTRUMENTATION P&ID SYMBOLS
STD
J-G-0103
2



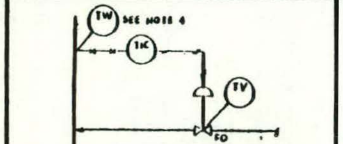
LOCAL FLOW RECORDER
(DIFFERENTIAL PRESSURE TYPE)
WITH 50° STEAM TRACING AND HOUSED



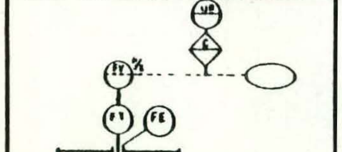
EXTERNAL FLOAT LEVEL SWITCH
WITH PANEL MOUNTED ALARM



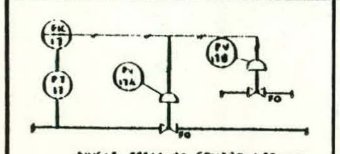
PRESSURE RECORDER
DIRECT CONNECTED ON LOCAL PANEL



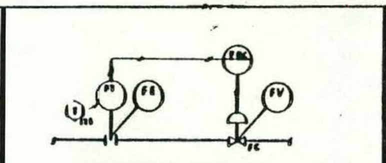
LOCAL TEMPERATURE INDICATING
CONTROLLER (FILLED SYSTEM SENSOR)



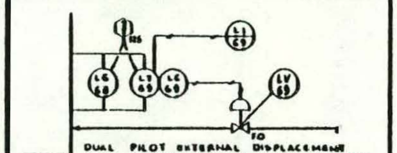
FLOW MEASUREMENT TO COMPUTER VIA PANEL MOUNTED AIR TO CURRENT CONVERTER & JACK FOR TREND RECORDER



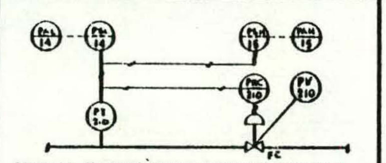
SINGLE PRESSURE CONTROLLER FOR
SPLIT-RANGE SERVICE



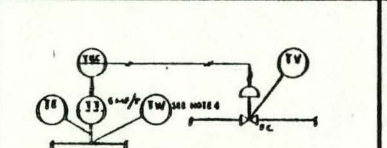
FLOW RECORDING CONTROLLER
PANEL MOUNTED
WITH 125° STEAM TRACING



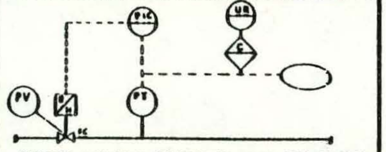
DUAL PILOT EXTERNAL DISPLACEMENT LEVEL CONTROLLER WITH PANEL MOUNTED INDICATOR AND LOCAL LEVEL GAUGE GLASS WITH TWO 125° STEAM TRACERS



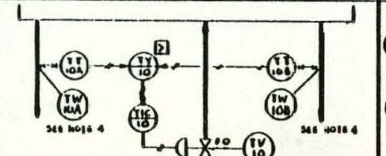
PRESSURE RECORDING CONTROL LOOP WITH HIGH-LOW MONITOR SWITCHES AND ALARMS



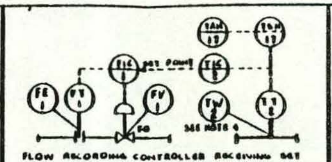
PANEL MOUNTED TEMPERATURE RECORDING CONTROLLER AND PANEL MOUNTED EMF/AIR TRANSMITTER



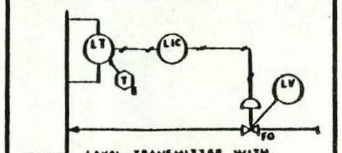
PRESSURE INDICATING CONTROLLER, WITH MEASUREMENT TO COMPUTER AND JACK FOR TREND RECORDER, ACTUATING ELECTRO-HYDRAULIC CONTROL VALVE.



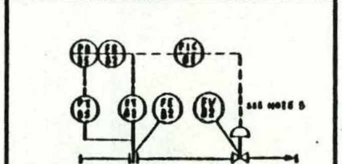
TEMPERATURE CONTROL LOOP WITH DUAL SENSORS AND HIGH SIGNAL SELECTOR RELAY



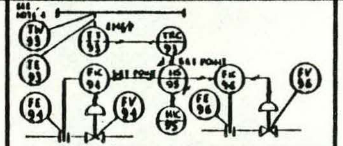
FLOW RECORDING CONTROLLER RECEIVING SET POINT SIGNAL FROM PANEL MOUNTED TEMPERATURE CONTROLLER WITH HIGH TEMPERATURE SWITCH AND ALARM



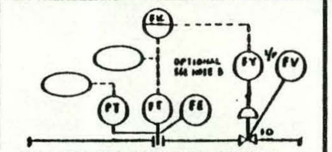
LEVEL TRANSMITTER WITH LOCAL INDICATING RECEIVER CONTROLLER WITH ELECTRICAL TRACING



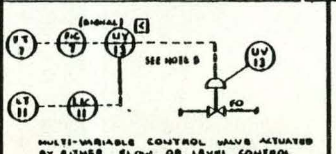
FLOW RECORDING & CONTROL LOOP WITH PRESSURE ON SECOND PEN I/P TRANSDUCER NOT SHOWN



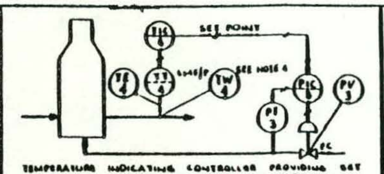
TEMPERATURE RECORDING CONTROLLER ACTUATING SET POINT OF MANUALLY SELECTED FLOW INDICATING CONTROLLERS, WITH OPTIONAL MANUAL LOADING OF FLOW CONTROL SET POINT.



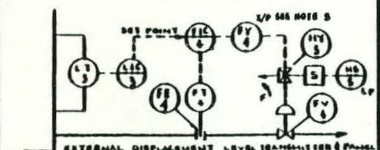
FLOW INDICATING CONTROLLER OPERATING ELECTRO-PNEUMATIC CONTROL VALVE, COMPUTER INPUTS FOR FLOW & PRESSURE



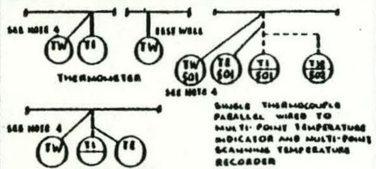
MULTI-VARIABLE CONTROL VALVE ACTUATED BY EITHER FLOW OR LEVEL CONTROL THRU A LOW SIGNAL SELECTOR RELAY I/P TRANSDUCER NOT SHOWN



TEMPERATURE INDICATING CONTROLLER PROVIDING SET POINT TO INDICATING PRESSURE CONTROLLER

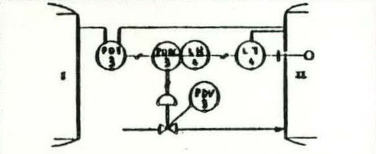


EXTERNAL DISPLACEMENT LEVEL TRANSMITTER & PANEL MOUNTED RECORDING CONTROLLER ACTUATING SET POINT OF FLOW RECORDING CONTROL LOOP WITH REMOTE ACTUATED SOLENOID VALVE.

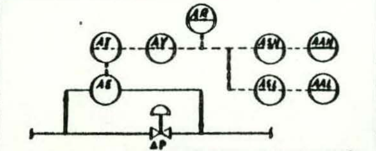


SINGLE THERMOCOUPLE PARALLEL WIRED TO MULTI-POINT TEMPERATURE INDICATOR AND MULTI-POINT SCANNING TEMPERATURE RECORDER

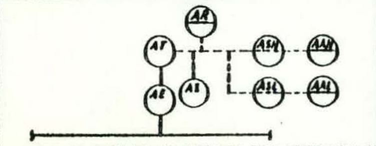
REMOTE MOUNTED TEMPERATURE INDICATOR



DIFFERENTIAL PRESSURE LOOP WITH LEVEL RECORDING ON SECOND PEN



ANALYZER FLOW THRU SAMPLE WITH ELECTRONICS UNIT IN CONTROL ROOM AND HIGH-LOW SWITCHES AND ALARMS.



ANALYZER PROBE IN-LINE TYPE WITH LOCAL ELECTRONICS UNIT AND PANEL MOUNTED RECORDER AND HIGH-LOW SWITCHES AND ALARMS.

NOTES

1. THESE EXAMPLES ARE PRESENTED TO ILLUSTRATE THE USE OF THE BASIC SYMBOLS SHOWN ON STANDARD DRAWING NO. J-G-0103
2. NUMBERS SHOWN ARE TYPICAL ONLY.
3. TYPICAL ILLUSTRATIONS ARE BASED ON ANSI STANDARD Y32.20-1975 (ISA S5.1)
4. THERMOCOUPLES, DIAL THERMOMETERS, AND TEMPERATURE INSTRUMENTS SHALL HAVE TWO TAGS TW & TI ETC. WELL SHALL BE STAMPED THE SAME AS IF ORDERED SEPARATELY. PLANT DESIGN GROUP WILL SHOW TW NUMBER ON MODELS AND ISOMETRICS.
5. I/P TRANSDUCER WILL BE SHOWN OR NOT SHOWN BY JOB STANDARD RULES. WHEN ANY DEVICE IS IS USED IN THE PNEUMATIC SIGNAL, SUCH AS A SOLENOID VALVE, THE TRANSDUCER MUST BE SHOWN.

REFERENCE DRAWINGS

INSTRUMENT IDENTIFICATION	J-G-0101
INSTRUMENT NUMBERING	J-G-0102
INSTRUMENT P&ID SYMBOLS	J-G-0103

3	9/4/75	ADDED INSTR. SYMBOLS FOR ELEMENTS AND CONTROL VALVES			[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	10		[illegible]	[illegible]	[illegible]
1	[illegible]	REDRAWN & REISSUED AS BECHTEL [illegible] ISA STD [illegible]			[illegible]		
NO.	DATE	REVISIONS					

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

INSTRUMENTATION P&ID SYMBOLS
TYPICAL ILLUSTRATIONS

STD J-G-0104 3

INDEX

TITLE	SHEET NO.	REVISION DATE AND NUMBER												
Index	1													
Line Designation Table:														

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG R	PROJ ENGR	APPR
△								
△								
△								

SCALE

DESIGNED

DRAWN

CHIEF ENGR

ORIGIN

BECHTEL

JOB No.

DRAWING No. DS- A-

REV.

"A" SIZE

FORM I 12/68

Specification No. 14222-A-1 Rev. 3 Sheet 45 of 46

NORMAL OPERATING CONDITIONS								LINE INFORMATION				DESIGN CONDITIONS									INSTALLED PIPING		REF. DWGS.	SERVICE INFORMATION		
MASS FLOW LBS/HR	VOLUME FLOW		WT. % VAPOR	PRESS PSIG	TEMP. °F	VISC. CP.	DENS. #/FT³ OR SP. GR.	VEL FT/SEC	ΔP/100' PSI	EFF. LENGTH	TOTAL ΔP	UPSET NOTE 1		EXP. NOTE 4	CODE NOTES 2 & 3		TEST	INSUL./STEAM TRACE	PIPE SPEC.	PIPE SIZE	ORIGINAL TAKE OFF LF	CURRENT TAKE OFF LF	P&ID LINE CALC.	FLUID	FROM - TO	LINE NO.
	QUAN.	UNIT										PRESS PSIG	TEMP °F	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG									

NOTES

1. SHOW MAXIMUM CONDITIONS OF COINCIDENT PRESSURE & TEMPERATURE IN THESE COLUMNS.
2. DETERMINE ANSI CODE DESIGN CONDITIONS AS FOLLOWS.
   DIVIDE THE UPSET PRESSURE BY A FACTOR OF 1.33, 1.2, OR 1.0 (SEE ANSI B31.3 PARAGRAPH 302.2.4)
   TO OBTAIN THE ADJUSTED TEMPORARY PRESSURE. THE CODE DESIGN PRESSURE
   AND TEMPERATURE ARE THEN BASED ON THE MORE SEVERE OF TWO CONDITIONS:
   (A) THE NORMAL PRESSURE AND COINCIDENT TEMPERATURE, OR
   (B) THE ADJUSTED TEMPORARY PRESSURE AND COINCIDENT TEMPERATURE.
3. FOR ASME CODE DESIGN REFER TO ASME SECTION I, PARAGRAPH PG 27, PG 56, PG 60
   SHOW ASTERISK * IN PRESSURE COLUMN IF ASME CODE DESIGN.
4. SHOW MAX. TEMPERATURE POSSIBLE DUE TO UPSET, STEAMOUT, ETC., FOR EXPANSION CHECK.

△				
△				
△				
△				
△				
△				
NO	DATE	REVISIONS	ENGR.	PROJ ENGR.

LINE DESIGNATION TABLE

JOB NO.	DRAWING NO.	REV.

SHEET ______ OF ______

SERVICE

LIQUID PUMPED

CORR./EROS. CAUSED BY

SOLIDS

PUMPING TEMPERATURE (PT) °F

VISCOSITY AT P.T. CENTISTOKES (CS)

VAPOR PRESSURE @ P.T. PSIA

SPECIFIC GRAVITY (S.G.) @ PT

FLOW - NORMAL @ 60 °F GPM

FLOW - NORMAL @ P.T. GPM

FLOW - DESIGN @ P.T. GPM

CALCULATIONS BY		I	I	II	II	III	III
		S	D	S	D	S	D
SUCTION PRESSURE	LOOP						
ORIGINAL PRESSURE	PSIA						
+ STATIC HD. (FT. × S.G. × .433)	PSI						
− LOSS (LINE + OTHER)	PSI						
PUMP SUCTION PRESSURE	PSIA						
NET POSITIVE SUCTION HEAD							
STATIC HEAD	FEET						
− LINE LOSS (PSI × 2.31/S.G.)	FEET						
+ [(ORIG. PR.) − (VAP. PR.)] × 2.31/S.G	FEET						
AVAILABLE NPSH (LIQUID PUMPED)	FEET						
PUMP REQ'D. NPSH (WATER)	FEET						
DISCHARGE PRESSURE							
DELIVERY PRESSURE	PSIA						
STATIC HEAD (FT. × S.G. × .433)	PSI						
LINE LOSS	PSI						
ΔP CONTROL VALVES	PSI						
ΔP EXCHANGERS	PSI						
ΔP FURNACES	PSI						
ΔP ORIFICES	PSI						
ΔP OTHERS *	PSI						
PUMP DISCHARGE PRESSURE	PSIA						
DIFFERENTIAL PRESSURE							
DISCHARGE PRESSURE	PSIA						
− SUCTION PRESSURE	PSIA						
TOTAL PUMP DIFF. PRESS.	PSI						
PUMP HEAD (PSI × 2.31/S.G.)	FEET						
HYDRAULIC HORSEPOWER = (GPM × DIFF. PRESS./1715)							
EFFICIENCY %							
BRAKE HORSEPOWER = [HYD. HP/EFF. (%)]							

* MINIMUM OF 2 PSI FOR DYNAMIC HEAD

III	FINAL						
II	PURCHASE						
I	ORIGINAL						
NO.			JOB ENGR	INSTR	MECH EQUIP	PROJECT ENGR	DATE

PUMP MAT'L -

CASE

INTERNALS

NO.	DATE	REVISION	BY

CLIENT

LOCATION

PUMP CALCULATION SHEET

PUMP NO.

LINE NO.

JOB NO.	DRAWING NO.	REV.

R&C SFE FORM 62 (4/77)

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FORM H-292

3	[illegible]	REVISED AS NOTED			
2	3/80	ISSUED FOR PHASE ZERO	HS		
1	3/7/8[illegible]	ISSUED FOR COST REDUCTION	HS		
0	2/8/80	ISSUE FOR APPROVAL	HS		

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
PIPING & INSTRUMENT DIAGRAM RESPONSIBILITIES

JOB NO. 14222
SPECIFICATION 14222-A-2
REV 3

SHEET 1 OF 16

1.0 INTRODUCTION

The document conveying the greatest amount of information for project engineering design is the piping and instrument diagram (P&ID). The way in which it develops on a project is extremely important. A Task Sequence Table is included as part of this instruction (Attachment A) to indicate the interrelationship of the P&ID with the efforts of various engineering disciplines and their schedule of work (See Section 5). It is imperative to pay close attention to the sequence and to completeness of information on each issue.

2.0 SCOPE

2.1 This instruction outlines the procedure to be followed in the preparation and issuance of piping and instrument diagrams. Drafting procedures are not covered.

△3 2.2 Process Flow Diagram preparation is covered separately in 14222-A-1.

3.0 RESPONSIBILITY

3.1 Project Engineer

The Supervising Project Engineer has complete responsibility for all engineering work, including preparation, approval, and issue of P&ID's. He must ensure that all engineers working on P&ID's are aware of these instructions which shall be consistently followed. The P&ID related work is usually delegated as follows:

3.2 Unit Engineer

Responsible for:

a) The preparation of all piping and instrument diagrams.
b) Checking for mechanical and specification accuracy of the diagram.
c) Coordinating information between P&ID's of related areas of plants.
d) Verifying that supplier information is correctly shown.
e) Ensuring that systems can functionally handle all abnormal situations such as startup, shut down and potential violent temperature, pressure and flow excursions.
f) Ensuring that cognizance has been taken of all applicable codes and environmental and safety practices.
g) Ensuring that the P&ID's recognize and meet maintenance needs.

h) Maintaining an up-to-date reproducible master mark-up of each P&ID, which can be used at any time either for dissemination of information or for establishing a cut-off point for revising and updating the master tracing.
i) Monitoring model progress against the P&ID's for layout operability and accuracy.
j) Conducting model progress and review meetings with other engineers, disciplines and client personnel, as necessary, to maintain orderly P&ID progress.
k) Making all P&ID issues.
l) Checking the piping drawings (isometrics & orthographics) to verify their agreement with final P&ID's.

3.3 Control System Engineer

Responsible for:

a) Working with Unit Engineer in the representation of control systems on P&ID's.
b) Reviewing control philosophy and ensuring conformance to project requirements and to recognized industry good practice.
c) Issuing uniform criteria for application of control systems/instrumentation.
d) Ensuring proper instrumentation symbolism on P&ID's and numbering all instruments.
e) Consulting (jointly with Unit Engineer) with Control Systems Specialist in Simulation and Advanced Control (SACS) for process controllability and for establishing the need for any dynamic simulation studies in order to design and/or verify certain control systems.
f) Preparing required functional control diagrams.
g) Control Systems will maintain an up-to-date mark-up of each P&ID specifically for control systems work only, which can be used at any given point in time for information dissemination and/or the cut-off point for incorporation in the master mark-up (See 3.2 h) and updating the next issue of the master tracing.

3.4 Plant Design Supervisor

Responsible for:

a) Issuing piping material classification specification.
b) If requested by Project Engineer, allocating line numbers and initiating the Line Designation Tables by filling in the line numbers and their locations. Subsequent additions or deletions of line numbers will be the responsibility of the Unit Engineer.

c) Providing Unit Engineer with information regarding changes in the configuration of the utility distribution P&ID when these changes become apparent.

d) Providing Unit Engineer with a reproducible mark-up of each P&ID to show revisions that match the model and/or isometrics, for incorporation in the master mark-up (See 3.2 h).

4.0 JOB P&ID'S - PREPARATION PROCEDURE

Job P&ID's are prepared on the basis of a firm process flow diagram in the following manner:

4.1 The P&ID will be developed by plants, sections, systems or subsystems of a facility. In a reformer, for example, a separate P&ID shall be prepared for each section; i.e., reactor section, compressor section and stabilizing section.

4.2 Several issues of every P&ID, each marking a certain phase of design development, will be required before the P&ID reaches its final form. The sequence and development procedure of the various issues are detailed in paragraphs 5.0 and 6.0

4.3 It may be necessary to issue the P&ID (normally during the early stages of design) with some items or areas of work not firm. These should be marked "hold" and circled. This practice should be held to a minimum. An explanatory note specifying the reason for the "hold" must be included.

4.4 While developing the P&ID's prior to any formal issue, the Unit Engineer should refrain from distributing preliminary copies of the semi-completed P&ID's without approval of the Project Engineering Manager. This is important in order to alleviate confusion which may result from publishing an incomplete design.

5.0 TASK SEQUENCE TABLE

To demonstrate the evolution of the Process or Utility Piping and Instrument Diagram, a Task Sequence Table (Attachment A) lists information requirements for each issue. The format of the table--showing information needed to begin, information required on the issue, and work initiated by the issue--permits job and manpower scheduling as a function of P&ID issues. The table also serves as a check list for P&ID work, both as to information expected from various design groups and information to be transmitted by the P&ID.

6.0 P&ID DEVELOPMENT

6.1 Guidelines for development of P&ID's by the Unit Engineer are Shown in Specification 14222-A-2."

6.2 Process and Utility P&ID's

The first three issues, covering the P&ID development phases from receipt of process design information to the signed construction issue are discussed below and shown on task sequence table (Attach. A).

6.2.1 Issue #1 Preliminary for design development (internal use only and issue for in-house review).

Hand drawn by Unit Engineer.
Control Systems Engineer will add all major instruments after reviewing them with Unit Engineer. Philosophy of major control shall be discussed at this stage with process, start-up and mechanical groups and reviewed △1 by "SACS" Engineer (Ref. para. 3.3). ⊕

This issue will include:

a. All major equipment numbered and titled.
b. All main process and utility lines.
c. All valves and break spools on lines and equipment.
d. Outlines of supplier furnished package units.
e. Major control instruments.

After the preliminary issue, the Unit Engineer will conduct a meeting to review each P&ID with process design, control systems, △1 ⊕ start-up and plant design representatives without involving the Client's personnel.

The Unit Engineer will then (jointly with Control Systems Engineer) modify the draft preliminary P&ID to incorporate comments agreed upon during review meeting. One copy of the modified P&ID will be sent to △1 the P&ID group for drafting or to CAD.

△1 ⊕ 6.2.2 Issue #2 Rev. 0 for Client approval (results of in-house review). Items marked with ⊕ are not mandatory in "Phase Zero" design effort.

While the modified preliminary P&ID is being drafted, the following activities will take place (some may have already started).

a) Unit Engineer

⊕ 1) Allocate line number and initiate Line Designation Tables (alternately Plant Design group can do this part at the discretion of the Project Engineer).
⊕ 2) Decide on line design conditions. If this cannot be determined for certain lines due to lack of required data at this stage (e.g. unknown supplier furnished information) estimate the expected design conditions of these lines.
⊕ 3) a. Select the appropriate piping classification.
  b. Size the lines.
⊕ 4) Decide on insulation and steam or electric tracing requirements. (As required for PH.0 estimate).
⊕ 5) Fill in the line tables.
⊕ 6) Complete preliminary pump calulation sheets.
7) Decide on required legend to be shown on all P&ID's (jointly with Control Systems and Plant Design groups).

b) Control Systems Engineer

1) Add miscellaneous instruments.
2) Complete instrument details, i.e. board/local, pneumatic/electrical, etc.
⊕ 3) Check elevations of level controllers (HLL/NLL/LLL) on vessels, etc.

6.2.2 Issue #2 (Cont.)

c) Plant Design

⊕ Issue Piping Material Classification Specs. (Classification index should have been previously issued).

The Unit Engineer will add clearly in red on an identical copy of the P&ID used for drafting, all the information emanating from the above plus any new information which may become available after the preliminary issue. The marked-up copy will be then given to the P&ID group or CAD for drafting.

Proper timing at this stage is extremely important; the marked-up copy must be given to the P&ID drafting section with sufficient time to complete drafting within schedule.

Upon completion of drafting, the P&ID will be checked and signed by the Unit Engineer, the Control Systems Engineer and the Process Design Engineer (who signs process P&ID's only) before finally issuing it for the Client's approval.

△1 ⊕ The first issue of the Line Designation Tables (LDT) will be issued with Rev. 0 of the P&ID and shall show the following information (Refer to Form 18):
Also see 14222-A-5 Line Designation Tables.

1) Line numbers, service information and ref. drawings.
2) Normal operation conditions.
3) Code design conditions. Lines with estimated design conditions shall be clearly identified so that the design figures can be revised in a later issue of the LDT when missing data becomes available.
4) Pipe sizes.
5) Pipe specs.

This issue of the P&ID will be used for estimating the required manhours for all design disciplines.

△1 ⊕ 6.2.3 Issue #3 Rev. 1 for Construction (the result of Bechtel/Client review - signed by Client and with all Bechtel signatures).

Incorporates revisions initiated by the Bechtel/Client review and additional

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6.2.3 Issue #3 (Cont.)

information generated by the Unit Engineer and other design disciplines since the issue for approval.

Because this issue is used by the Design Groups to proceed with final design and purchase of material, it represents a distinct milestone in the life of the project. At this stage, all major equipment and most of the control and piping systems are well defined. Undefined piping shall be reported by the Unit Engineer to Plant Design Group on △3 Form 183 to be issued later for Phase 1 design.

Line tables accompanying this issue, shall show, in addition to actual revisions, the insulation and steam or electric tracing requirements, the expansion temperatures and the test pressures of all the lines. Informal revision lists covering major changes only will accompany this issue.

Ideally, the construction issue (Rev. 1) should provide all required information to complete the engineering work. In actual practice, this issue has to be revised several times for various reasons e.g. to show late vendor's information and to incorporate revisions requested by the Client or dictated by detail design work. Issues subsequent to the construction issue will be accompanied by formal revisions lists and the revised LDT's and indices.

△1 ⊖ 6.3 Other Types of P&ID's

These are prepared on the basis of the process and utility P&ID's. Since these are subsidiary P&ID's, they may not follow the same development phases as outlined above. However, all instructions regarding timely issues, line tables, revision lists, equipment numbering, etc. shall apply.

The auxiliary P&ID will be initiated by the Unit Engineer, marked up for instrumentation by the Control Systems Engineer and reviewed by the Mechanical Group. Should an auxiliary P&ID be deemed necessary to clarify interconnections for one particular discipline (e.g. Control Systems) then the group supervisor of this discipline may initiate (subject to approval of the Project Engineer) the development of this P&ID within his own group and transmit it to Unit Engineer for issue.

Special control diagrams will be initiated by the Control Systems Engineer (jointly with Electrical Engineer if necessary) and reviewed by the Unit Engineer.

In all cases the responsibility for these P&ID's remains with the Unit Engineer.

7.0 REVISIONS

The coordination of all changes to P&ID's shall be the responsibility of the Unit Engineer. He is responsible for maintaining a master mark-up of each P&ID on which he will record changes to the drawing during the interim between revisions to the P&ID tracings. It is also his responsiblity to transmit this information to the Design Groups, Process Group and others so that they are kept abreast of any and all changes. Formal revision lists will not be made until after the "Issue for Construction" because until this point is reached design is in a state of development. However, this issue sets design and releases material for Procurement. Thereafter, changes must be officially documented so that they become a matter of record and are implemented by the groups involved.

The following procedure shall be followed to report changes to all concerned and to revise the P&ID's.

△1 7.1 Reporting of Changes - Phase I

After "Issue for Construction" and prior to the final issue of the P&ID, the Unit Engineer will prepare a hand written report each Friday. The report will follow the same format and numbering used on the formal revision lists and will list all changes entered on the master mark-up during the week. He may elect to include some free hand sketches to clarify certain items. In case of no change, the weekly report will also be issued indicating this fact.

Reports shall be given serial numbers, dated and continued until the following revision of the P&ID. Control of interim revision notices shall be maintained by the Unit Engineer.

Copies of each report shall be distributed to the Supervising Project Engineer, the Materials Coordinator and all the design disciplines.

△1 7.2 Revision of Original Tracings - Phase I

After the contruction issue, P&ID revisions shall be made at the discretion of the Unit Engineer whenever the full distribution of the P&ID is required.

Revised P&ID's shall be accompanied with formal revision lists, including items previously reported in the weekly reports, and the revised sheets and index of the line designation tables. All these documents will be entered in the Drawing Control.

△1 7.3 Formal Revision Lists - Phase I

Generally changes on the P&ID are too extensive to be listed in the "revision notes" space of the drawing title block. When this occurs, the changes shall be described on a separate "A" size sheet. This sheet shall carry a distinct project drawing number, be titled "Revision List for P&ID (Dwg. No.)" and be included with each transmittal of the revised P&ID. If more than one "A" sheet is required the additional sheets will carry the same number and a sheet number assigned to each. For example:

A-A-103, Rev. 3 - Sheet 1 of 4
A-A 103, Rev. 3 - Sheet 2 of 4

7.3.1 Subsequent revisions described on "A" sheets for a particular P&ID shall reuse the same "A" size drawing number for each issue.

7.3.2 List the revisions on "A" size sheets in the following format. See sample (Attachment B).

Valves

a) Added (List)
b) Deleted (List)
c) Changes
    1. Size (List)
    2. Type (List)
    3. Code (List)

Notes:

Accuracy is important. Valve adjustments on material requistions will be made based on this listing.

7.3.2 (Cont.)

Lines

a) Added. (List)
b) Deleted (List)
c) Changes
    1. Size (List)
    2. Specs. (List)
    3. Other (as insulation, steam tracing, special details, etc.) (List)

Instruments

a) Added. (List) Add location of instruments relative to lines or equipment.
b) Deleted. (List)
c) Changes. (List)

Equipment

a) Added. (List)
b) Deleted. (List)
c) changes (List)

Miscellaneous

a) Adding and removing holds. (List)

7.3.3 Show P&ID grid number opposite each item revised. Also identify whether each item is an engineering design allowance (EDA) or a change order(CO).

7.3.4 On all changes first state what it was and second, what it changed to.

7.3.5 P&ID's utilizing the "A" sheets to describe changes shall have the following notation in the revision note space:

"Revised per Drawing A-A-(Dwg. No.) Rev. (No.)"

△1 8.0 APPROVALS - Phase I

The construction issue of all P&ID's must be approved by:

a) Supervising Process Engineer (Process P&ID's only and excepting outside proprietary processes).

b) Control Systems Engineer.
c) Unit Engineer.
d) Mechanical Engineering Staff (if applicable).
e) Project Engineer.
f) Client's representative, unless specifically waived.

9.0 CONCLUSION

Every effort shall be exerted to maintain this standardized procedure for piping and instrument diagrams. Modifications are justified only in response to client requirements and approval of the Supervising Project Engineer for a specific job and will be the subject of separate job instructions.

△1 10.0 ATTACHMENTS

Task Sequence Table: Issue No. 1 - Preliminary
Task Sequence Table: Issue No. 2 - Results of In House Review
Task Sequence Table: Issue No. 3 - Results of Client Review
Standard Drawing A-A-103 Sample: Revision List for P&ID's

TASK SEQUENCE TABLE
ISSUE NO. 1 - PRELIMINARY
ISSUE FOR DESIGN DEVELOPMENT & IN-HOUSE REVIEW

Items marked (|) to be added in Phase I
⚠ unless otherwise designated in Subcontractors Contract

INPUT INFORMATION REQUIRED

FROM PROCESS

● Process Flow Diagram
0 Vessels design sketches showing liquid ⊕ levels and ⊕ internals
● Fired heaters process data sheets
● Compressors data sheets (process information only)
0 Heat exchange equipment process data sheets
0 Cooling methods & requirements

FROM PROJECT

0 Mechanical specifications which include:
  Design philosophy & applicable codes
  ⊕ Turnaround block valves & blinds
  ⊕ Installed equipment spares policy
  Drivers; power medium
  Winterization philosophy
  Noise & pollution requirement
  ⊕ Housing of control centers
  Applicable standard drawings
  Future provisions
  Drainage systems
0 Basic engineering design data
● Job instructions for specific changes from

FROM UNIT ENGINEER

⊕ 0 Pump calculation sheets
⊕ 0 Lines design conditions

FROM CONTROL SYSTEMS

0 Uniform criteria for application of control systems/instrumentation

FROM PLANT DESIGN

0 Piping Material Classification Index

FROM METALLURGY (jointly with Project)

⊕ 0 Material Selection Guide Diagram

INFORMATION REQUIRED ON P&ID

EQUIPMENT

-All major equipment including numbers, titles and available heading information
⊕ -Bottom tangent line elevation for vertical vessels
⊕ -Outside bottom elevation for horizontal vessels
⊕ -Liquid levels in vessels
⊕ -Vessels internals

PIPING

-All main flow lines including valves
⊕ -Defined auxiliary systems e.g. start-up, shut-down, pump-out, steam-air decoking and regeneration, snuffing steam ---etc.
-Preliminary line sizes & specs ⊕

INSTRUMENTS

-Principal instrumentation control
-PSV locations

WORK INITIATED BY P&ID ISSUE

GENERAL

-Review P&ID by Process, Start-up, Project, Control Systems and Plant Design groups

UNIT ENGINEER

⊕ -Initiate Line Designation Tables (alternatively by Plant Design)
-Prepare preliminary utility balance
-Size lines and select appropriate piping specs. ⊕

CONTROL SYSTEMS

-Add miscellaneous instruments
-Complete instrument details e.g. board/local and pneumatic/electric
⊕ -Establish need for dynamic simulation for certain control systems

PLANT DESIGN

⊕ -Proceed with equipment arrangement on preliminary model
⊕ -Start line routing diagrams
⊕ -Study instruments & electric rack locations

ELECTRICAL

⊕ -Start single line diagrams
⊕ -Evaluate A/G vs U/G transmission

CIVIL/STRUCTURAL

-Study grades & drainage
⊕ -Plan preliminary U/G system

⊕ **START-UP**

-Comment on start-up, shut-down & pump-out systems.
-Propose shut-off requirements & location of certain valves.

CONSTRUCTION

-Study construction logistics, support facilities, erection and location requirements. Plan preliminary construction schedule.

LEGEND

0 Preliminary Data
● Firm Data
⊕ Not Phase Zero

ATTACH "A"
E.I. A-1, Rev. 6
Page 1 of 3

TASK SEQUENCE TABLE
△ ⊕ ISSUE NO. 2 - RESULTS OF IN-HOUSE REVIEW
REV. 0 - ISSUE FOR CLIENT APPROVAL

(Entire Sheet Phase I)

INPUT INFORMATION REQUIRED

GENERAL
Comments from all groups on preliminary issue

FROM PROCESS
- ● Stream properties
- ● Vessels design sketches showing liquid levels & internals
- ● Heat exchange equipment data sheets
- ● Tray data sheets
- ● Cooling methods & requirements
- ● Effluent systems
- O Relief valves data sheets

FROM PROJECT
- ● Mechanical specifications
- ● Basic engineering design data

FROM UNIT ENGINEER
- ● Pumps calculation sheets
- ● Lines design conditions
- ● Line numbers, selected sizes & specs
- ● Definition of auxiliary systems which were not shown on preliminary issue
- ● Equipment missing details e.g. number of parallel exchanger shells and air cooled exchanger sections, various exchanger nozzles, furnace passes---etc. (coordinated with mechanical group)
- O Equipment performance/dynamic response data (obtained from mechanical group)

FROM VESSEL GROUP
- O Vessels coordination drawings

FROM CONTROL SYSTEMS
- ● Uniform criteria for application of control system/instrumentation
- ● Decision regarding board/local & pneu./elect.
- ● Control valve manifold general requirements
- ● Level gauge & level control details

FROM PLANT DESIGN
- ● Piping Material Classification Index
- O Piping Material Specifications

FROM METALLURGY
- ● Material Selection Guide Diagram

INFORMATION REQUIRED ON P&ID

EQUIPMENT
-Complete heading information
-Material classification on columns & vessels
-Relief valves - set pressures & preliminary sizes

PIPING
-Line numbers, sizes, specs and insulation/ steam tracing requirements
-Piping class. spec. break
-Boiler code and limits
-Sample points & types of sampling devices
-Steam traps and types
-Complete missing auxiliary systems & piping
-All valving
-Tight shut off valves & operating blinds

INSTRUMENTS
-Detailed control scheme
-Control valve manifolding

WORK INITIATED BY P&ID ISSUE

PLANT DESIGN
-Plot plan studies
-Pipeway layout studies
-Vessel nozzle orientation & piping layout
-Exchangers nozzle orientation & piping layout
-Vessel instrumentation
-Vessel platforms & ladders
-Bulk material (pipes, fittings & small valves) take-off and preliminary order
-Valves take-off and solicit bids
-Long delivery items (mainly alloy piping, fittings & valves - also special valves) take-off, solicit bids and order.

CONTROL SYSTEMS
-Start sizing control valves, relief valves, orifice plates and orifice runs as data is generated by Unit Engineer
-Start instrument data sheets
-Start approved dynamic simulation studies (if not already underway to aid in plant design).

ELECTRICAL
-Plan required electrical drawings
-Continue single line diagrams
-Investigate area classifications
-Study electrical controls

VESSELS
-Continue vessel design details & procurement

CIVIL/STRUCTURAL
-Continue U/G studies
-U/G bulk material take-off
-Start foundations design

LEGEND
O Preliminary Data
● Firm Data

ATTACH "A"

TASK SEQUENCE TABLE
⊕ ISSUE NO. 3 RESULTS OF CLIENT REVIEW
△1 REV. 1 - ISSUE FOR CONSTRUCTION

(Signed by Client)
(Entire Sheet Phase I)

INPUT INFORMATION REQUIRED

GENERAL
-Client's comments
-Comments from all Bechtel groups on Rev. 0

FROM PROCESS
● Relief valves data sheets
● Relief loads & occurrences
● Complete missing process data

FROM UNIT ENGINEER
● Sizing of on-plot relief system

FROM CONTROL SYSTEMS
● Instruments numbers
● Data sheets on
    Control valves
    Relief valves
    Level gauges
    Level controllers
    In-line instruments
● Requirements for special control valve manifolds

FROM PLANT DESIGN
● Piping Material Specifications

LEGEND
● Firm Data

INFORMATION REQUIRED ON P&ID

EQUIPMENT
-Final vessel liquid levels
-Final number of exchanger shells and air cooled exchanger sections.
-Heater arrangement & passes and all ancillary equipment e.g. fans, dampers, air preheater--etc.
-Final selection of drivers
-Update equipment & piping furnished by supplier. Mark & list "holds" on items not firm.

PIPING
-Sizes of all relief lines
-Complete operating vents & drains
-Final line sizes, specs, insulation and steam/electric tracing requirements
-Code numbers for special items
-Utility tie-ins
-Complete steam-out & snuffing steam lines
-Complete gas purge lines
-Complete closed drain system
-Complete minimum flow by passes if required
-Lines for special pump seal fluids
-Major expansion joints
-Complete type of sample connections and of steam traps

INSTRUMENTS
-Instrument numbers
-Control valve sizes
-Relief valve sizes
-Flow meter run size if different from line size
-Instrument purging & winterizing
-Note for special control valve manifold

WORK INITIATED BY P&ID ISSUE

UNIT ENGINEER
-Complete line designation tables
-Issue a pressure profile for compressor circulating system at different operating conditions e.g. S.O.R., E.O.R. (start of run & end of run)

VESSELS
-Complete vessel drawings
-Finalize nozzle sizes & locations
-Continue design on miscellaneous vessels
-Re-check with Unit Engineer all vessel skirt heights

CIVIL/STRUCTURAL
-Start final grade drawings
-Start final civil design drawings

PLANT DESIGN
-Issue plot plan for client approval
-Start equipment modeling
-Commit all piping material (except those on hold)
-Valve tabulation
-Continue piping studies
-Continue misc. adder/platform dwgs.

CONTROL SYSTEMS
-Continue design & complete data sheets
-Order instruments
-Continue appoved dynamic simulation studies & issue report

ELECTRICAL
-Issue area classification drawing
-Continue all electrical drawings
-Order electrical equipment

ATTACH "A"

ITEM	GRID NO.	WAS	CHANGED TO	E.D.A. / C.O.
VALVES				
3BD319-2"	B-3	3BD319-2"	Added valve	
3P311-1½"	A-4	3P311-1½"	Deleted valves at PV201A	
3BD308-3"	A-4	3BD308-3"	Changed plug valves at PV201B to gates	
LINES				
3BD327-1"	B-3	--	Added Line	
3BD320-1"	C-4	3BD320-1"	Deleted	
3BD312-1"	B-3	3BD312-1½"	Changed size	
INSTRUMENTS				
PI 590 on 3P-112	D-3	--	Added	
PDCV 214 on 3P-90	D-3	PDCV 214	Deleted	
LAH-3 & LAL-3 on 3C-1	F-1	LAH-3 & LAL-3	Relocated to main panel	
EQUIPMENT				
G-322B - Pump	E-1	--	Added pump	
F-310A - Filter	F-5	F-310A Filter	Deleted	
K-317 - Compressor	D-5	800 BHP & 1028 ACFM	600 BHP & 800 ACFM	

ATTACHMENT "B"

Sample Revision List

NO	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG R	PROJ ENGR	APPR
△								
△								
0		Revision for P&ID 3R-A-5 Rev. 2						

SCALE	DESIGNED	DRAWN	CHIEF ENGR

ORIGIN

XYZ OIL COMPANY
HYDROTREATER
REVISION LIST FOR
P&ID 3R-A-5

JOB No.	
DRAWING No.	**REV.**
A-A-103	0

INDEX

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3	10/2/80	REVISED SH.3, 4 & 10. REPLACED TABLE 6
2	7/14/80	GENERAL REVISIONS
1	3/80	ISSUED FOR PHASE ZERO
4	[illegible]	REVISED SHEETS 13 & 16

BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
BASIC ENGINEERING DATA

JOB NO. 14222
SPECIFICATION 14222-A-3
REV 4

THE BRECKINRIDGE PROJECT
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05- 800R20717
Project Specification
Basic Engineering Design Data

GENERAL INFORMATION

△1 **CUSTOMER'S NAME** Ashland Synthetic Fuels, Inc; Airco Energy Co. Inc.
REFINERY LOCATION BRECKINRIDGE COUNTY, KENTUCKY
UNITS COAL LIQUEFACTION

SYSTEM OF MEASUREMENTS IS TO BE ENGLISH. If otherwise, details: ENGLISH

△1 **CONTRACTOR'S SPECIFICATIONS ARE TO BE USED.** BY ALL SUBCONTRACTORS

YES - AS APPROVED FOR PROJECT.

In the event of conflicting requirements, those stated in the Project Specification shall govern.

All construction shall conform with the latest edition of the applicable sections of ASME, ASTM, AIEE, NEC, TEMA, AISI, NEMA, AISC, ACI and other governing codes of standard practice. The following regulatory agency state △1 **or local codes or laws shall supplement the above.**

△1 **Pressure Vessels** ASME SECTION VIII DIV. 1 OR 2; ASME SECTION IX: WELDING QUALIFICATIONS

Boilers ASME SECTION I ASTM STDS. FOR REFRACTORIES

Buildings & Structural UBC 1979; AISC; ACI 318-71, LOCAL CODES

Electrical ANSI CI-1975, C2-1973; APIRP 500 A/B/C; APIRP 540; NEMA-UL; IEEE 141-1976, 242-1975, 446-1974

Sanitary LOCAL, EPA, NATIONAL PLUMBING CODE-IBC

Aircraft Warning FAA

Safety OSHA, MESA

Water Pollution LOCAL, EPA, COMMONWEALTH OF KENTUCKY STANDARDS

Air Pollution EPA, NATIONAL PRIMARY STANDARD, COMMONWEALTH OF KENTUCKY AP-1 (SEC. J)

Noise OSHA, AOI STANDARD (WALSH-HEALY) MEASURED AT 3 FT. FROM SOURCE

Piping ANSI B31.1, B31.3, B16.5

Exchangers: TEMA; ASME Section VIII on all steam Generators (Waste Heat Exchangers).

Storage Tanks: API 650

Exceptions to Codes: None

THE BRECKINRIDGE PROJECT
ASFI-AECI U.S. DOE CONTRACT NO. DE-FC05-800R20717
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△2 UTILITY INFORMATION

STEAM

1. In Process Area

SERVICE	PRESSURE, psig			TEMPERATURE, °F.			VALUE
	Nor	Max	Min	Nor	Max	Min	c/1000#
High Pressure 900	875	900	850	750	750	725	
Med. Pressure 600	600	660	575	700	720	488	
Low Pressure 150 SAT	150	190	140	366	383	361	
Clean Exhaust 50 SAT	50	75	40	298	320	287	
Oily Exhaust							

2. At Boiler Plant

SERVICE	PRESSURE, psig			MAX. T°F	AVAIL. #/Hr	VALUE c/1000#
	Nor	Max	Min			
High Pressure	900	925	875	750		
Med. Pressure SAT.	625	685	600	503		
Low Pressure	175	215	165	450		
Exhaust						
Deaerator						

CONDENSATE

1. Condensate from 900 psig steam system shall discharge @ TBD psig TBD

2. Condensate from 600 psig steam system shall discharge @ TBD psig TBD
150psig and 50psig TBD

3. Condensate available at ~~battery limits~~@ 40 psig at SAT °F and at ______ GPM.

3. Deaerated Boiler Feed Water to Process Areas △3

Service Boiler Pressure	Pressure, Psig			Temperature °F		
	Nor.	Max.	Min.	Nor.	Max.	Min.
900	1050	1100	1000	292	292	270
600	725	750	700	292	292	270
150 & 50	250	300	200	292	292	270

UTILITY INFORMATION

ELECTRICAL POWER

SERVICE	HORSEPOWER RANGE		VOLTAGE	PHASE	FREQ-CPS (HERTZ-Hz)	KVA
	From	To △3				
Motors	0	3/4 △3	115 (1)	1	60	
	1	200 △3	460	3	60	
	201	5000 △3	4000	3	60	
Instruments △3			115	1	60	
Lighting Distribution △3			120/208	1	60	
Transformer capacity available for this project (secondary conditions)			Later			
Supply to Refinery 4 HP ABOVE 5001 △1			161,000	3	60	
Supply-overhead circuits △3			2			

In plant generation: △3 1 unit . 4000 volts △3 △3 50 MW

1. All electric lights shall be 115 V,grounded on one side. △1

2. Incremental value of electrical power is △1 9.5 ¢ per KWH. (1987)

3. Is special insulation for climatic conditions required: None

4. Special conditions are:

5. How reliable is Power System? See BREC Letter March 27/80 △3

6. Average number of power failures per year? See "5" above.

Remarks:

1. Continuous "On-Off" type motors (<1HP) should be 460V, 3 phase, 60 Hz.
2. Area classification: By Bechtel.
3. Below grade distribution for power; Above grade for lighting and instrumentation
4. Vector Rotation -CCW and 1-2-3 sequence
   Phase relationship-NEMA/ANSI standards.
   Relaying requirements- NEMA/ANSI standards
5. Uninterruptible power supply (UPS): Required for 30 minutes operation of all instruments except computers.

△3 6. For motors above 5000 HP, 13.2 kV and 34.5 kV systems will be available. Selections will be made on the basis of economics.

UTILITY INFORMATION

WATER

DESCRIPTION	SERVICE				
	Circulating Cooling Water	**Cooling Tower Water Make-up**	**Raw Boiler Feed Make-up**	**Treated Boiler Feed Make-up**	
Source	CWT	OHIO RIVER	OHIO RIVER		△2
Return	CWT				
Supply Pressure at Grade psig	50				
Return Pressure at Grade psig	35				
Supply T°F for Exchanger Design	85		--		
* Maximum Return T°F	115				
Availability over use GPM	As req'd				
Value, ¢/1000 Gals.					
pH			6.7 to 8.5		
PPM Total Hardness as $CaCO_3$			88 to 190		
PPM Calcium as $CaCO_3$					
PPM Magnesium as $CaCO_3$					
PPM Total Alkalinity as $CaCO_3$			-		
PPM "P" Alkalinity as $CaCO_3$					
PPM Sulfate as SO_4			42 to 162		
PPM Chloride as Cl			14 to 55		
PPM Silica as SiO_2			5 to 35		
PPM Suspended Solids			7 to 614		
PPM Dissolved Solids			334		

*** At any Exchanger**

Piping Design 150psig at 200°F

See Table 6, Sheet 25, for more complete data.

1. **78 °F wet bulb for cooling tower design.**

△2 2. **Boiler feed water treatment:** Condensate From Medium Pressure Boilers
Low Pressure Boilers: Cold-Lime Zeolite

3. **Cooling water treatment:** Chromate

△2 4. Potable Water: 50psig, Ambient Piping Design 150psig, 150°F.

5. Utility Water: 75psig, Ambient, Piping Design 150psig, 150°F.

6. Cooling water supply is to be underground to each service.

7. Firewater is to have 4 hours storage, based on flow to be determined by Bechtel. Pressure to be 125psig, Ambient temperature, at the most remote user during maximum anticipated usage.

8. Cooling water thermal relief valves to be set at 75psig.

THE BRECKINRIDGE PROJECT
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Project Specification
Basic Engineering Design Data

UTILITY INFORMATION

FUEL						
DESCRIPTION	TYPE					
	OIL			GAS		
	Fuel Oil		Startup Oil	REFINERY FUEL GAS △2	MEDIUM BTU GAS △2	Startup Gas
°API	28		28			
Viscosity, SSU @ °F						
Temperature at Burner °F	100		100			
Gross Heating Value Btu/Gal.	140,000		140,000			
Availability over use, GPM						
Value, $/BBL						
Wt. ppm Vanadium	NIL		△1 NIL			
Wt. % Sulfur	0.05		0.05			
Header Pressure, Nor. PSIG	150				50@100°F	
Burner Pressure, Nor. PSIG	100				5	
Fuel Gas Header, Max. PSIG					75	
Sp. Gr.				1.0	0.67	
△2 Net Heating Value, Btu/SCF				1525	270 △2	TBD
Availability over use, CF/H						
Value, ¢/1000 CF				(1)	(1)	
Vol. % H_2S				-	-	
Grains/CF, Sulfur				-	0.054	

Remarks:

△2 (1) $6.00/MILLION BTU

THE BRECKINRIDGE PROJECT
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
Project Specification
Basic Engineering Design Data

UTILITY INFORMATION

AIR, NITROGEN

	SERVICE			
△2	Instrument Air	**Plant Air** △2	Low Pressure Nitrogen	High Pressure Nitrogen
Source	Boiler Plant	Boiler Plant	Oxygen Plant	Oxygen Plant
Auxiliary Source (1)				
Pressure, PSIG △2	115	115	50	TBD
Temperature	Ambient	Ambient	Ambient	Ambient
Dew Point	-40°F	-40°F	-40°F	-40°F
Oil Free	Yes	Yes	Yes	Yes

Remarks:

△1 (1) Independent facilities for generation of air and nitrogen will be required. Size to be determined later.

EQUIPMENT DESIGN INFORMATION

PUMPS AND COMPRESSORS

	EQUIPMENT					
	Pumps		Compressors		Air Blowers	
	Operating	Spare				
Driver Type						
Compressor Type						
Driver by Steam Balance						
Full Spares						
Three-Pump Hookups Allowed	YES					
Minimum Spares	TBD					
No Spares			TBD		TBD	

1. Are direct acting steam reciprocating pumps acceptable for limited use? Not normally
2. Steam reciprocating pumps shall exhaust to: Atmosphere
3. Shall electric power failure be considered in sparing policy: See note D
4. For air blower design, use 95 % relative humidity and 96 °F dry bulb temperature. △2

Remarks:

Note A: All pump and compressor motor drivers shall be sized according to the individual pump curve or compressor design such that they will be non-overloading with the design fluid (and with the installed impeller).

Note B: All reciprocating machines shall have suction valve unloaders for 0, 25, 50, 75, and 100%.

Note C: Types of compressors and drivers, where large machines are required, will be determined by ASFI and Bechtel.

Note D: Plant will be protected against power failure by auxiliary power generation and/or steam drives.

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EQUIPMENT DESIGN INFORMATION

HEAT EXCHANGERS

(A) AIR COOLERS

1. **To what extent shall air cooled exchangers be used:** Maximum.
Use 130°F break point between air and water cooling
2. **Preferred tube length (Std. lengths in U.S.A. are:** 30 Ft. △1
3. 96 △2 **°F dry bulb for air cooler sizing.**
4. Steel tubes: 1" OD, 12 BWG (min.)

(B) SHELL & TUBE UNITS

1. **Preferred straight tube lengths are:** 20 Ft. **(*).**
2. **Preferred carbon steel and low alloy (up to and including 5 Cr 1/2 Mo) tube size is** 3/4 **inch,** 14 **BWG.**
3. **Preferred brass or admiralty tube size is** 3/4 **inch,** 16 **BWG.**
4. **Preferred high alloy (above 5 Cr 1/2 Mo and up through austenitic) tube size is** 3/4 **inch,** 16 **BWG.**
5. **What is the limitation of bundle diameter?** 48 **inches.**
6. **What is the limitation of bundle weight?** 15 tons **lbs. or tons.**
7. Fouling factors: Water side 0.002
8. Design for 10 PSI ΔP on cooling water side.

Remarks: (*) For U-tube units the maximum nominal length (from tube ends to bend tangent) will be limited to the straight tube length.

9. Minimum water velocity: 5 Ft/sec.
10. Maximum water velocity

Red Brass, AL-brass, Inh Admiralty	8 Ft./sec.
△1 Carbon steel, 70-30 Cupronickel & Monel:	10 Ft./sec.
90-10 Cupronickle:	12 Ft./sec.
304 & 316 Stainless steel:	15 Ft./sec.

11. All exchangers must be self draining.
12. Preferred FIN type should be tension wound or extruded.
13. All water cooled exchangers to have block valves on both inlet & outlet plus a thermal relief. Valved flushings connections are to be located inside the block valves on both water inlet and outlet.

EQUIPMENT DESIGN INFORMATION

HEATERS

1. Heater shall be equipped with -

   (a) Gas burners only and without provisions for the future installation of oil burners YES. See note 5

   (b) Gas burners initially but with provisions for the future installation of oil burners ____________.

   (c) Gas burners for onstream operation but with oil burners for start-up and stand-by purposes ____________.

   (d) Oil burners only ____________.

   (e) Combination oil and gas burners arranged to fire either or both fuels alternately or simultaneously at full load conditions ____________.

2. A pilot burner shall be provided for each oil burner or combination burner unless otherwise indicated ____________.

3. Stack height shall be 400 △3 feet, minimum above grade line. Minimum temperature shall be 250°F. Total length to be lined. △3

4. Licensee's specifications, if any, regarding: △1 FAA Lites.

   (a) Tube and fitting specifications ____________

   (b) Noise level Walsh Healy Act and OSHA

5. Remarks Heaters will normally be fired either with refinery gas (1000 to △2 1600 BTU/CF) or a mixture of refinery gas and medium BTU gas (250 to 350 BTU/CF) Separate firing facilities and piping will be required. △2

6. Pilot Burners shall be provided with 10% of fired duty or 6.0 MM BTU/HR MAX.
7. Efficiency must be 90% or above (based on lower heating value).
8. When generating superheated steam, superheat temperature must be controlled.

EQUIPMENT DESIGN INFORMATION

INSTRUMENTS

1. Shall the control board be graphic? No
2. Shall the control board be semi-graphic? No
3. Shall the control board be non-graphic? Yes, Cathode-Ray tubes used
4. Shall instruments be miniature? Yes - where used.
5. Shall the multi-point temperature indicator be mounted on a console desk? Remote multiplexing to be used
6. Shall instruments be electronic? Yes
7. Shall control valves be operated pneumatically? Yes
8. Shall extent of instrumentation be minimum required for operation? No
9. If extent of instrumentation is not to be minimum:

9.1 Shall all process charge and product streams be measured with flow recorders? or Data Logger : yes

9.2 Shall charge and product stream flow recorders be integrating meters? No

9.3 To what extent shall process streams be measured with flow recorders? As required for operations

9.4 To what extent shall heat exchangers be equipped with temperature points to measure their performance? △1 As required by Process.

9.5 If heat exchangers are to be equipped with performance measuring temperature points, describe the temperature measuring device. △1 Test wells only.

9.6 Shall all utility flow rates be metered and recorded as process unit totals? By Data Logger - excluding cooling water

9.7 Shall utility stream flow recorders be integrating meters? As required by Operations. △1

9.8 Shall provisions be made for any type of individual utility flow rate metering, such as fuel to heaters or water to exchangers?
Fuel to heaters: As required by Process.
△1 Water to exchangers : As required by Process.

9.9 Shall all process levels be shown on the control board? If not on C.B. show on CRT.

9.10 Shall high and low level alarms be used? Yes

9.11 Shall continuous stream analysers be used? As required for operations

10. Other remarks
Electronics are to be distributed; communications are to be by Data Highway

11. Winterizing shall be by steam tracing or diaphragm seals.

△1 Electric tracing shall only be used if controlled temperature is required or there is no steam available in the area. Do not use electric tracing if operating temperature of the process fluid is too high for the insulation of the heating element (500°F).

DESIGN INFORMATION

BLOWDOWN AND FLARE

△4 1. Shall relief valves handling hydrocarbon vapor be vented directly to the atmosphere? No. To knock-out pots and flares, except hydrogen, which is vented to the atmosphere.

△4

△4 2. **Shall liquid relief system be combined with vapor relief system?** Yes. To plant knock-out pots.

3. Flare shall be smokeless to 10% of maximum load.
4. Simultaneous power and cooling water failure shall not be considered.

Remarks:

5. Maximum flare header back pressure at process unit battery limits shall be 10 PSIG. There shall be a liquid knock-out pot at this point as well as the low point of the header (s).
6. All relief valves with a set pressure of 100 PSIG or less shall be balanced bellows type. Relief valves with a set pressure above 100 PSIG shall be of the conventional type.

EQUIPMENT DESIGN INFORMATION

COLUMN INTERNALS

1. **For general fractionation, are valve type trays or bubble cap trays desired?** No. Sieve trays are preferred if turndown is not a factor.

2. **For certain applications, process conditions will require a particular type of tray. In these instances, the type of tray shall be specified and** △1 **designed by:** ASFI or Bechtel, or Process Licensor.

3. **Steel trays will be furnished for mild service. Suitable alloy will be used where corrosive conditions warrant.** Do not use steel trays unless agreed by ASFI. Use type 410 trays,valves and holddowns unless corrosive conditions warrant a more suitable alloy.

Remarks:

1. FRI sieve trays to have following design criteria:
   a.) Minimum 8% hole area
   b.) Use sloped downcomers with the tops of downcomer having at least 8% of the tower cross-sectional area
   c.) 3 or 5 pass trays are not to be used.
   d.) Deviations must have ASFI approval.

2. If valve type trays are required, Koch type T or Glitsch type A-2 trays desired, with ASFI approval.

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SITE INFORMATION

CLIMATIC DATA

1. **-10 °F. shall be used for winterizing.**
Record data: Min. -16°F, Max. 108°F
2. **Direction of prevailing wind is from** SW
3. **If location is within continental U.S.A. can wind pressure be in accordance with** Uniform Building Code: 25psf Table 23-F
4. **If A58.1 is not used, structural design wind pressure for various height zones shall be as specified in code** UBC **or as follows:**

English System

- a) ____psf below ______ft.
- b) ____psf above ______ft. but below ______ ft.
- c) ____psf above ______ft. but below ______ ft.
- d) ____psf above ______ft.
- e) Wind velocity used in structural design __________mph.
- f) Shape factors: Flat surfaces ______Cylindrical surfaces __________Open framed structures ______________
- g) If shape factors are in accordance with a specific code, what is code Uniform Building Code 1979

5. **Maximum recorded rainfall in 24 hours** 4.5 **inches.**
6. **Maximum recorded rainfall in 15 mins.** 1.1 **inches.**
7. **Design snow loading shall be** 20 **psf.** ANSI 58.1-1972 Fig.3.
8. **Provisions for earthquake shall be** Uniform Building Code: Zone 2 △2
9. Atmospheric pressure: 14.4 PSIA
10 Design Ambient Temperatures:

Winter -10°F Dry Bulb
Remarks: Summer 96°F Dry Bulb △2
78°F Wet Bulb

UNIT ELEVATION

UNIT ELEVATION Data to be provided on establishment of Site Plan.

1. Refinery site is ______________ feet above sea level.
2. Bench mark for this unit is ______________ which is at elevation ____________
____
3. The following elevations, referred to the bench mark are:

   Low point existing grade ______________________________
   High point existing grade ______________________________
   High point finished grade ______________________________
   △4 High point finished paving 415 ft (MSL)
   Base Line 100 ft

4. Minimum height for finished top of foundations and high point of finished floors in buildings will be at base line unless otherwise noted. Other elevations to be used are: ______________________________
____
____
____

Remarks:

SITE INFORMATION

SOIL CONDITIONS

Data to be provided on completion of Soils Program.

1. Have soil explorations been made in the area? _______ If so, please supply a copy of report.

2. If soil explorations have not been made, please supply the following with reference to any existing foundation design:

   2.1 Ground Water Level
   2.2 Bearing Value _______ PSF Avg.
   2.3 Foundation Depth _______ feet
   2.4 Piling? Bedrock Below 100 Ft. △2
   2.5 Frost Line Depth 1.5 feet to be confirmed.

3. Are there existing foundations or obstructions above or below grade in the process area? _______

Remarks:

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SITE INFORMATION

WATER RUN-OFF

1. Give details of paving required in process area 6" reinforced concrete, welded wire fabric.

2. Are oil drains combined with rainwater sewer system? No.

3. Roads and approach areas to be asphalt.

Remarks:

GENERAL INFORMATION

1. Type and construction of buildings shall be:

Control houses Concrete block, insulated formed steel deck on steel beams for flat roof. Explosion resistant to 3PSIG outside pressure.

Compressor shelters Rigid steel frame, transite siding, pitched roof.

Switchgear shelters Air blowers for circulation. Not pressurized.

Pump shelters By Bechtel, if any.

Other buildings: Insulated metal.

2. Extent and type of fireproofing shall be:

Skirts 2" Insulating concrete inside & outside or 3" regular.

Pipe rack In process Units: 2" insulating on columns and any load bearing member to FIN-FAN levels

Structural supports Same

3. Preference of insulation and weather covering.

EQUIPMENT	INSULATION		WEATHER COVERING		
	Block	Blanket	Mastic	Aluminum	Felt
Vessels	x			x	
Exchangers	x			x	
Piping	x			x	

Remarks:

A. Air conditioning is required for the control house. Filtering may also be required.

ECONOMICS FOR TRADE-OFF STUDIES

This section provides a method for evaluating incremental or optional investments where these result directly in a saving in operating costs. It should be limited to those cases where there are no intangible factors such as safety, reliability or ecological effects.

Engineering trade-off studies are to be made using the following costs which have been projected to 1987:

STEAM	COST	UNITS
900psig	△2 $ 16.30	1000 pounds
600	14.26	1000 pounds
150	△2 14.16	1000 pounds
50	13.95	1000 pounds
WATER (COST) △2		
Condensate	0.94	△1 1000 gallons
Demineralized Water	4.00 @ 100°F	1000 gallons
Boiler Feed Water	△1 9.74 @ 250°F	1000 gallons
Cooling Water	0.078	1000 gallons
FUEL		
Fuel Gas	6.00	1 million BTU
Coal	2.42	1 million BTU
ELECTRIC POWER	△1 0.095	Kilowatt Hour
CATALYST & CHEMICALS	Quotes from Suppliers	

Maintenance	5.% of installed cost per year.
Property Tax & Insurance	2.5% of installed cost per year.
Capital Recovery	△1 25.% of installed cost per year.

Includes depreciation, interest, income taxes and profits.

The incremental investment to save operating cost should be paid back in 24,260 hours of operation.

The above is to be used for incrementally changing equipment. However, when adding equipment which is not already included in the design, the installed cost increment should be obtained from Cost Engineering.

TABLE 1

NOISE GUIDELINES*

Daily Exposure Hours	Allowable Intensity dBA
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
3/4	107
1/2	110
1/4	115

* In-plant exposure, cumulative.

△1 (Without protective ear covers for instance).

TABLE 2

NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS

(expressed as micrograms per cubic meter at 25°C, 760 mm pressure)

POLLUTANT	PRIMARY STANDARD		SECONDARY STANDARD	
	Annual Mean	Maximum Concentration (Allowed Once Yearly)	Annual Mean	Maximum Concentration (Allowed Once Yearly)
Sulfur Oxides (SO_x) (measured as SO_2)	80	365 (over 24 hours)		1,300 (over 3 hours)
Particulates	75	260 (over 24 hours)	60	150 (over 24 hours)
Carbon Monoxide (CO)	--	10 milligrams/m^3 (over 8 hours) 40 milligrams/m^3 (over 1 hour)	Same as Primary Standard	
Photochemical Oxidants	--	160 (over 1 hour)	Same as Primary Standard	
Hydrocarbons (HC)	--	160 (over 3 hours--6-9 a.m.)	Same as Primary Standard	
Nitrogen Dioxide (NO_2)	100	--	Same as Primary Standard	

TABLE 3

PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

Particulate matter	Micrograms/cu.m.
Annual geometric mean	19
24-Hour maximum	37
Sulfur Dioxide	
Annual arithmetic mean	20
24-Hour maximum	91
3-Hour maximum	512

Basis: Maximum allowable increase for Class II area.

TABLE 4

OCCUPATIONAL EXPOSURE GUIDELINES

	LIMIT(1)	
	ppm(w)	mg/m^3
Nitrogen Dioxide	5	9
Carbon Monoxide	50	55
Sulfur Dioxide	5	13
Inert or Nuisance Dust		
Respirable	-	5
Total Dust	-	15
Chlorine	1	3
Benzene	10	30
Toluene	200	750
Ethylene Oxide	50	90
Ethyl Benzene	100	435
Hydrogen Sulfide	20	30

(1) An employee's exposure to any material shall not exceed the 8-hour time weighted average given for that material in this table.

TABLE 5

WASTE WATER EFFLUENT GUIDELINES

		Maximum
Ammonia,	ppm	1.00
Oil & Grease,*	ppm	10.00
Chromium,	ppm	0.05
Lead,	ppm	0.05
Zinc,	ppm	1.00
Cyanide,	ppm	0.01
Sulfides,	ppm	0.10
pH		6 - 9

* Floating

03303280 OHIO RIVER AT CANNELTON DAM, KY

LOCATION.--Lat 37°53'58", long 86°42'20", Hancock County, Hydrologic Unit 05140201, at Cannelton Dam, 0.7 mi (1.1 km) upstream from Indian Creek, 3.3 mi (5.3 km) upstream from Lead Creek, and at mile 720.8 (1,159.8 km).

DRAINAGE AREA.--97,000 mi² (251,000 km²), approximately.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--October 1975 to current year.

GAGE.--Gate opening and water-stage recorders. Datum of headwater gage 0.4 mi (0.6 km) upstream is 374.0 ft (114.00 m) Ohio River datum. Datum of tailwater gage 0.4 mi (0.6 km) downstream is 26.0 ft (7.92 m) lower.

REMARKS.--Records good. Daily discharge computed from head, gate openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs upstream from station.

EXTREMES FOR PERIOD OF RECORD.--Maximum daily discharge, 561,000 ft³/s (15,900 m³/s) Mar. 18, 1978, maximum headwater gage height, 21.16 ft (6.450 m) Mar. 18, 1978; maximum tailwater gage height, 46.44 ft (14.155 m) Mar. 18, 1978; minimum daily discharge, 10,100 ft³/s (286 m³/s) Aug. 25, 1976.

EXTREMES FOR CURRENT YEAR.--Maximum daily discharge, 561,000 ft³/s (15,900 m³/s) Mar. 18, maximum headwater gage height, 21.16 ft (6.450 m) Mar. 18, maximum tailwater gage height, 46.44 ft (14.155 m) Mar. 18; minimum daily discharge, 11,400 ft³/s (323 m³/s) Sept. 26.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	100000	47200	223000	127000	504000	75500	398000	273000	105000	90600	98900	135000
2	158000	49600	266000	111000	446000	72400	362000	231000	93700	87500	107000	141000
3	153000	55900	265000	109000	348000	75100	302000	167000	91200	82400	110000	119000
4	143000	39400	259000	106000	229000	61200	248000	135000	75900	86200	76500	87700
5	147000	48900	271000	93300	184000	72600	225000	130000	69900	103000	62600	43600
6	135000	47100	322000	83300	147000	64500	207000	143000	69700	122000	59700	51900
7	110000	68700	357000	78800	108000	78400	197000	160000	67600	138000	57700	20500
8	100000	94100	374000	106000	115000	86100	196000	165000	64200	119000	75400	35400
9	99300	139000	387000	211000	93200	111000	205000	196000	73900	84600	106000	30500
10	97000	171000	369000	263000	94000	139000	214000	228000	99200	73100	111000	27700
11	108000	181000	305000	231000	103000	145000	219000	253000	123000	69700	109000	23800
12	136000	183000	227000	241000	95100	262000	207000	261000	123000	52800	107000	12200
13	147000	175000	193000	280000	91500	315000	198000	275000	104000	57200	110000	33300
14	140000	158000	191000	253000	91300	407000	173000	276000	91300	50700	114000	53000
15	117000	133000	229000	200000	75000	463000	162000	272000	81300	45100	97000	24800
16	95100	113000	240000	165000	82400	529000	145000	265000	66100	75400	83900	15800
17	76800	125000	246000	150000	87700	552000	134000	265000	46200	89900	61500	27100
18	65600	130000	258000	114000	90100	561000	123000	268000	51000	64900	58900	33900
19	67600	127000	282000	135000	83300	559000	111000	265000	68800	63000	72100	40200
20	74300	125000	312000	135000	79700	549000	106000	263000	67600	48600	48900	29100
21	74300	157000	294000	112000	73700	532000	121000	268000	66000	31000	54800	45600
22	70400	185000	259000	125000	63400	504000	137000	273000	76600	41400	38300	21300
23	54700	158000	238000	116000	64900	455000	146000	265000	80300	26500	13200	33000
24	44100	124000	224000	101000	79000	394000	157000	245000	65800	35500	18800	25300
25	45700	120000	206000	111000	64200	352000	168000	234000	51300	55300	19300	19900
26	73600	143000	185000	150000	57300	332000	170000	226000	52400	60000	21000	11400
27	45900	153000	169000	235000	67400	339000	166000	231000	54900	28700	37200	30700
28	70900	148000	165000	328000	81200	364000	197000	230000	62600	24300	24700	21800
29	63900	129000	165000	429000	---	392000	252000	216000	71300	35900	55300	30600
30	73900	140000	163000	440000	---	411000	274000	179000	85400	34400	52000	15200
31	54900	---	147000	507000	---	413000	---	133000	---	78000	86900	---
TOTAL	3001600	3673100	7801000	5934400	3707100	9760800	5910000	6989000	2296700	2054700	2148400	1240400
MEAN	96830	122400	251600	191600	132400	314900	197000	225400	76620	66280	69300	41350
MAX	158000	185000	387000	507000	504000	561000	398000	276000	123000	138000	114000	141000
MIN	44100	39400	147000	78800	57300	64500	106000	130000	46200	24300	13200	11400

CAL YR 1977 TOTAL 42127400 MEAN 115400 MAX 468000 MIN 13500
WTR YR 1978 TOTAL 54522200 MEAN 149400 MAX 561000 MIN 11400

OHIO RIVER MAIN STEM

03303280 OHIO RIVER AT CANNELTON DAM, KY
(National stream-quality accounting and pesticide network station)

WATER-QUALITY RECORDS

LOCATION.--Samples collected 2.0 mi (3.2 km) upstream from discharge station.
PERIOD OF RECORD.--Water years 1975 to current year.
PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: October 1974 to current year.
WATER TEMPERATURES: October 1974 to current year.
REMARKS.--Flow regulated by Ohio River system of locks, dam, and reservoirs.
COOPERATION.--Records of conductance and temperature collected on right bank at Cannelton Dam and furnished by Ohio River Valley Water Sanitation Commission and by Corps of Engineers. Samples for pesticide analyses were collected by the U.S. Geological Survey and analyses made by the Environmental Protection Agency.
EXTREMES FOR PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: Maximum daily, 638 micromhos Aug. 10, 1977; minimum daily, 190 micromhos Apr. 12, 1977.
WATER TEMPERATURES: Maximum daily, 30.0°C July 23, 24, 1977; minimum daily, 0.0°C on several days during January 1977.
EXTREMES FOR CURRENT YEAR.--
SPECIFIC CONDUCTANCE: Maximum daily, 507 micromhos July 10; minimum daily, 222 micromhos, Feb. 2.
WATER TEMPERATURE: Maximum daily, 30.0°C on several days during summer period; minimum daily, 0.0°C on several days during January.

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	TIME	STREAM-FLOW, INSTANTANEOUS (CFS)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	TURBIDITY (NTU)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARDNESS (MG/L AS CACO3)
OCT										
19...	1330	70200	390	7.3	16.0	5	--	180	K6	130
NOV										
08...	1315	93000	405	7.4	17.0	1	--	250	K9	130
DEC										
14...	1435	194000	325	7.4	3.0	90	--	1600	4100	120
MAR										
10...	1145	151000	315	6.9	3.0	25	--	430	350	159
21...	1400	557000	300	7.2	5.0	220	--	1300	2100	97
APR										
12...	1305	211000	300	7.3	12.0	45	--	46000	--	120
MAY										
03...	1130	169000	325	6.8	13.0	85	--	590	K520	120
31...	1415	120000	320	7.0	20.0	--	30	360	270	120
JUN										
28...	1245	58900	395	7.4	30.0	--	6.0	35	46	150
JUL										
19...	1315	7700	420	7.6	29.0	--	10	200	K8	149
AUG										
16...	1230	57600	355	7.5	27.5	--	5.0	150	K290	140
SEP										
13...	1325	33000	370	7.4	27.0	--	1.0	K9	24	149

DATE	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	ALKALINITY (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
OCT										
19...	73	35	9.2	18	3.3	53	63	24	.2	5.6
NOV										
08...	59	37	9.0	18	3.0	71	60	25	.1	5.4
DEC										
14...	57	34	8.2	12	2.5	62	50	17	.1	6.3
MAR										
10...	86	40	11	18	2.4	77	72	26	.1	6.3
21...	55	27	7.3	13	3.9	43	56	16	.1	5.6
APR										
12...	67	33	9.3	12	2.2	53	61	17	.1	5.8
MAY										
03...	58	33	8.9	13	2.0	61	50	19	.1	5.2
31...	63	33	8.9	11	2.0	57	58	15	.1	5.9
JUN										
28...	69	43	12	17	2.4	68	78	25	.1	1.7
JUL										
19...	63	45	11	24	3.2	75	93	30	.2	3.3
AUG										
16...	76	40	10	20	3.2	63	79	24	.2	3.7
SEP										
13...	71	45	11	19	3.4	87	65	23	.2	5.1

K--Results based on colony count outside the acceptable range (non-ideal colony count).

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, AM-MONIA + ORGANIC DIS. (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS NO3)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)
OCT										
19...	207	1.0	.01	.48	.49	--	1.5	6.6	.10	--
NOV										
08...	184	.44	--	--	.44	--	1.4	6.3	.11	--
DEC										
14...	177	1.3	--	--	1.2	--	2.5	11	.31	--
MAR										
10...	241	1.2	.39	.71	1.1	.86	2.3	10	.08	.06
21...	171	1.3	.34	1.2	1.5	.73	2.8	12	.35	.02
APR										
12...	196	--	.10	--	--	--	--	--	.12	--
MAY										
03...	167	1.1	.01	.66	.67	.29	1.8	7.8	.20	.02
31...	194	1.3	.00	--	--	--	--	--	.10	.03
JUN										
28...	241	1.3	.03	.54	.57	.48	1.9	8.3	.07	.03
JUL										
19...	294	1.5	.03	.35	.38	.16	1.9	8.3	.08	.04
AUG										
14...	237	--	--	--	--	--	--	--	--	--
SEP										
13...	266	1.3	.02	.61	.63	.33	1.9	8.5	.13	.09

DATE	CARBON, ORGANIC TOTAL (MG/L AS C)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)	CARBON, ORGANIC SUS-PENDED TOTAL (MG/L AS C)	PHYTO-PLANK-TON, TOTAL (CELLS PER ML)	CHLOR-A PERI-PHYTON CHROMO-GRAPHIC FLUOROM (MG/M2)	CHLOR-B PERI-PHYTON CHROMO-GRAPHIC FLUOROM (MG/M2)	LENGTH OF EXPO-SURE (DAYS)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
OCT										
19...	5.9	--	--	--	--	--	--	32	6070	100
NOV										
08...	--	--	--	2800	3.34	.590	21	20	5020	100
DEC										
14...	17	--	--	--	--	--	--	304	163000	100
MAR										
10...	--	15	1.1	210	--	--	--	445	181000	100
21...	9.1	--	--	--	--	--	--	472	710000	100
APR										
12...	--	--	--	--	--	--	--	236	134000	100
MAY										
03...	--	6.2	2.2	720	--	--	--	188	85400	100
31...	6.4	--	--	1400	--	--	--	54	17500	100
JUN										
28...	--	--	--	--	--	--	--	7	1110	100
JUL										
19...	--	1.4	1.0	--	--	--	--	15	312	100
AUG										
15...	--	--	--	--	34.6	8.67	--	17	2640	100
SEP										
13...	2.5	--	--	--	--	--	--	13	1140	100

DATE	ARSENIC TOTAL (UG/L AS AS)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BARIUM, DIS-SOLVED (UG/L AS BA)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, TOTAL RECOV-ERABLE (UG/L AS CO)
OCT									
19...	1	1	0	0	0	3	<10	1	0
MAR									
10...	0	0	0	0	16	3	<10	2	0
MAY									
03...	1	1	100	0	20	4	20	1	6
JUL									
19...	1	1	0	0	1	0	10	0	0

WATER QUALITY DATA, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978

DATE	COBALT, DISSOLVED (UG/L AS CO)	COPPER, TOTAL RECOVERABLE (UG/L AS CU)	COPPER, DISSOLVED (UG/L AS CU)	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	LEAD, TOTAL RECOVERABLE (UG/L AS PB)	LEAD, DISSOLVED (UG/L AS PB)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)
OCT 19...	0	12	7	900	10	12	9	60	10
MAR 10...	0	37	9	1600	10	22	1	230	190
MAY 03...	0	52	7	6500	60	42	3	280	0
JUL 19...	0	20	13	690	50	14	0	50	0

DATE	MERCURY TOTAL RECOVERABLE (UG/L AS HG)	MERCURY DISSOLVED (UG/L AS HG)	SELENIUM, TOTAL (UG/L AS SE)	SELENIUM, DISSOLVED (UG/L AS SE)	SILVER, TOTAL RECOVERABLE (UG/L AS AG)	SILVER, DISSOLVED (UG/L AS AG)	ZINC, TOTAL RECOVERABLE (UG/L AS ZN)	ZINC, DISSOLVED (UG/L AS ZN)
OCT 19...	<.5	<.5	0	0	0	0	20	10
MAR 10...	.5	<.5	0	0	1	0	50	10
MAY 03...	<.5	<.5	0	0	0	0	60	0
JUL 19...	.5	.5	0	0	0	0	50	20

DATE	DIAZINON, TOTAL IN BOTTOM MATERIAL (UG/KG)	DIELDRIN TOTAL (UG/L)	DIELDRIN, TOTAL IN BOTTOM MATERIAL (UG/KG)	ENDRIN, TOTAL (UG/L)	ENDRIN, TOTAL IN BOTTOM MATERIAL (UG/KG)	ETHION, TOTAL (UG/L)	ETHION, TOTAL IN BOTTOM MATERIAL (UG/KG)	HEPTACHLOR, TOTAL (UG/L)	HEPTACHLOR, TOTAL IN BOTTOM MATERIAL (UG/KG)	HEPTACHLOR EPOXIDE TOTAL (UG/L)	HEPTACHLOR EPOXIDE TOT. IN BOTTOM MATL. (UG/KG)
NOV 08...	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAR 10...	--	ND	--	ND	--	ND	--	ND	--	ND	--
MAY 03...	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATE	LINDANE TOTAL (UG/L)	LINDANE TOTAL IN BOTTOM MATERIAL (UG/KG)	MALATHION, TOTAL (UG/L)	MALATHION, TOTAL IN BOTTOM MATERIAL (UG/KG)	METHOXYCHLOR, TOTAL (UG/L)	METHOXYCHLOR, TOT. IN BOTTOM MATL. (UG/KG)	METHYL PARATHION, TOTAL (UG/L)	METHYL PARATHION, TOT. IN BOTTOM MATL. (UG/KG)	METHYL TRITHION, TOTAL (UG/L)	METHYL TRITHION, TOT. IN BOTTOM MATL. (UG/KG)	PARATHION, TOTAL (UG/L)
NOV 08...	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAR 10...	ND	--	ND	--	ND	--	ND	--	ND	--	ND
MAY 03...	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATE	PARATHION, TOTAL IN BOTTOM MATERIAL (UG/KG)	PCB, TOTAL (UG/L)	PCB, TOTAL IN BOTTOM MATERIAL (UG/KG)	TOXAPHENE, TOTAL (UG/L)	TOXAPHENE, TOTAL IN BOTTOM MATERIAL (UG/KG)	TOTAL TRITHION (UG/L)	TRITHION, TOTAL IN BOTTOM MATERIAL (UG/KG)	2,4-D, TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)	SILVEX, TOTAL (UG/L)	SIMAZINE TOTAL COULSON COND. (UG/L)
NOV 08...	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAR 10...	--	ND	--	ND	--	ND	--	ND	ND	ND	--
MAY 03...	ND	ND	ND	ND	ND	ND	ND	--	--	--	--

ND--Looked for but not detected.

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1976 TO MAY 1978

DATE	NOV 4.76		NOV 18.76		DEC 16.76		MAY 12.77		JUN 10.77	
TIME	1240		1405		1330		1300		1315	
TOTAL CELLS/ML	12000		570		2600		6700		3100	
DIVERSITY: DIVISION	0.6		0.9		1.0		1.4		1.7	
.CLASS	0.6		0.9		1.0		1.4		1.7	
..ORDER	0.6		1.3		1.6		1.9		2.0	
...FAMILY	0.6		1.6		2.1		2.4		2.9	
....GENUS	0.6		2.2		3.0		3.1		3.3	
ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
CHLOROPHYTA (GREEN ALGAE)										
.CHLOROPHYCEAE										
..CHLOROCOCCALES										
...CHARACIACEAE										
....SCHROEDERIA	--	-	3	1	--	-	--	-	--	-
...COELASTRACEAE										
....COELASTRUM	--	-	--	-	--	-	220	3	110	3
...HYDRODICTYACEAE										
....PEDIASTRUM	--	-	--	-	--	-	--	-	240	8
...MICRACTINIACEAE										
....GOLENKINIA	--	-	--	-	--	-	--	-	--	-
....MICRACTINIUM	--	-	27	5	73	3	--	-	--	-
...OOCYSTACEAE										
....ANKISTRODESMUS	--	-	--	-	190	7	110	2	21	1
....CHODATELLA	--	-	--	-	--	-	110	2	•	0
....CLOSTERIOPSIS	--	-	--	-	--	-	--	-	--	-
....DICTYOSPHAERIUM	--	-	--	-	120	5	--	-	650#	21
....FRANCEIA	--	-	--	-	--	-	--	-	•	0
....KIRCHNERIELLA	--	-	--	-	--	-	•	0	•	0
....OOCYSTIS	--	-	--	-	58	2	--	-	--	-
....QUADRIGULA	--	-	--	-	--	-	--	-	--	-
....SELENASTRUM	--	-	--	-	--	-	--	-	--	-
....TETRAEDRON	--	-	--	-	--	-	--	-	--	-
....TREUBARIA	--	-	--	-	--	-	--	-	--	-
...SCENEDESMACEAE										
....ACTINASTRUM	--	-	--	-	--	-	--	-	--	-
....CRUCIGENIA	--	-	55	10	--	-	--	-	57	2
....SCENEDESMUS	--	-	55	10	73	3	460	7	230	8
....TETRASTRUM	--	-	--	-	--	-	320	5	28	1
..TETRASPORALES										
...PALMELLACEAE										
....GLOEOCYSTIS	--	-	--	-	--	-	--	-	64	2
....SPHAEROCYSTIS	--	-	--	-	--	-	--	-	--	-
..VOLVOCALES										
...CHLAMYDOMONADACEAE										
....CHLAMYDOMONAS	--	-	--	-	--	-	--	-	42	1
..ZYGNEMATALES										
...DESMIDIACEAE										
....COSMARIUM	--	-	--	-	--	-	--	-	--	-
....EUASTRUM	--	-	--	-	--	-	--	-	--	-
....STAURASTRUM	--	-	--	-	--	-	--	-	--	-

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1976 TO MAY 1978

DATE	NOV 4,76		NOV 18,76		DEC 16,76		MAY 12,77		JUN 10,77	
TIME	1240		1405		1330		1300		1315	
ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
CHRYSOPHYTA										
.BACILLARIOPHYCEAE										
..CENTRALES										
...COSCINODISCACEAE										
....CYCLOTELLA	--	-	48	8	670#	26	1100#	17	28	1
....MELOSIRA	1300	11	320#	55	790#	31	2000#	29	140	5
....STEPHANODISCUS	--	-	--	-	--	-	--	-	42	1
..PENNALES										
...ACHNANTHACEAE										
....ACHNANTHES	--	-	--	-	--	-	--	-	*	0
....COCCONEIS	--	-	--	-	--	-	*	0	28	1
....RHOICOSPHENIA	--	-	--	-	--	-	*	0	--	-
...CYMBELLACEAE										
....AMPHORA	--	-	--	-	--	-	--	-	--	-
....CYMBELLA	--	-	--	-	15	1	--	-	*	0
...DIATOMACEAE										
....DIATOMA	--	-	--	-	--	-	54	1	--	-
...FRAGILARIACEAE										
....ASTERIONELLA	--	-	--	-	150	6	110	2	--	-
....FRAGILARIA	--	-	--	-	58	2	400	6	21	1
....SYNEDRA	--	-	--	-	--	-	*	0	*	0
...GOMPHONEMATACEAE										
....GOMPHONEMA	--	-	--	-	15	1	--	-	--	-
...NAVICULACEAE										
....GYROSIGMA	--	-	--	-	--	-	--	-	--	-
....NAVICULA	110	1	21	4	58	2	160	2	*	0
...NITZSCHIACEAE										
....NITZSCHIA	--	-	34	6	170	7	220	3	*	0
...SURIRELLACEAE										
....SURIRELLA	--	-	--	-	--	-	--	-	--	-
.CHRYSOPHYCEAE										
..CHRYSOMONADALES										
...OCHROMONADACEAE										
....DINOBRYON	--	-	--	-	--	-	--	-	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)										
.CYANOPHYCEAE										
..CHROOCOCCALES										
...CHROOCOCCACEAE										
....AGMENELLUM	--	-	--	-	--	-	--	-	--	-
....ANACYSTIS	--	-	--	-	120	5	--	-	1000#	33
..HORMOGONALES										
...NOSTOCACEAE										
....ANABAENA	--	-	--	-	--	-	--	-	--	-
....APHANIZOMENON	--	-	--	-	--	-	--	-	--	-
...OSCILLATORIACEAE										
....OSCILLATORIA	11000#	88	--	-	--	-	1200#	19	--	-
EUGLENOPHYTA (EUGLENOIDS)										
.CRYPTOPHYCEAE										
..CRYPTOMONIDALES										
...CRYPTOCHRYSIDACEAE										
....CHROOMONAS	--	-	--	-	--	-	--	-	92	3
...CRYPTOMONODACEAE										
....CRYPTOMONAS	--	-	--	-	--	-	81	1	180	6
.EUGLENOPHYCEAE										
..EUGLENALES										
...EUGLENACEAE										
....EUGLENA	--	-	--	-	--	-	--	-	--	-
....PHACUS	--	-	--	-	--	-	--	-	--	-
....TRACHELOMONAS	110	1	10	2	--	-	--	-	28	1
PYRRHOPHYTA (FIRE ALGAE)										
.DINOPHYCEAE										
..PERIDINIALES										
...GLENODINIACEAE										
....GLENODINIUM	--	-	--	-	--	-	--	-	*	0
...PERIDINIACEAE										
....PERIDINIUM	--	-	--	-	--	-	--	-	--	-

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%
* - OBSERVED ORGANISM, MAY NOT HAVE BEEN COUNTED; LESS THAN 1/2%

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1976 TO MAY 1978

DATE	JUN 30,77		JUL 26,77		AUG 18,77		SEP 21,77	
TIME	1235		1250		1310		1400	
TOTAL CELLS/ML	5200		4400		27000		5200	
DIVERSITY: DIVISION	1.5		1.4		0.6		1.0	
.CLASS	1.6		1.4		0.6		1.0	
..ORDER	1.6		1.9		0.6		1.6	
...FAMILY	2.0		2.5		1.0		1.8	
....GENUS	2.5		3.0		1.0		2.6	
ORGANISM	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT
CHLOROPHYTA (GREEN ALGAE)								
.CHLOROPHYCEAE								
..CHLOROCOCCALES								
...CHARACIACEAE								
....SCHROEDERIA	•	0	28	1	--	-	•	0
...COELASTRACEAE								
....COELASTRUM	--	-	140	3	--	-	--	-
...HYDRODICTYACEAE								
....PEDIASTRUM	430	8	450	10	180	1	--	-
...MICRACTINIACEAE								
....GOLENKINIA	--	-	--	-	--	-	•	0
....MICRACTINIUM	--	-	56	1	--	-	--	-
...OOCYSTACEAE								
....ANKISTRODESMUS	30	1	--	-	--	-	--	-
....CHODATELLA	--	-	--	-	--	-	•	0
....CLOSTERIOPSIS	--	-	--	-	--	-	--	-
....DICTYOSPHAERIUM	80	2	56	1	--	-	--	-
....FRANCEIA	--	-	--	-	--	-	--	-
....KIRCHNERIELLA	--	-	•	0	--	-	71	1
....OOCYSTIS	•	0	56	1	--	-	--	-
....QUADRIGULA	30	1	--	-	--	-	--	-
....SELENASTRUM	40	1	--	-	--	-	--	-
....TETRAEDRON	--	-	--	-	--	-	•	0
....TREUBARIA	--	-	85	2	--	-	--	-
...SCENEDESMACEAE								
....ACTINASTRUM	--	-	•	0	--	-	--	-
....CRUCIGENIA	140	3	--	-	--	-	71	1
....SCENEDESMUS	430	8	140	3	300	1	140	3
....TETRASTRUM	120	2	--	-	--	-	•	0
..TETRASPORALES								
...PALMELLACEAE								
....GLOEOCYSTIS	--	-	--	-	--	-	--	-
....SPHAEROCYSTIS	--	-	--	-	--	-	--	-
..VOLVOCALES								
...CHLAMYDOMONADACEAE								
....CHLAMYDOMONAS	•	0	--	-	--	-	--	-
..ZYGNEMATALES								
...DESMIDIACEAE								
....COSMARIUM	--	-	70	2	•	0	--	-
....EUASTRUM	--	-	--	-	--	-	•	0
....STAURASTRUM	•	0	--	-	--	-	--	-

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1976 TO MAY 1978

DATE	JUN 30,77		JUL 26,77		AUG 18,77		SEP 21,77	
TIME	1235		1250		1310		1400	
ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
CHRYSOPHYTA								
.BACILLARIOPHYCEAE								
..CENTRALES								
...COSCINODISCACEAE								
....CYCLOTELLA	160	3	340	8	320	1	290	5
....MELOSIRA	570	11	1800#	42	1800	7	480	9
....STEPHANODISCUS	50	1	130	3	*	0	--	-
..PENNALES								
...ACHNANTHACEAE								
....ACHNANTHES	--	-	--	-	--	-	--	-
....COCCONEIS	--	-	--	-	--	-	*	0
....RHOICOSPHENIA	--	-	--	-	--	-	--	-
...CYMBELLACEAE								
....AMPHORA	--	-	--	-	--	-	--	-
....CYMBELLA	--	-	--	-	--	-	--	-
...DIATOMACEAE								
....DIATOMA	--	-	28	1	*	0	--	-
...FRAGILARIACEAE								
....ASTERIONELLA	--	-	--	-	--	-	--	-
....FRAGILARIA	*	0	--	-	*	0	--	-
....SYNEDRA	*	0	180	4	--	-	*	0
...GOMPHONEMATACEAE								
....GOMPHONEMA	--	-	--	-	*	0	--	-
...NAVICULACEAE								
....GYROSIGMA	--	-	*	0	*	0	--	-
....NAVICULA	--	-	--	-	*	0	--	-
...NITZSCHIACEAE								
....NITZSCHIA	*	0	--	-	*	0	--	-
...SURIRELLACEAE								
....SURIRELLA	--	-	--	-	*	0	--	-
.CHRYSOPHYCEAE								
..CHRYSOMONADALES								
...OCHROMONADACEAE								
....DINOBRYON	--	-	--	-	--	-	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)								
.CYANOPHYCEAE								
..CHROOCOCCALES								
...CHROOCOCCACEAE								
....AGMENELLUM	120	2	--	-	--	-	2400#	47
....ANACYSTIS	2800#	54	520	12	--	-	740	14
..HORMOGONALES								
...NOSTOCACEAE								
....ANABAENA	--	-	230	5	--	-	110	2
....APHANIZOMENON	--	-	--	-	22000#	83	140	3
...OSCILLATORIACEAE								
....OSCILLATORIA	--	-	--	-	1800	7	610	12
EUGLENOPHYTA (EUGLENOIDS)								
.CRYPTOPHYCEAE								
..CRYPTOMONADALES								
...CRYPTOCHRYSIDACEAE								
....CHROOMONAS	30	1	--	-	--	-	--	-
...CRYPTOMONADACEAE								
....CRYPTOMONAS	70	1	--	-	--	-	--	-
.EUGLENOPHYCEAE								
..EUGLENALES								
...EUGLENACEAE								
....EUGLENA	--	-	*	0	--	-	*	0
....PHACUS	--	-	--	-	--	-	--	-
....TRACHELOMONAS	40	1	--	-	--	-	--	-
PYRRHOPHYTA (FIRE ALGAE)								
.DINOPHYCEAE								
..PERIDINIALES								
...GLENODINIACEAE								
....GLENODINIUM	--	-	--	-	--	-	--	-
...PERIDINIACEAE								
....PERIDINIUM	*	0	--	-	--	-	--	-

NOTE: # - DOMINANT ORGANISM, EQUAL TO OR GREATER THAN 15%
* - OBSERVED ORGANISM, MAY NOT HAVE BEEN COUNTED; LESS THAN 1/2%

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1976 TO MAY 1978

DATE	NOV 8,77	MAR 10,78	MAY 3,78	MAY 31,78
TIME	1315	1145	1130	1415
TOTAL CELLS/ML	2800	210	720	1400
DIVERSITY: DIVISION	1.6	0.2	1.0	1.5
.CLASS	1.6	0.2	1.0	1.6
..ORDER	1.9	1.1	1.4	2.2
...FAMILY	2.2	2.6	2.8	3.0
....GENUS	2.8	2.9	3.0	3.7

ORGANISM	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT
CHLOROPHYTA (GREEN ALGAE)								
.CHLOROPHYCEAE								
..CHLOROCOCCALES								
...CHARACIACEAE								
....SCHROEDERIA	--	-	--	-	--	-	--	-
...COELASTRACEAE								
....COELASTRUM	--	-	--	-	--	-	--	-
...HYDRODICTYACEAE								
....PEDIASTRUM	--	-	--	-	--	-	--	-
...MICRACTINIACEAE								
....GOLENKINIA	--	-	--	-	--	-	14	1
....MICRACTINIUM	--	-	--	-	--	-	29	2
...OOCYSTACEAE								
....ANKISTRODESMUS	240	9	--	-	--	-	29	2
....CHODATELLA	--	-	--	-	--	-	--	-
....CLOSTERIOPSIS	16	1	--	-	--	-	--	-
....DICTYOSPHAERIUM	160	6	--	-	--	-	--	-
....FRANCEIA	--	-	--	-	--	-	--	-
....KIRCHNERIELLA	--	-	--	-	--	-	--	-
....OOCYSTIS	33	1	--	-	--	-	--	-
....QUADRIGULA	--	-	--	-	--	-	--	-
....SELENASTRUM	--	-	--	-	--	-	--	-
....TETRAEDRON	--	-	--	-	--	-	--	-
....TREUBARIA	--	-	--	-	--	-	--	-
...SCENEDESMACEAE								
....ACTINASTRUM	65	2	--	-	--	-	110	8
....CRUCIGENIA	--	-	--	-	--	-	57	4
....SCENEDESMUS	230	8	--	-	--	-	310#	22
....TETRASTRUM	33	1	--	-	--	-	--	-
..TETRASPORALES								
...PALMELLACEAE								
....GLOEOCYSTIS	--	-	--	-	--	-	--	-
....SPHAEROCYSTIS	65	2	--	-	--	-	110	8
..VOLVOCALES								
...CHLAMYDOMONADACEAE								
....CHLAMYDOMONAS	--	-	8	4	--	-	--	-
..ZYGNEMATALES								
...DESMIDIACEAE								
....COSMARIUM	--	-	--	-	--	-	--	-
....EUASTRUM	--	-	--	-	--	-	--	-
....STAURASTRUM	--	-	--	-	--	-	--	-

OHIO RIVER MAIN STEM

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

PHYTOPLANKTON ANALYSES, OCTOBER 1976 TO MAY 1978

DATE	NOV 8,77		MAR 10,78		MAY 3,78		MAY 31,78	
TIME	1315		1145		1130		1415	
ORGANISM	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT	CELLS /ML	PER- CENT
CHRYSOPHYTA								
.BACILLARIOPHYCEAE								
..CENTRALES								
...COSCINODISCACEAE								
....CYCLOTELLA	24	1	16	7	54	8	57	4
....MELOSIRA	1300#	46	56#	26	--	-	43	3
....STEPHANODISCUS	57	2	--	-	--	-	14	1
..PENNALES								
...ACHNANTHACEAE								
....ACHNANTHES	--	-	8	4	14	2	--	-
....COCCONEIS	*	0	--	-	--	-	14	1
....RHOICOSPHENIA	--	-	--	-	--	-	--	-
...CYMBELLACEAE								
....AMPHORA	--	-	--	-	14	2	--	-
....CYMBELLA	*	0	8	4	--	-	29	2
...DIATOMACEAE								
....DIATOMA	--	-	--	-	68	9	14	1
...FRAGILARIACEAE								
....ASTERIONELLA	--	-	--	-	--	-	140	10
....FRAGILARIA	--	-	--	-	68	9	--	-
....SYNEDRA	--	-	40#	19	54	8	72	5
...GOMPHONEMATACEAE								
....GOMPHONEMA	--	-	32	15	95	13	14	1
...NAVICULACEAE								
....GYROSIGMA	--	-	--	-	--	-	--	-
....NAVICULA	16	1	32	15	68	9	86	6
...NITZSCHIACEAE								
....NITZSCHIA	*	0	16	7	14	2	14	1
...SURIRELLACEAE								
....SURIRELLA	--	-	--	-	16	2	--	-
.CHRYSOPHYCEAE								
..CHRYSOMONADALES								
...OCHROMONADACEAE								
....DINOBRYON	--	-	--	-	--	-	14	1
CYANOPHYTA (BLUE-GREEN ALGAE)								
.CYANOPHYCEAE								
..CHROOCOCCALES								
...CHROOCOCCACEAE								
....AGMENELLUM	--	-	--	-	--	-	--	-
....ANACYSTIS	330	12	--	-	--	-	--	-
..HORMOGONALES								
...NOSTOCACEAE								
....ANABAENA	--	-	--	-	--	-	210#	15
....APHANIZOMENON	--	-	--	-	--	-	--	-
...OSCILLATORIACEAE								
....OSCILLATORIA	170	6	--	-	240#	34	--	-
EUGLENOPHYTA (EUGLENOIDS)								
.CRYPTOPHYCEAE								
..CRYPTOMONIDALES								
...CRYPTOCHRYSIDACEAE								
....CHROOMONAS	--	-	--	-	--	-	--	-
...CRYPTOMONADACEAE								
....CRYPTOMONAS	--	-	--	-	--	-	--	-
.EUGLENOPHYCEAE								
..EUGLENALES								
...EUGLENACEAE								
....EUGLENA	*	0	--	-	--	-	--	-
....PHACUS	*	0	--	-	--	-	--	-
....TRACHELOMONAS	24	1	--	-	14	2	14	1
PYRRHOPHYTA (FIRE ALGAE)								
.DINOPHYCEAE								
..PERIDINIALES								
...GLENODINIACEAE								
....GLENODINIUM	--	-	--	-	--	-	--	-
...PERIDINIACEAE								
....PERIDINIUM	--	-	--	-	--	-	--	-

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%
* - OBSERVED ORGANISM, MAY NOT HAVE BEEN COUNTED; LESS THAN 1/2%

OHIO RIVER MAIN STEM

03303280 OHIO RIVER AT CANNELTON DAM, KY--Continued

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
1	---	332	325	327	228	---	315	360	370	440	432
2	---	336	312	333	222	---	334	372	396	493	444
3	---	336	---	339	244	---	314	338	399	494	434
4	403	338	---	343	---	---	309	341	400	481	410
5	409	338	---	354	---	---	295	341	399	475	417
6	435	346	---	364	255	---	302	346	398	481	428
7	431	355	---	376	255	---	310	346	398	463	423
8	432	363	---	361	244	---	306	262	398	492	420
9	---	360	---	362	255	---	308	262	409	505	421
10	---	357	---	334	311	416	---	396	432	507	412
11	423	---	---	324	316	400	313	397	326	503	435
12	416	---	---	326	300	400	324	281	---	501	421
13	376	---	340	310	---	389	328	286	437	503	419
14	357	334	339	305	311	366	314	301	435	504	426
15	340	321	321	318	333	333	333	397	422	501	425
16	346	286	314	331	311	344	338	391	413	501	426
17	333	278	310	335	322	255	353	393	421	487	422
18	334	250	---	336	333	250	353	396	412	477	426
19	344	256	---	339	327	255	353	389	403	472	432
20	346	261	---	339	361	266	353	388	399	459	445
21	345	254	---	343	---	278	343	388	414	473	450
22	339	256	381	345	---	302	---	386	420	491	443
23	338	262	386	341	---	324	333	390	427	499	433
24	337	263	388	336	---	302	338	387	434	499	427
25	337	269	378	331	---	302	349	391	442	497	418
26	324	309	363	337	---	292	359	385	465	493	403
27	320	307	336	---	---	---	---	385	453	490	377
28	328	313	351	---	---	308	293	378	447	496	358
29	338	322	356	333	---	302	328	379	437	477	355
30	341	318	359	---	---	313	359	375	429	458	378
31	330	---	360	---	---	292	---	368	---	446	406

TEMPERATURE (DEG. C) OF WATER, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
1	23.5	15.0	8.5	3.5	1.0	---	11.5	16.5	24.0	29.5	29.5
2	23.0	15.0	8.0	3.5	1.0	---	12.0	16.5	24.5	29.5	29.5
3	21.5	15.0	---	3.5	1.0	---	12.0	17.0	24.5	29.5	29.0
4	21.0	15.5	---	2.0	---	---	12.0	17.5	25.0	29.5	29.0
5	21.0	15.5	---	2.0	---	---	11.5	18.5	25.0	29.5	28.5
6	21.0	15.5	---	3.0	.5	---	11.5	18.5	25.0	29.5	29.5
7	20.5	16.0	---	3.0	.5	---	12.0	19.0	24.5	29.5	28.0
8	20.0	16.0	---	3.0	1.0	---	12.0	14.0	24.0	29.5	27.0
9	19.5	16.0	---	1.5	1.0	---	12.0	14.0	24.5	29.5	27.0
10	19.0	15.5	---	1.5	.5	3.0	---	19.0	25.0	29.0	27.0
11	18.5	14.5	---	1.0	.5	3.5	13.0	19.0	24.5	29.0	29.0
12	18.0	14.0	---	1.0	.5	3.5	11.5	19.0	---	29.0	28.0
13	17.0	13.5	---	1.0	---	3.5	13.0	19.0	25.5	29.0	29.0
14	16.5	13.5	---	1.0	1.0	3.5	13.5	19.5	25.5	29.0	28.0
15	16.5	13.5	---	.5	1.0	4.5	13.5	20.0	25.5	28.5	29.5
16	16.0	13.5	---	.5	.0	4.5	13.0	20.0	25.5	28.5	29.5
17	16.0	---	5.0	.0	.5	4.5	14.5	20.5	26.0	29.0	28.5
18	16.5	---	---	.0	1.0	4.5	13.5	21.0	25.5	29.0	29.0
19	16.0	---	---	.0	1.5	4.5	14.5	20.5	25.5	29.0	29.0
20	15.5	---	---	.0	.5	5.5	13.5	21.0	25.5	28.5	29.0
21	16.0	---	---	.0	---	5.5	13.5	21.0	26.5	29.0	28.5
22	15.5	---	3.5	.0	---	5.5	---	21.5	26.0	29.5	28.5
23	15.5	---	3.5	.0	---	5.5	14.5	21.5	26.0	30.0	29.0
24	15.5	---	3.5	.5	---	6.5	14.0	---	26.0	29.5	29.0
25	15.5	11.0	3.5	.5	---	6.5	13.5	---	26.0	29.5	29.0
26	15.0	10.0	3.0	.5	---	6.5	15.0	---	26.5	30.0	28.5
27	15.0	9.0	2.0	---	---	---	---	---	26.0	30.0	28.5
28	15.0	9.0	2.0	1.5	---	6.5	13.5	---	26.0	30.0	29.0
29	15.0	8.5	2.0	---	---	7.0	13.5	---	26.0	30.0	29.0
30	15.0	9.0	2.0	---	---	7.0	13.5	---	26.0	30.0	27.0
31	15.0	---	2.0	1.0	---	9.0	---	---	---	30.0	27.0

1.0 SCOPE

Bechtel and all Subcontractors shall use Drawing Control and Drawing Supplements for tracking and reporting progress to ASFI and Bechtel.

Subcontractor's forms may be used if the same information is reported and there is compatibility with CEBUS computer program.

2.0 DRAWING CONTROL

2.1 Purpose

The Drawing Control is a complete list of the drawings for a job, with their scheduled and actual start and issue dates. It tells the engineering groups, the Construction Department, and the Purchasing Department when drawings will be issued so they can plan their work accordingly. Reforecasts of drawing issue dates on the bi-weekly issues show where corrective action may be necessary to insure on-time job completion.

2.2 Responsibility

The Drawing Control is the responsibility of the Project Engineering Supervisor.

2.3 Description and Nomenclature

The Drawing Control lists all major drawings prepared for a job, including flow diagrams and P&ID's. Minor drawings and other engineering documents appear on the Drawing Control Supplement which is discussed in Section 3.0. Documents shown on the supplement include pipe support details, instrument details, data sheets, sketches, line designation tables and instrument installation schedules. Piping isometrics, specifications and lists of material are handled on other separate controls.

The Drawing Control is on 8½" x 11" sheets of 20 lines; one drawing is listed on each line. The drawings are grouped on the sheets by plants and within each plant by Bechtel letter group. (See Standard Drawing A-501). Each letter group is shown on a separate page. A sample Drawing Control sheet (form 213-A) is attached, which describes the method used in completing the form.

	3/30	ISSUED FOR PHASE ZERO	HS		
	2/8/80	ISSUED FOR APPROVAL	HS		

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
DRAWING CONTROL & DRAWING CONTROL SUPPLEMENT

JOB NO. 14222
SPECIFICATION 14222-A-4 REV 1

2.4 Procedure

As soon as possible the Project Engineer, (or Unit Engineers if the job is a large one) lists the drawings which will be required and assigns numbers. The drawing numbers and titles are typed or printed neatly on Drawing Control forms 213-A. When titles are not known, groups of numbers are set aside for drawings until the exact titles are decided upon. Actual start and issue dates are recorded as they occur.

When the Project Schedule is established, schedule dates for each drawing are put onto the Drawing Control. This is done by the Project (or Unit) Engineer working with the design disciplines concerned. These dates must be determined carefully so that they are in complete agreement with the Project Schedule.

The Drawing Control may be issued and maintained either manually or by computer, as determined by the Project Engineering Supervisor.

The manual procedure will be used for Phase 0 Premliminary Engineering. The CEBUS computer system will be used for Phase 1 Detailed Engineering.

When using the manual procedure, the Drawing Control should be issued bi-weekly on the dates specified by the Project Scheduler. The Project administrative Assistant is responsibel for logging the actual issue dates of the drawings and the purpose of their issue, and for keeping the original sheets between issues. Approximately 3 days before the scheduled issue date, the Administrative Assistant distributes the applicable Drawing Control sheets to the responsbile Project, or Unit, Engineers and the design group's supervisor, who check the sheets for accuracy, add or delete drawings as necessary, reforecast construction issued dates if necessary, and update the bar chart to show the percent complete. The forecast column is used if the "scheduled" construction issue date will not be met. Further reforecast dates, if required, are shown in the same box, or under "remarks". Do not erase previous forecast dates. The Drawing Control sheets are returned to the Administrative Assistant who issues them after review by the Project Engineering Supervisor.

When the computerized drawing control system is used in Phase 1, it will be included in the CEBUS program (Control of Engineering Budget and Schedule). The manual Drawing Control forms are filled in as above, and the information is transferred to the computer by typing the input on a "Data Point" 2200 or equal, desk top recorder. After the computer has received the initial input, the Drawing Control log can be printed out from the computer data. (See sample attached). In addition, a work list can be produced which shows exceptions (drawings behind schedule), and drawings scheduled to be issued within the next period. The Project or Unit Engineers and the Group Supervisors maintain current drawings status by markup of their print-outs. Typically, the markups are gathered and issued bi-monthly, once on the accounting month end date (Friday before last Thursday) and once two weeks after that date, and the marked up information is put to the computer.

2.5 Comparison of Accomplishments with the Plan

The Drawing Control must be checked regularly by the Project Engineer, Unit Engineers and Supervisors to determine which drawings are behind schedule so that every effort can be made to meet the schedule dates.

2.6 The Drawing Summary Schedule (Form 275A)

The Drawing Summary Schedule is prepared by the Project Planning and Scheduling Group so the Project Engineers and the Design Supervisors may readily see the progress of drawing completions compared with schedule requirements.

The Drawing Summary Schedule is on 11" x 17" pages of 27 double lines. Plant numbers and description are placed on the left side of the page. Vertical lines divide the balance of the sheet into rectangles representing two-week intervals. The scheduled cumulative number of drawings issued for construction is entered on the upper lines in the column corresponding to the date scheduled. Actual number of drawings issued by a certain date are entered on the lower line in the column corresponding to that date.

Isometrics, pipe support details, instrument details and instrument installation schedules are not included in the Drawing Summary Schedule. The individual design groups are responsible for maintaining their own schedules for such drawings.

Superimposed over the tabulations is a cumulative graph showing the current schedule and the actual number of drawings issued. It does not show reforecasts. A sample Drawing Summary Schedule is attached.

3.0 DRAWING CONTROL SUPPLEMENT

3.1 Purpose

The Drawing Control Supplement is a list of the minor drawings not in the drawing control. It also includes such items as data sheets and indices. See attached form for types of documents to be listed. Scheduled and actual dates for drawings start and issue are shown. This provides engineering groups with data from which to plan their work. Forecast dates show where corrective action may be necessary.

3.2 Responsibility

The Drawing Control Supplement is the responsibility of Unit Engineers with input from the Design Group Supervisors.

3.3 Form

The form used for the Drawing Control Supplement is No. 213-B. Items are grouped on the sheets by plant and within each plant by Bechtel letter group. The prefixes to be used and an example of numbering are shown on Attachment "A". Prefixes (types of drawings listed) can be mixed in numbering sequences, as long as the title identifies the equipment.

3.4 Procedure

As soon as possible after project start, list the titles and assign drawing numbers. When titles are not known, set aside groups of numbers until exact titles are decided.

When the project schedule is established, put schedule dates onto the control. As soon as it becomes evident that a schedule date will not be met, the Unit Engineer or Supervisor concerned must enter a new date in the forecast column. "Schedule" dates are never changed. Do not erase forecast dates when reforecasting, simply line through the old date.

The Drawing Control Supplement is issued as required by the Project Procedure. It must be reviewed regularly so corrective action may be taken on items behind schedule.

△1 4.0 Attachments

Standard Drawing A-501 Rev. 0, Group Letters for Drawing Indexes and Material Requisitions.

Drawing Control Form 213A, Rev. 3-56.

Civil/Structural/Architectural Drawing Control Log Sample.

Datapoint 2000 Pictorial Representation.

Drawing Summary Schedule Sample; Form 275A, 2-63.

Drawing Control Supplement Sample; Form 213B, Rev. 3-56.

GROUP LETTER	GROUP	DESCRIPTION
A	GENERAL	Plot Plans, P&I Diagrams, Maps, Basic Engineering Design Data Sheets, Indexes.
B	PROCESS	Process Design, Flow Diagrams, Data Sheets, etc.
C	COLUMNS AND PRESSURE VESSELS	All pressure vessels of any pressure designed in accordance with the ASME code. This includes towers columns, reactors, regenerators, spheres, drums, etc., including trays, liners, lining, packing, internals and appurtenances.
D	TANKS	All storage vessels other than ASME code vessels. Includes API atmospheric or low pressure storage tanks, bins, spheroids, hoppers, silos, etc., including internals and appurtenances.
E	EXCHANGERS	Heat transfer equipment such as tubular exchangers, condensers, evaporators, reboilers, coolers, fin-fan coolers and cooling towers; excludes fired heaters.
F	FIRED HEATERS	Fired heaters, furnaces, ovens, boilers, fired kilns and driers, including superheaters, air preheaters, tubes, headers, settings, burners, stacks, flues, draft fans and drivers associated with heaters, includes flare stacks and framework, incinerators.
G	PUMPS AND DRIVERS	Includes all pumps and their drivers.
H	VACUUM EQUIPMENT	Vacuum pumps, ejectors and other vacuum producing apparatus. Includes drivers and integral auxiliary equipment.
J	INSTRUMENTS	All instruments and control equipment (except electric power switchboards, controls and meters), including safety (relief) valves, measuring devices, controllers, control valves, indicators, sight glasses, alarms, instrument panels, fittings, control signal pneumatic tubing, air piping and filters, and winterization of instrumentation.
K	COMPRESSORS & DRIVERS	Compressors, blowers, fans and their drivers.
L	PIPING	All process and utility piping(except the following covered elsewhere: sewer and drainage piping(S Group); building plumbing, heating, ventilating and air conditioning(R Group); instrument piping and tubing(J Group); column and vessel internals(C or D Group); and integral piping on pumps or compressors, etc., (G or K Group)
M	STRUCTURES	All steel, concrete, masonry, wood or other structures except buildings. Includes bridges, pipe stanchions, platforms, stairs, ladders, conduit racks.
N	INSULATION	Thermal insulation of piping, vessels, tanks and equipment, also fireproofing of vessel skirts, legs, supports and structures.
P	ELECTRICAL	All electrical equipment and material(except process instrumentation covered under J Group). Includes generators and drivers, motor controls, switchgear, transformers,
P	ELECTRICAL (continued)	converters, rectifiers, transmission and distribution, communication systems, lighting, grounding, all necessary wire and conduit, cathodic protection. For equipment numbering refer to Std. Dwg. P-A101.
Q	FOUNDATIONS	All foundations for buildings, structures or equipment. Includes piling, ground floor slabs, trenches, pits, basins and associated earthwork, soils surveys.
R	BUILDINGS	All permanent buildings above their foundations and floorslab. Includes all integral permanently installed equipment, elevators, plumbing, piping, heating, ventilating and air conditioning and painting.
S	SITE IMPROVEMENTS	Includes clearing, grubbing, grading, fencing, signs, railroads, roads, walks, paving, parking areas, landscaping, sewers and drainage systems, topographic surveys.
T	MATERIAL HANDLING EQUIPMENT	Bucket elevator, conveyors, cranes, hoists, chutes, feeders, weighing devices and hoppers, scales, packaging devices.
U	EXPENDABLES	Chemicals, catalysts, refrigerants, etc.
V	PACKAGE UNITS	Includes integral "package" units, such as air-driers, refrigeration systems, etc., where applicable.
W	WELDING & METAL PROCESSING	Welding, casting and other metal processing specifications.
X	PAINTING	All paint and thinner for plant with exception of buildings.
Y	PROCESSING	Crushers, pulverizers, blenders, screens, separators, cyclones, filters, centrifuges, mixers, grinders, dryers, extruders and similar machinery including drivers.
Z	WATER & WASTE TREATMENT	All equipment intended specifically for treatment of water for general supply, cooling water, boiler feed water, etc., or for treatment of waste water for pollution control. Includes clarifiers, reactors, ion exchange equipment, chemical feeders, mixers, agitators, storage hoppers, liquid filters, settlers, cycle timer and specialty controls.

Note: For a more detailed description, refer to the Refinery and Chemical Standard Code of Accounts.

Reference: Standard Drawing A-506 Numbering Drawings and Documents.

See 14222-A-10 for title block to be used for the Breckinridge Project.

Addition: 1

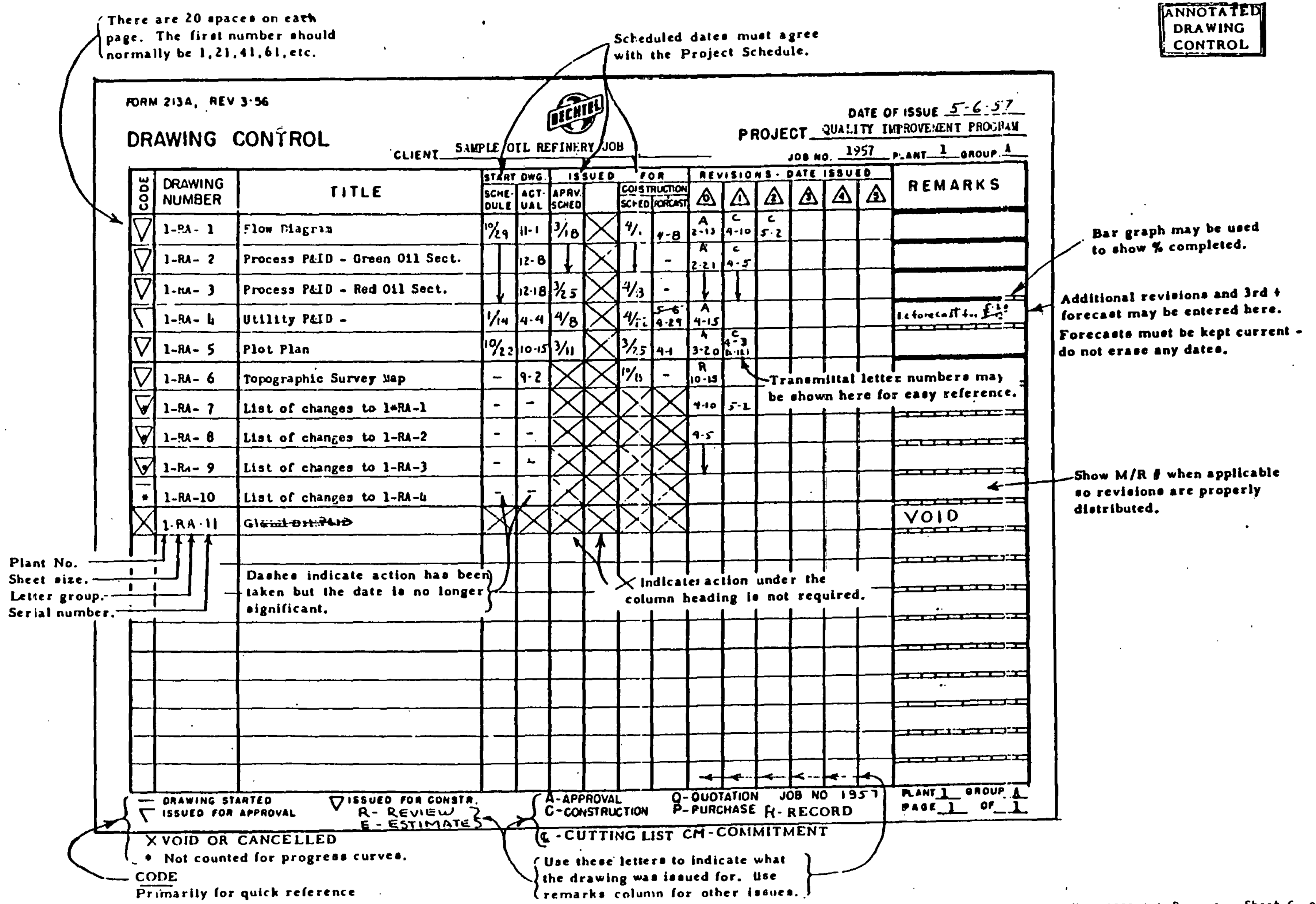
BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

GROUP LETTERS FOR DRAWING INDEXES
AND MATERIAL REQUISITIONS

JOB NO.	DRAWING NO.	REV.
STANDARD	A-501	10

ANNOTATED
DRAWING
CONTROL



FORM 213A, REV 3-56

DRAWING CONTROL

CLIENT SAMPLE OIL REFINERY JOB

DATE OF ISSUE 5-6-57
PROJECT QUALITY IMPROVEMENT PROGRAM
JOB NO. 1957 PLANT 1 GROUP A

CODE	DRAWING NUMBER	TITLE	START DWG. SCHE-DULE	START DWG. ACT-UAL	ISSUED FOR APRV. SCHED		ISSUED FOR CONSTRUCTION SCHED	ISSUED FOR CONSTRUCTION FORCAST	REVISIONS - DATE ISSUED △0	△1	△2	△3	△4	△5	REMARKS
▽	1-RA- 1	Flow Diagram	10/29	11-1	3/18	X	4/1	4-8	A 2-13	C 4-10	C 5-2				
▽	1-RA- 2	Process P&ID - Green Oil Sect.	↓	12-8	↓	X	↓	-	A 2-21	C 4-5					
▽	1-RA- 3	Process P&ID - Red Oil Sect.	↓	12-18	3/25	X	4/3	-	↓	↓					
Γ	1-RA- 4	Utility P&ID -	1/14	4-4	4/8	X	4/22	~~5-6~~ 4-29	A 4-15						Reforecast to 5-20
▽	1-RA- 5	Plot Plan	10/22	10-15	3/11	X	3/25	4-1	A 3-20	C 4-3 (L-181)					
▽	1-RA- 6	Topographic Survey Map	–	9-2	X	X	10/15	-	R 10-15						
▽*	1-RA- 7	List of changes to 1*RA-1	-	-	X	X	X	X	4-10	5-2					
▽*	1-RA- 8	List of changes to 1-RA-2	-	-	X	X	X	X	4-5						
▽*	1-RA- 9	List of changes to 1-RA-3	-	-	X	X	X	X	↓						
— *	1-RA-10	List of changes to 1-RA-4	-	-	X	X	X	X							
X	1-RA-11	~~Gland Oil P&ID~~	X	X	X	X	X	X							VOID

— DRAWING STARTED
Γ ISSUED FOR APPROVAL
▽ ISSUED FOR CONSTR.
X VOID OR CANCELLED
* Not counted for progress curves.

CODE
Primarily for quick reference

R- REVIEW
E - ESTIMATE
A-APPROVAL
C-CONSTRUCTION
Q-QUOTATION
P-PURCHASE
R- RECORD
CL-CUTTING LIST
CM-COMMITMENT

JOB NO 1957
PLANT 1 GROUP A
PAGE 1 OF 1

There are 20 spaces on each page. The first number should normally be 1,21,41,61,etc.

Scheduled dates must agree with the Project Schedule.

Bar graph may be used to show % completed.

Additional revisions and 3rd + forecast may be entered here.

Forecasts must be kept current - do not erase any dates.

Transmittal letter numbers may be shown here for easy reference.

Show M/R # when applicable so revisions are properly distributed.

Plant No.
Sheet size.
Letter group.
Serial number.

Dashes indicate action has been taken but the date is no longer significant.

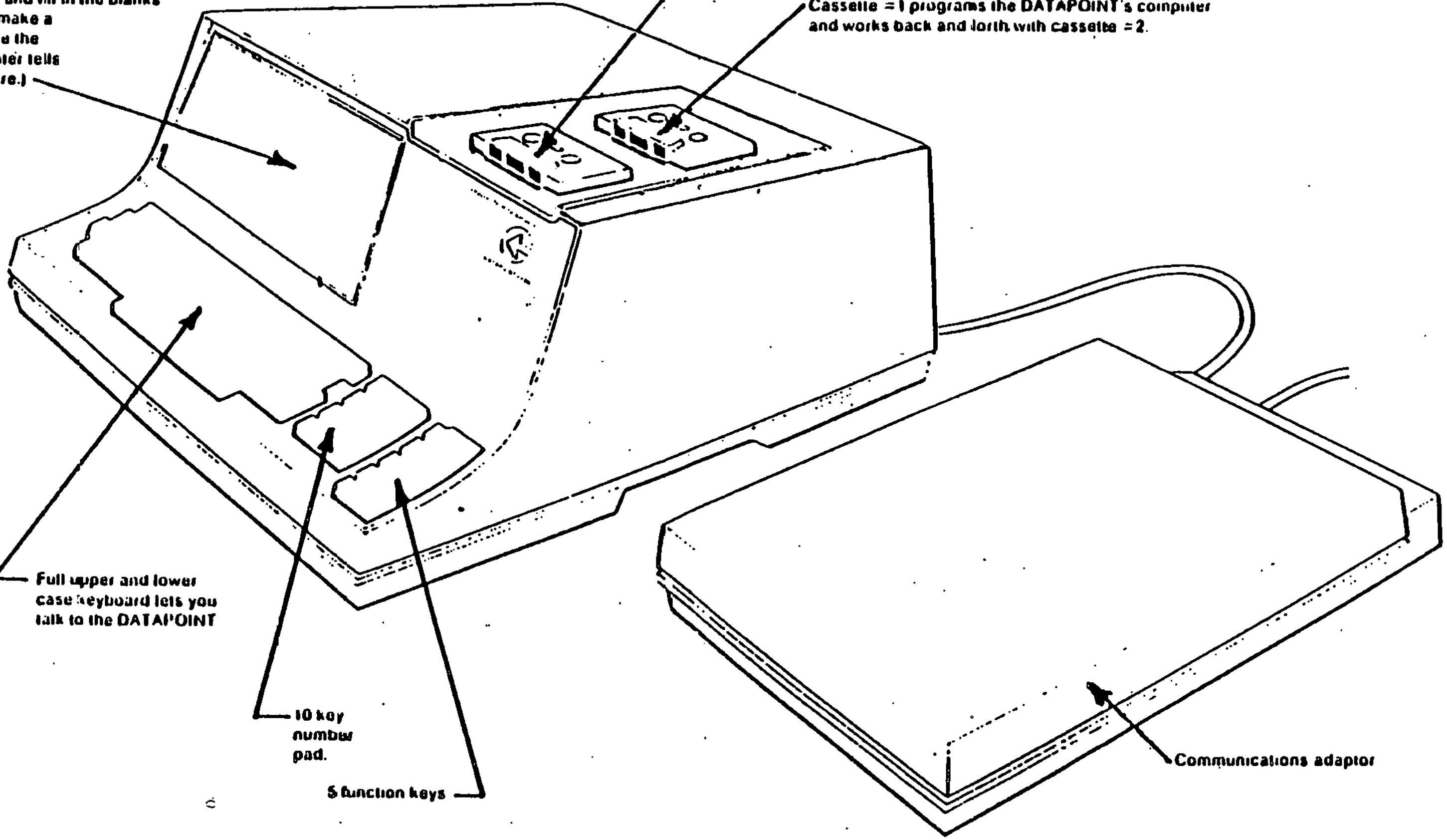
X Indicates action under the column heading is not required.

Use these letters to indicate what the drawing was issued for. Use remarks column for other issues.

```
                                  CIVIL/STRUCTURAL/ARCHITECTTURAL DRAWING CONTROL LOG
AE670C                              AGNS-BNFP WASTE FACILITIES - JOB NO. 10752                                   PAGE   3
                                                        10/24/75
 FIRST LINE---SCHEDULE DATES                          1      2      3      4      5      6      7      8      9     10
 SECOND LINE--FORECAST (F) AND ACTUAL (A) DATES     START  START  ISSUED ISSUED ISSUES CLIENT ISSUED FIRST  SECOND AS     ACTIV
 THIRD LINE---INSTRUCTIONS, COMMENTS                ENGR'G DRAFT- FOR    FOR    FOR    APPRVL FOR    REVI-  REVI-  BUILT  BUDGET
                                                           ING    INTER- CLIENT QUOTES RECV'D CONST  SION   SION   REVI-
DRAWG NUMBER REVDT  SIZE      DESCRIPTION                         NAL    APPRVL                                    SION
             REVNO  SYSTEM                                        REVIEW
             Q CL   CA                              EXCEPTIONS COMMENTS


04-S-021            ..E... CONCRETE PAVING DETAILS  13OC5  15OC5  07NO5   NA     NA     NA    28NO5                02JL6  000100
------------                                        13OC5A 15OC5A         NA     NA     NA                                     60
                           -

40-M-012     16MY5  ..E... CRIB CONSTRCTN SHORING   17MR5                                     15AP5  16MY5         02JL6  000130
             01            SYST - WASTE TANK AREA   17MR5A                                    14AP5A 16MY5A                   380
                           -

40-Q-020     09JL5  ..C... DRLLD CST-IN-PLCE PILES  01AP5                                     10AP5  09JL5         02JL6  000110
             01            CRIB CONST SHOR SYS(SH1) 01AP5A                                    25AP5A 09JL5A                   660
             QQ            -

40-Q-021     09JL5  ..C... DRLLED CST-IN PLCE PILES 03AP5                                     10AP5  09JL5         02JL6  000110
             01            CRIB CONST SHOR SYS(SH2) 03AP5A                                    25AP5A 09JL5A                   660
             QQ            -

47-M-234            ..E... HCS - STAIRS & HANDRAILS 22SE5  29SE5  10OC5   NA     NA     NA    21NO5                02JL6  000150
------------                                        22SE5A 23SE5A 10OC5A  NA     NA     NA    28NO5F                           60
                           -

47-M-323            ..E... STEEL FRAMING - STORAGE  17OC5  24OC5  07NO5   NA     NA     NA    19DE5                02JL6  000130
------------               BUILDING                 17OC5A                NA     NA     NA                                    160
                           -

47-M-324            ..E... HLS - STAIRS & HANDRAILS 22SE5  29SE5  10OC5   NA     NA     NA    21NO5                02JL6  000150
------------                                        22SE5A 23SE5A 10OC5A  NA     NA     NA    28NO5F                           60
                           -

47-M-325            ..E... CSF ROOF                 10OC5  24OC5  31OC5   NA     NA     NA    21NO5                02JL6  000150
------------               STEEL FRAMING            24OC5A 07NO5F 28NO5F  NA     NA     NA    12DE5F                          120
                           -

47-M-999-130               MISCELLANEOUS SHELTERS   22AU5                                     19DE5                02JL6  000130
                                                                                                                               60
                           -

47-M-999-150               STRUCTURAL MISCELLANEOUS 22AU5                                     19DE5                02JL6  000150
------------                                                                                                                   95
                           -                        TREND S2434(+75)

47-Q-101            ..E... WFW FDN. PLAN SHEET 1    10OC5  17OC5  31OC5   NA     NA     NA    14NO5                02JL6  000110
------------                                        24OC5A 14NO5F 28NO5F  NA     NA     NA    12DE5F                          180
                           -

47-Q-102            ..E... WFW FDN. PLAN (SHEET 2)  10OC5  17OC5  31OC5   NA     NA     NA    14NO5                02JL6  000110
------------                                        24OC5A 14NO5F 28NO5F  NA     NA     NA    12DE5F                           80
                           -

( SORT BY ---IDENTIFICATION NUMBER                    )      2      3      4      5      6      7      8      9     10
```

Specification No. 14222-A-4 Rev. 1 Sheet 7 of 10

DATAPOINT 2200



Cassette = 2 records all the information. Data can go from here directly to an IBM computer magnetic tape, bypassing punchcards altogether.

Cassette = 1 programs the DATAPOINT's computer and works back and forth with cassette = 2.

960 character display — lets you see what you're doing. (For data entry, display your format and fill in the blanks If you make a mistake the computer tells you here.)

Full upper and lower case keyboard lets you talk to the DATAPOINT

10 key number pad.

5 function keys

Communications adaptor

SAMFLE

DRAWING SUMMARY SCHEDULE

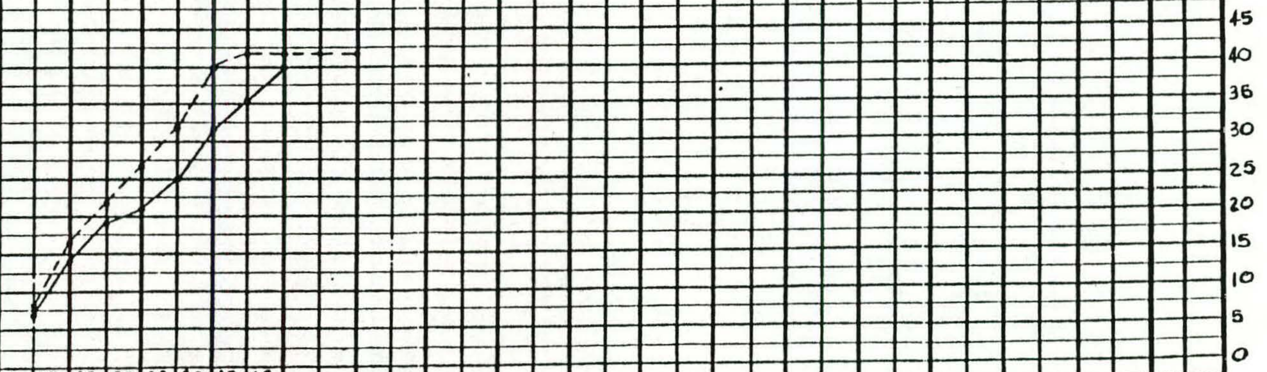
SAMPLE OIL REFINERY

LEGEND- TOP LINE: SCHEDULED ISSUE FOR CONSTRUCTION - - -
BOTTOM LINE, ACTUAL ISSUE FOR CONSTRUCTION —
ALL DATA IS CUMULATIVE

DATES SHOWN ARE FRIDAYS — DRAWING CONTROL ISSUE DATES

JOB NO. 00001
PLANT____ GROUP ALL
PAGE____ OF____ PAGES
DATE 9/15/77

LETTER GROUP	DESCRIPTION	TOTAL	6/1	6/15	7/1	7/15	8/1	8/15	9/1	9/15	10/1	10/15
A	GENERAL		5 5	10 9	12 11	15 11	17 13	20 18	22 20	22 22	22	22
B	PROCESS FLOW DIAGRAMS											
C/D	COLUMNS, VESSELS & TANKS		3 2	7 5	10 8	12 10	15 12	20 14	20 16	20 18	20	20
J	INSTRUMENTS											
L	PIPING											
M	STRUCTURAL											
P	ELECTRICAL											
Q	FOUNDATIONS											
R	BUILDINGS											
S	SERVICES											
T/V	SPECIAL EQUIPMENT											
	TOTAL		8 7	17 14	22 19	27 21	32 25	40 32	42 36	42 40		



FORM 275A. 2-63

FORM 213B, REV. 3-56 SAMPLE ATTACH. A

DATE OF ISSUE ______

DRAWING CONTROL SUPPLEMENT

CLIENT SAMPLE OIL REFINERY

PROJECT ______

JOB NO. ______ PLANT 2 GROUP G

CODE	DRAWING NUMBER	TITLE	START DWG. SCHEDULE	START DWG. ACTUAL	ISSUED FOR APRV. SCHED		ISSUED FOR CONSTRUCTION SCHED	ISSUED FOR CONSTRUCTION FORECAST	REVISIONS - DATE ISSUED ⚠0	⚠1	⚠2	⚠3	⚠4	⚠5	REMARKS
▽	DS-2G-1	DATA SHEET PUMP 2G-101	5/3	5/10			6/1	6/8 6/15	6/20 Q	7/18 P					
▽	CS-2G-2	CALC SHEET PUMP 2G-101	6/21	6/21			7/15		7/20 C						

— SEQUENCE NO.

— GROUP LETTER (SEE STD DWG A-501)

— PLANT NO

— PREFIX:

DS - DATA SHEETS, LINE DESIGNATION TABLES

DD - DETAILS & DIAGRAMS

IS - INSTALLATION SCHEDULES

PS - PIPE SUPPORT DESIGN SHEETS

CS - CALCULATION SHEETS

LM - MATERIAL SUMMARY SHEETS

SK - SKETCHES

— DRAWING STARTED

⌐ ISSUED FOR APPROVAL

▽ ISSUED FOR CONSTR.

A - APPROVAL

C - CONSTRUCTION

Q - QUOTATION

P - PURCHASE

PAGE ______ OF ______

1.0 SCOPE

△1 This specification applies to work performed by Bechtel and its Subcontractors as defined in the applicable agreement documents if required in preparation of the capital cost estimate during Phase Zero. Bechtel and its Subcontractors are to maintain Line Designation Tables (LDTs) throughout all phases of the project subsequent to Phase Zero.

2.0 PURPOSE

The Line Designation Tables provide a listing of pertinent design information for the process and utility pipe line in each plant. The Line Designation Tables are used by the engineering office design groups and the jobsite personnel for installation, stress analysis, supports, insulation, steam-electric tracing, field hydrostatic testing, for monitoring quantities of installed piping, and as a basis for calculating wall thicknesses of large diameter pipe.

3.0 RESPONSIBILITY

The Unit Engineer is responsible for preparation and maintenance of the Line Designation Tables. He is responsible for assigning line numbers, sizing pipe lines, keeping the master copy current to show additions, cancellations, revisions, and for periodically issuing the Line Designation Tables to all concerned.

4.0 GENERAL

4.1 Line Designation Tables/P&ID Relationship

Project Instruction 14222-A-1, Basic Instruction for P&ID Development, and 14222-A-2, P&ID Responsibilities, explain the relationship of Line Designation Tables and P&IDs and should be read in conjunction with this instruction.

4.2 Line Designation Table (Form 18)

The Line Designation Table is prepared on Form 18, attached. Prepare LDT sheets for each commodity in each plant using the commodity symbols in Specification 14222-A-1, Section 2.40 The list may be modified to suit the requirements of the job. For example, the form may be extended to provide additional colums for both steam and electric tracing data and additional notes.

4.3 Drawing Numbers

The Line Designation Tables for each plant are prepared in two sets; one set includes all process lines and the other set includes all utility lines.

FORM 11-292 7-66

△					
△	[illegible]	REVISED AS NOTED	[illegible]		
△	7/15/80	ISSUED FOR PHASE ZERO	HS	[illegible]	[illegible]
△	3/80	ISSUED FOR APPROVAL	TS		

BECHTEL

ASFI THE BRECKINRIDGE PROJECT
U.S. DOE COOPERATIVE AGREEMENT NO. DE_FC05-800R20717
PROJECT SPECIFICATIONS
LINE DESIGNATION TABLES

JOB NO. 14222

SPECIFICATION	REV
14222-A-5	2

Each set is prefaced with an Index Sheet, Form 1 (Attachment B), with data sheet numbers as follows (X = Plant Number:

DS-X-A-1 - for process line tables
DS-X-A-2 - for utility line tables

Title the Index Sheet:

1st Line: Process (or Utility) Line Designation Tables
2nd Line: Plant No., Name

Title the LDT sheets:

1st Line: Line Designation Table
2nd Line: Plant No., Name
3rd Line: Commodity, Commodity Symbol

Assign Sheet 1 number to the Index Sheet and number the LDT sheets consecutively, starting with Sheet 2.

List the commodities alphabetically on the Index Sheet.

4.4 LDT for Undefined Piping

Separate Line Table sheets are prepared for process and utility systems for each plant to identify systems which cannot be defined or identified on the P&ID at the time of the first material forecast.

List the Undefined System LDT sheets on the Index Sheets and include them in the LDT sets when issuing the LDT's.

Cancel the Undefined System LDT sheets when the system has been identified and registered on the regular LDT's. Retain the cancelled sheets for the record.

4.5 LDT Issue

LDT's shall be issued with the Revision 0 issue of the P&ID's and shall show at least the following: Phase 0 of the Breckinridge Project will exclude those items marked by ⊕ .

Line No.
Fluid
Normal Operating Conditions
⊕ Code Design Conditions
Routing (From - to)
Reference Drawings
Pipe Specifications
⊕ Pipe Size

4.6 LDT Revisions and Reissues

Reissue the LDT's with Revision 1 of the P&ID's. The LDT's shall be updated to include all revisions, the insulation and steam or electric tracing requirements, expansion temperature, and test pressures of all the lines.

In addition to the above, reissue the LDT's whenever there are significant or numberous P&ID/LDT changes, so that all parties concerned are informed. Too frequently the Line Tables containing major piping design data changes are issued after the Piping Group has committed pipe material on the previous data.

Indicate changes to the line data by placing a revision mark (triangle) at right side of the LDT sheet,and in the column effected.

5.0 COMPLETION OF LDT'S

The following defines the information to be shown on the LDT sheet and provides references to Bechtel instructions and design guides and to Code design requirements which shall be considered in conjunction with this instruction. Note that the following paragraphs explain the LDT data columns (refer to Attachment A) in the sequence of completion.

5.01 Line Numbering

The pipelines in each plant shall be numbered consecutively starting with 1 (one), or as specified in Job Instructions, for each commodity as follows:

Line No: 3CW-12
Where: 3 = Plant No.
CW = Commodity (See Std. Dwg. A-513)
12 = Line Number

After the first issue of the P&ID's (for Bid, Estimate or Client approval) do not reuse previously deleted line numbers or change line numbers after numbers have been assigned to specific lines.

Generally, a new line number should be assigned whenever the following situations occur:

a) Line originates from a piece of equipment.
b) At points of line size change, i.e. in major headers.

c) Pipe specification breaks regardless of whether or not size changes.
d) Line branches to 2 or more destinations or bypasses a major piece of equipment.

Do not assign a new line number when only the following changes occur:

a) Revision of flow when not accompanied by a correction in line size.
b) Revision of pressure and/or temperature when not accompanied by a change in pipe specification.
c) Line flows through control valve, in-line strainer, etc., unless downstream pipe size also changes. Pipe size change to permit mating with control valves or equipment connections are not considered line size changes.
d) Passing of a line from one plant, or unit, to another. The line carries the originating plant's line number, up to the first piece of equipment, brach line, line or specification change in the destination plant.

5.02 From - To (Routing of Pipe)

List the equipment numbers at which the pipeline originates and terminates. If the line originates or terminates at another line, list this line number and also the P&ID coordinates of the intersection. If the line terminates in air, state atmosphere, grade, OWS (oily water sewer), etc.

5.03 Fluid

Be as descriptive as possible; state instrument air instead of only air, cooling water instead of water, naphtha feed instead of hydrocarbon. Use abbreviations; for example, H_2 - hydrogen, CW - cooling water, IA - instrument air, etc. If available use the terms stated in 14222-A-1 Para. 2.40.

5.04 Reference Drawings

List the P&ID(s) on which the line appears and the CS (Line sizing calculation sheet) number, if any.

5.05 Normal Operating Conditions

The data for process line is available from the Process Flow Diagrams, or Heat and Material Balance Stream

Properties charts issued by the Process Design Group. Data for utility lines comes from many sources including Project Basic Design Data Sheets (give pressure and temperatures for the supply and return of cooling water, steam condensate, air, fuel oil, etc.) and vendor data, and project utility balance.

a) Mass Flow

List the flow rate that governs design. This is either the maximum continuous operating flow rate or an intermittent flow rate if it is greater than approximately 120% of the continuous rate.

b) Pressure

Consider hydrostatic head and friction losses in establishing the operating pressure. For liquids it is the higher of either the upstream pressure or the pressure at the lowest elevation of the system. For gases it is the upstream pressure; note that the gas velocity should be determined at this pressue and that the increased velocity at downstream end shall be considered in sizing the line.

c) Miscellaneous

Volume flow rate, temperature, viscosity, and density are all given at flowing conditions.

5.06 Pipe Size

List the nominal diameter of pipe selected for the service.

Project Instruction 14222-A-1 Section 3.10 gives velocity ranges and unit pressue drops as a basis for sizing lines.

Often the size of small pipe is determined by other than flow criteria; for example, 1½" or 2" usually is the minimum size permitted in pipeways to avoid excessive line sag.

5.07 Pipe Specification

Piping Material Specification (to be issued in Phase 1) will give the maximum allowable code design pressue/temperature limits, material flange rating and corrosion allowance for each service class of piping.

Job Specification 14222-L-1 details pipe wall schedules (wall thicknesses) etc., for pipe diameters up to about 20". When the wall thickness is not given in the specification the Unit Engineer/Job Piping Engineer calculates the required thickness based on the code of design pressure and temperature. The service code letter is entered on the LDT.

The Piping Design Group issues a Supplementary Table of Wall Thicknesses for the above calculated lines.

5.08 Line Information

Fluid velocity and unit pressure loss data may be obtained by any of the following methods:

Charts in Bechtel Fluid Flow Book - Volume V
Calculations based on formula in Bechtel Fluid Flow Book - Volume V
Time Share Program
Computer Program ME-142

If using ME-142, preface the computer printout sheets of the line sizing program with an appropriately sized index sheet, listing CS (calculation sheet) drawing numbers and titles:

CS-X-A-1 - Process Line Calculation Sheets
CS-X-A-2 - Utility Line Calculation Sheets

(X - symbolizes plant number)

Mark the printout sheets to indicate the selected line size.

The Unit Engineer shall prepare a line calculation sheet, Form 62 attached, for each critical flow including two-phase, compressor circuits, thermosiphon, pump suction/discharge, large diameter or long pipe line flows. This shall show the basic process data, equations and calculations for density, velocity, pressure loss and Reynolds

Number; a sketch of the line; the effective length; and the assumptions made in sizing the line.

The line calculation sheets, Form 62, shall be numbered consecutively, starting with 3 and titled as follows:

CS-X-A-3 - Line XP-5, XP-10
CS-X-A-4 - Line XP-2, Pump, 5, Pump XG-501
CS-X-A-5 - Etc.

(X - symbolizes plant number)

5.09 Upset

Upset Pressure and Temperature are based on abnormal operating conditions, if any, including loss of cooling water, catalyst regeneration, instrument failure, inadvertently closed valve, etc. The Unit Engineer shall establish the coincident pressure and temperature for each abnormal operating condition and shall list the conditions that govern the piping design.

Care is required in establishing the upset temperature for steam/electric traced lines as the tracing material selection is based on temperature; for example, 400°F is the dividing point between copper and steel tracing tubing.

Where piping is part of a system protected by a pressure safety-relief valve on vessels or equipment the Upset Pressure is the sum of a+b+c, where:

a - Relief valve set pressure
b - Pressure drop in piping to the relief valve at maximum relieving flow (Max.3%)
c - Static head of fluid between relief valve and piping.

For pump discharge piping subject to pump shut-off pressure the Upset Pressure is the sum of a+b+c, where:

a - Pump suction source relief valve set pressure
b - Static head of fluid on pump suction at source vessel "high liquid level"
c - Pump shut-off differential head

For preliminary work assume pump shut-off is 120% of pump rated differential pressure; when supplier's pump data is available, recheck the calculations and correct as required.

5.10 Code - General Requirements

The Code (design) pressure and temperature are functions of Upset conditions and are the minimum values to which the pipe must be designed. Specification 14222-L-3 Piping Design Basis, lists the governing design regulations, reviews the requirements for steam generation vessels and defines the piping subject to ASME Boiler and Pressure Vessel Code, Section 1.

5.11 Code Design Requirements - Petroleum Refineries

a) OSHA (Occupational Safety and Health Act) requires that petroleum refinery piping design considerations shown on the LDT's shall be in accordance with the rules in ANSI B31.3 (American National Standards Institute Code for Pressure Piping). This code covers all piping within a petroleum refinery including fluidized solids, oil, gas, steam, water, air, chemical and refrigerant lines except as excluded in Par. 300.1.3 and 300.1.4 (primarily boiler code and low pressure piping).

b) Paragraph 301.2 of ANSI B31.3 states that the design pressure shall be not less than most severe conditions of coincident pressure and temperature. The most severe condition is defined as the combination which requires the greatest pipe wall thickness and the highest flange rating.

c) The following are some of the conditions to be evaluated in determining the minimum code design temperature.

1. Maximum process operating temperature.
2. Vapor-liquid equilibrium temperature corresponding to the design pressure.
3. For Piping downstream of heat exchangers, the maximum temperature which can occur when bypassing the exchanger for cleaning. If there is no bypass, the maximum downstream temperature occurs when there is a loss of coolant flow, e.g. fan failure in the case of an air fin cooler

4. For compressor discharge piping, the maximum temperature which can occur when the compressor is on recycle.

5. Catalyst regeneration temperature.

d) Refer to ANSI B31.3, Par. 301.3.1, for permissible pipe metal temperature adjustments when the pipe is uninsulated. Normally, the fluid temperature is listed as the code (metal) temperature because most hot lines are insulated and both temperatures are nearly identical.

e) ANSI B31.3, Par. 302.2.4, defines allowances by which the pressure rating or allowable stresses may be exceeded during upset conditions. In actual practice we apply these allowances to the upset pressure to determine the required code design pressure. These allowances are expressed in "duration factors" of 1.33, 1.2 and 1.0 and are applied as follows:

A 1.33 duration factor is used if the upset condition does not last more than 10 hours at any one time or more than 100 hours a year.

A 1.2 duration factor is used if the upset condition does not last more than 50 hours at any one time or more than 500 hours a year.

A 1.0 duration factor is used when:

1. Duration of upset condition exceeds that permitted by the 1.2 duration factor, or

2. Piping is cast-iron or similar non-ductile material, or

3. Piping is austenitic stainless steel or certain nickel alloys. Refer to ANSI B31.3 Appendix A for exceptions.

5.12 Code Procedure - Petroleum Refineries

a) Use the following procedures to establish the minimum required code design conditions and to select/confirm a piping service class.

The maximum allowable code design values are stated as PRESS-TEMP. LIMITED in the Job Piping Material Specification.

A piping service class is acceptable if the required minimum code design point falls on or below the plotted PRESS-TEMP. LIMITS line or if the calculated required wall thickness plus corrosion allowance is less than the thickness shown in the piping service class.

b) Determine the required code design conditions and select/confirm piping service class as follows:

1) If only the pressure is effected by the upset condition, the higher of either the normal operating pressure or the upset pressure divided by the duration factor (1.33, 1.2 or 1.0) becomes the required minimum code design pressure. In this case the normal operating temperature becomes the code design temperature.

Use these minimum code design values to select/ confirm a piping service.

2) In most cases the PRESSURE-TEMP. LIMITS range is adequate, enabling the user to evaluate the piping service class but if the upset temperature is outside this range it may be necessary to calculated the wall thickness ratio. If R = 1 the upset condition governs, indicating that the piping service class is not acceptable:

$$R = \frac{t_u}{t_n} = \frac{(S_n \;/\; P_n \quad (Y_n)}{F \quad (S_u \;/\; P_u + (Y_u)}$$

Where:

R = ratio of calculated wall thicknesses w/o corrosion allowance
t = minimum wall thickness w/o corrosion allowance
n = normal conditon
S = allowable stress at applicable temperature
P = pressure, psig
Y = material factor per ANSI B31.3, Table 304.1.1
F = duration factor (1.0, 1.2, 1.33

3) If only the temperature increases and stays below 900°F, the required code design values are the normal pressure and the upset temperature. For this case Pn = Pu and Yn = Yu.

4) If only the temperature is affected by the upset condition, but exceeds 900°F, use method 2 above, except in this case Pn = Pu and Yn ≠ Yu.

5) If both pressure and temperature are affected by the upset conditions, but temperature stays below 900°F, the code design condition shall be determined by using method 2 above, except Pn ≠ Pu and Un = Yu.

6) If both pressure and temperature are affected by the upset condition, and the temperature exceeds 900°F, the code design condition shall be determined by using method 2 above, except Pn ≠ Pu and Yn ≠ Yu.

5.13 Test

This is the minimum test pressure to which the jobsite personnel pressurize the pipe line to prove its integrity. Normally, this is a hydrostatic test with pressure at 1.5 times the code design pressure, adjusted for hydrostatic head and for code design temperatures exceeding 650°F. Piping stress values from ANSI B31.2 shall be used in refinery work.

△2 Specification 14222-L-6, Piping Installation and Testing, describes Operational, Vacuum, Piping, Air, and Visual Examination Tests as possible alternates to the above hydrostatic test. Establish the extent of alternate testing early in the job because considerable Field planning is required. Add appropriate notes to the Line Table to explain the requirements.

The test pressure to be shown on the Line Table is the minimum test pressure required; a maximum allowable test pressure is stated in the piping service class.

5.14 Expansion

This column lists the maximum pipe temperature resulting from upset, steam-tracing, steam-out, regeneration or abnormal operating conditions and is used only for stress analysis.

Failure to correctly establish this temperature early in the piping layout part of the job can result in expensive pipe and support modifications. The Unit Engineer should consult Process and Startup personnel to evaluate any questionable system.

5.15 Insulation

△2 The requirement for heat/cold conservation or personnel protection insulation is normally indicated by noting the insulation thickness or PP (personel protection). Design Guides N-1 and N-2 and Standard Specifications N-501 and N-502, Heat and Cold Conservation Insulation, give basic design information which will be issued later for Phase 1 design. A job will be issued to give specific design data and procedure.

5.16 Pipeline Tracing

Insert "ST" or "ET" in this column to indicate the requirement for either ST, steam tracing, or ET. electric tracing, of pipe lines for winterproofing or heating.

△2 Job Specifications will be issued in Phase 1 to define the types of tracing to be provided for the job.

Engineering Instruction L-17, Model and Drafting Procedures for Steam Tracing and Design Guide A-1, Steam Tracing of Piping, give general information and design data for steam tracing. Form 381, Index for Steam Traced Lines, is completed later to specify the detailed design of the tracer.

Electric Tracing is covered by Engineering Instruction P-4, Design Guide P-3 and Form 163. These instructions and forms will be issued later for Phase 1 design.

5.17 Installed Piping

E.I. A-36, Development and Control of Installed Piping Quantities, gives general instructions which will be supplemented by specific Job Instructions. The pipe takeoff quantities are entered by the Unit Engineer.

6.0 ATTACHMENTS

Line Designation Table Form 18

Pump Calculation Sheet Form 62

Line Designation Table Index

NORMAL OPERATING CONDITIONS								LINE INFORMATION				DESIGN CONDITIONS									INSTALLED PIPING		REF. DWGS.	SERVICE INFORMATION		
MASS FLOW LBS/HR	VOLUME FLOW		WT. % VAPOR	PRESS PSIG	TEMP. °F	VISC. CP.	DENS. #/Ft³ OR SP. GR.	VEL FT/SEC	ΔP/1000' PSI	EFF. LENGTH	TOTAL ΔP	UPSET NOTE 1		EXP. NOTE 4	CODE NOTES 2 & 3		TEST	INSUL. / STEAM TRACE	PIPE SPEC.	PIPE SIZE	ORIGINAL TAKE OFF LF	CURRENT TAKE OFF LF*	P&ID LINE CALC.	FLUID	FROM - TO	LINE NO.
	QUAN.	UNIT										PRESS PSIG	TEMP °F	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG									

NOTES:

1. SHOW MAXIMUM CONDITIONS OF COINCIDENT PRESSURE & TEMPERATURE IN THESE COLUMNS.
2. DETERMINE ANSI CODE DESIGN CONDITIONS AS FOLLOWS
   DIVIDE THE UPSET PRESSURE BY A FACTOR OF 1.33, 1.2, OR 1.0 (SEE ANSI B31.3 PARAGRAPH 302.2.4) TO OBTAIN THE ADJUSTED TEMPORARY PRESSURE. THE CODE DESIGN PRESSURE AND TEMPERATURE ARE THEN BASED ON THE MORE SEVERE OF TWO CONDITIONS:
   (A) THE NORMAL PRESSURE AND COINCIDENT TEMPERATURE, OR
   (B) THE ADJUSTED TEMPORARY PRESSURE AND COINCIDENT TEMPERATURE.
3. FOR ASME CODE DESIGN REFER TO ASME SECTION I, PARAGRAPH PG 27, PG 58, PG 59
   SHOW ASTERISK * IN PRESSURE COLUMN IF ASME CODE DESIGN
4. SHOW MAX. TEMPERATURE POSSIBLE DUE TO UPSET, STEAMOUT, ETC., FOR EXPANSION CHECK

FORM 18, REV 1-75

NO	DATE	REVISIONS	ENGR.	PROJ. ENGR
5				
4				
3				
2				
1				
0				

BECHTEL

LINE DESIGNATION TABLE

JOB NO.	DRAWING NO.	REV.

SHEET ________ OF ________

SERVICE * ____________________

LIQUID PUMPED

CORR./EROS. CAUSED BY

SOLIDS

PUMPING TEMPERATURE (PT) °F

VISCOSITY AT P.T. CENTISTOKES (CS)

VAPOR PRESSURE @ PT. PSIA

SPECIFIC GRAVITY (S.G.) @ PT

FLOW NORMAL @ 60 °F GPM

FLOW - NORMAL @ P.T. GPM

FLOW - DESIGN @ P.T. GPM

CALCULATIONS BY		I	I	II	II	III	III
SUCTION PRESSURE	LOOP	S	D	S	D	S	D
ORIGINAL PRESSURE	PSIA						
+ STATIC HD. (FT. × S.G. × .433)	PSI						
− LOSS (LINE + OTHER)	PSI						
PUMP SUCTION PRESSURE	PSIA						
NET POSITIVE SUCTION HEAD							
STATIC HEAD	FEET						
− LINE LOSS (PSI × 2.31/S.G.)	FEET						
+ [(ORIG. PR.) − (VAP. PR.)] × 2.31/S.G	FEET						
AVAILABLE NPSH (LIQUID PUMPED)	FEET						
PUMP REQ'D. NPSH (WATER)	FEET						
DISCHARGE PRESSURE							
DELIVERY PRESSURE	PSIA						
STATIC HEAD (FT. × S.G. × .433)	PSI						
LINE LOSS	PSI						
ΔP CONTROL VALVES	PSI						
ΔP EXCHANGERS	PSI						
ΔP FURNACES	PSI						
ΔP ORIFICES	PSI						
ΔP OTHERS *	PSI						
PUMP DISCHARGE PRESSURE	PSIA						
DIFFERENTIAL PRESSURE							
DISCHARGE PRESSURE	PSIA						
SUCTION PRESSURE	PSIA						
TOTAL PUMP DIFF. PRESS.	PSI						
PUMP HEAD (PSI × 2.31/S.G.)	FEET						
HYDRAULIC HORSEPOWER = (GPM × DIFF. PRESS./1715)							
EFFICIENCY %							
BRAKE HORSEPOWER = (HYD. HP/EFF. (%))							

* MINIMUM OF 2 PSI FOR DYNAMIC HEAD

PUMP MAT'L -

CASE

INTERNALS

III	FINAL						
II	PURCHASE						
I	ORIGINAL						
NO.			JOB ENGR	INSTR	MECH EQUIP	PROJECT ENGR	DATE

NO.	DATE	REVISION	BY

CLIENT

LOCATION

PUMP CALCULATION SHEET

PUMP NO.

LINE NO.

JOB NO.	DRAWING NO.	REV.

R&C SFE FORM 62 (4-77)

INDEX

TITLE	SHEET NO.	REVISION DATE AND NUMBER
Index	1	
Line Designation Table:		

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG'R	PROJ ENGR	APPR
△								
△								
△								

SCALE

DESIGNED

DRAWN

CHIEF ENGR

ORIGIN

JOB No.

DRAWING No. DS- A-

REV.

"A" SIZE FORM 1 12/68

PLANT NUMBERS

PLANT NUMBERS	
1	Coal Drying and Pulverizing
2	Coal Slurry Preparation
3	H-Coal® Preheating and Reaction
4	H-Coal Primary Separation
5	H-Coal Recycle Slurry Preparation
6	H-Coal Recycle Hydrogen Compression
7	Gas Plant
8	Cryogenic Hydrogen Purification
9	Sour Water Treating
10	Sulfur Plant
11	
12	Gasification and Purification
13	
△2 14	Delete
15	Oxygen Plant
16	
17	Distillate Separation
18	Naphtha Treating and Reforming
19	Flare System
20	Tankage

FORM H-292 7-66

△		
△2	3/9/81	REVISED TO DELETE PLTS 14&43 AND ADD PLTS 40.45. &50
△1	4/80	ISSUED FOR PHASE ZERO
△0	3/3/80	ISSUED FOR APPROVAL

BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
PLANT NUMBERS

JOB NO. 14222

SPECIFICATION	REV
14222-A-6	2

SHEET 1 OF 3

PLANT NUMBERS

PLANT NUMBERS	
21	Interconnecting Piping
22	River Facilities
23	Rail, Truck, Pipe Line
24	
25	
26	Coal Receiving and Storage
27	Coal Washing and Secondary Crushing
△1 28	
29	
30	Electrical Distribution
31	Steam Generation and Boiler Feedwater Treating
32	Water Systems; Raw, Potable, CW
33	Fire Systems
34	Sewers and Waste Water Treatment
35	Stack Gas Scrubbing
36	Instrument Air and Plant Air Systems
△2 37	Telecommunications System
38	Inert Gas System
39	Purge and Flush Oil Systems
△2 40	Site Development
41	Buildings
42	Solid Waste Management
△2 43	Delete
44	Landfill
△2 45	Transportation

FORM H-293 7/66

PLANTS NUMBERS	
46	
47	
48	
49	
△2 50	General, Overall Plant

1.0 SCOPE

△2 Bechtel and Subcontractors shall develop preliminary plot plans in accordance with these instructions. The preliminary plot plans shall be drawn to scale and provided with outline dimensions in Phase Zero.

2.0 SPECIFICATIONS

Minimum requirements are defined in the following specifications:

14222-L-4 - Piping Design and Layout
14222-L-9 - Equipment Layouts

These specifications are to be issued separately.

3.0 STANDARD DRAWINGS

Minimum requirements are also defined in the following Standard Drawings which are attached:

A-521 - Minimum Spacing Requirements of Equipment in Process and Off-Plot Tankage Areas.
A-522 - Cross Section Typical Process Unit

4.0 REFERENCE DOCUMENTS

Reference documents listed in the above Specifications and Standard Drawings will be issued in Phase 1 of the Breckinridge Project.

FORM H-292 7-66

△					
△2	[illegible]	REVISED PAR. 1.0	[illegible]		4/82
△1	3/19/30	ISSUED FOR PHASE ZERO			
△0	2/13/30	ISSUED FOR APPROVAL			

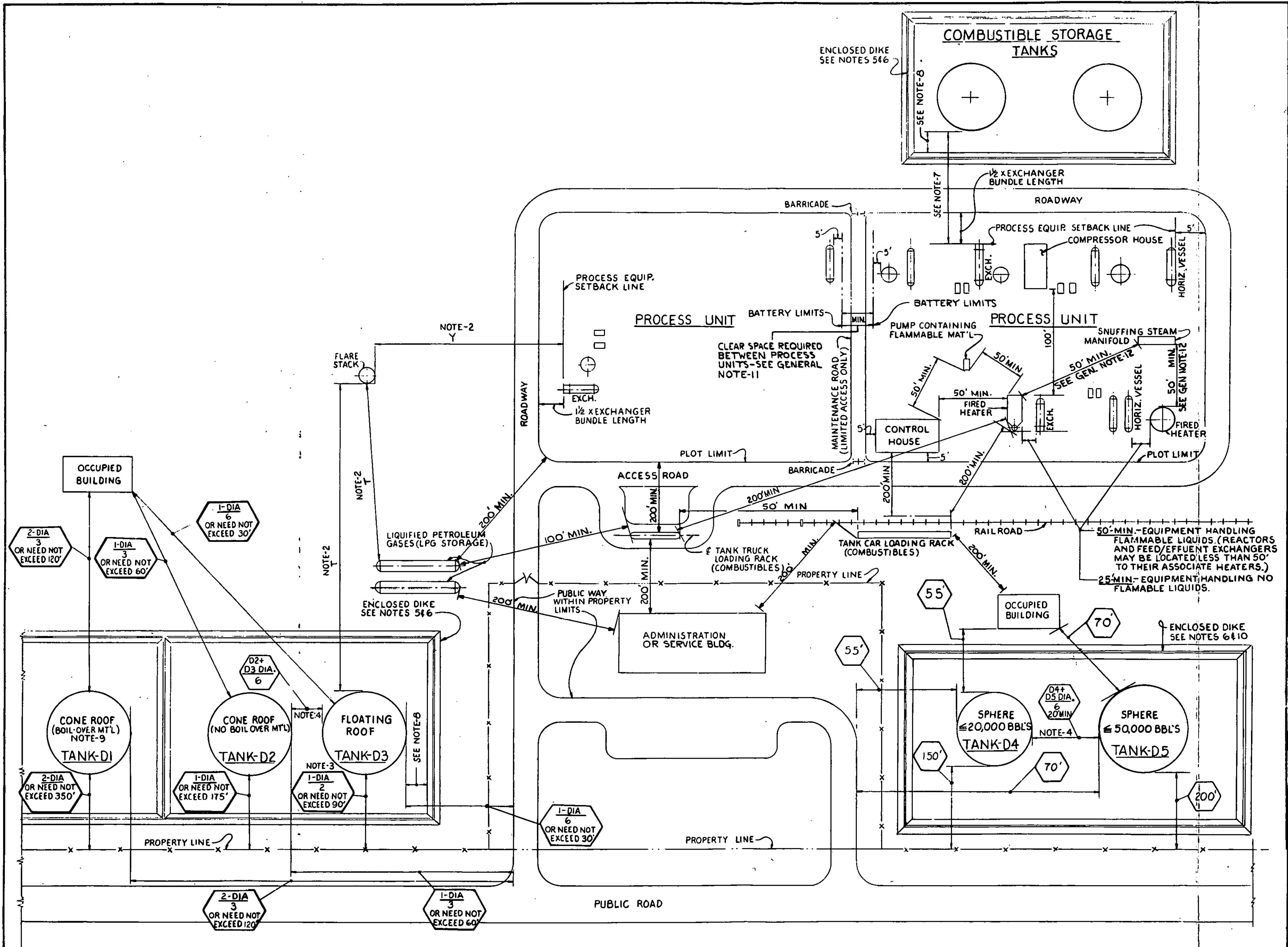
ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
PLOT PLANS

JOB NO. 14222

SPECIFICATION	REV
14222-A-7	2

SHEET 1 OF 3

SIZE D



See 14222-A-10 for title block to be used for the Breckinridge Project.

GENERAL NOTES

1. ALL DIMENSIONS SHOWN THUS ⬡ INDICATE MINIMUM PRESCRIBED BY (OSHA) OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION 5/70 SECTION 1910.106 FLAMMABLE AND COMBUSTIBLE LIQUIDS.
2. ALL OTHER DIMENSIONS REPRESENT BECHTEL RECOMMENDED SPACING AND DIMENSIONS EXTRACTED FROM THE (OIA) OIL INSURANCE ASSOCIATION CHARTS.

Y = DISTANCE PER HEAT RELEASE CALCULATIONS

T = HEIGHT OF FLARE STACK OR Y DISTANCE, WHICHEVER IS GREATER

3. TANK SPACING TO PROPERTY LINES, PUBLIC WAYS AND BUILDINGS SHOWN MEAN ONE-HALF THE DIAMETER OR 90', WHICHEVER IS LESS. $\frac{1\text{-DIA}}{2}$ – TANK DIA. DIVIDED BY 2
4. SPACING BETWEEN ADJACENT TANKS CANNOT BE LESS THAN ONE-HALF THE DIAMETER OF SMALLER TANK IF SMALL ONE IS LESS THAN HALF THE DIAMETER OF LARGER.
5. THE VOLUMETRIC CAPACITY OF A DIKED AREA SHALL NOT BE LESS THAN THE GREATEST AMOUNT OF LIQUID THAT CAN BE RELEASED FROM THE LARGEST TANK WITHIN AN AREA PLUS DISPLACEMENT OF ALL OTHER TANKS WITHIN THE SAME COMPOUND.
6. THE WALLS OF A DIKED AREA SHALL BE LIMITED TO AN AVERAGE HEIGHT OF 6 FT. ABOVE INTERIOR GRADE. A VARIANCE TO ABOVE RULE CAN BE APPLIED FOR THRU "OSHA" PROGRAM DIRECTIVE NO. 100-11.
7. A) COMBUSTIBLE STORAGE TANKS WITH OVER 10,000 BBL's. CAPACITY – LOCATE 250 FEET FROM NEAREST EQUIPMENT.
   B) COMBUSTIBLE STORAGE TANKS WITH LESS THAN 10,000 BBL's. CAPACITY – LOCATE 150 FEET FROM NEAREST EQUIPMENT.
8. THE MINIMUM DISTANCE BETWEEN TANKS AND TOE OF INTERIOR DIKE WALLS AS REQUIRED BY (NFPA) NATIONAL FIRE PROTECTION ASSOCIATION IS 5 FEET; HOWEVER, BECHTEL PRACTICE IS TO USE 10 FEET, WHICH ALLOWS BETTER ACCESS FOR TANK CONSTRUCTION.
9. BOIL-OVER MEANS THE EXPULSION OF CRUDE OIL (OR CERTAIN LIQUIDS) FROM A BURNING TANK.
10. SPHERES MAY BE LOCATED WITHIN THE SAME DIKE ENCLOSURE PROVIDING THEY CONTAIN SAME COMMODITY. CAPACITY SHALL BE 50% OF VESSEL CONTENTS FOR HYDROCARBONS WITH RVP (REID VAPOR PRESSURE) OF 100 PSI OR LESS AND 25% OF VESSEL CONTENTS FOR HYDROCARBONS WITH RVP MORE THAN 100 PSI.
11. THE MINIMUM CLEAR AND OPEN SPACE REQUIRED BY THE OIA BETWEEN BATTERY LIMITS OF ADJOINING PROCESS UNITS ARE AS FOLLOWS:
    a) REFINERIES – 50 TO 100 FT.
    b) PETROCHEMICAL PLANTS –
       1) HIGH HAZARD TO HIGH HAZARD = 200 FT.
       2) HIGH HAZARD TO LOW HAZARD = 100 FT.
       3) LOW HAZARD TO LOW HAZARD = 50 FT.
    c) HYDROREFINING UNITS = 100 FT.
12. USE 75FT. MIN. DISTANCE BETWEEN FIRED HEATERS (IN HYDROGEN SERVICE) & SNUFFING STEAM MANIFOLDS.
13. FIRED HEATERS – IN ADDITION TO ADEQUATE SPACING FROM OTHER EQUIPMENT, HEATERS SHOULD BE LOCATED UPWIND (WITH RESPECT TO PREVAILING WINDS) OF PROCESS EQUIPMENT TO MINIMIZE THE POSSIBILITY OF POTENTIAL VAPOR CLOUDS BEING IGNITED BY THE HEATER.

FOR ADDITIONAL INFORMATION AND REFERENCES REGARDING PIPING AND EQUIPMENT LAYOUT, SEE ENGINEERING STD. SPECIFICATIONS L-502, L-511 AND STANDARD DRAWING A-522.

No.	DATE	REVISIONS	BY	CH'K	DESIGN SUPV.	ENG'R	PROJ. ENGR.	APPR.
△								
2	9/75	Added general notes 11, 12 & 13. Added additional min. spacing requirements for tank truck and car loading racks. Deleted "X" Dimension reference in note-2	M.S.	H.G.				
1	1/74	REVISED & REDRAWN						
0	6/72	ISSUED AS STANDARD	Jw	WHS				

SCALE NONE | DESIGNED | DRAWN L.S. | CHIEF ENGR.

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

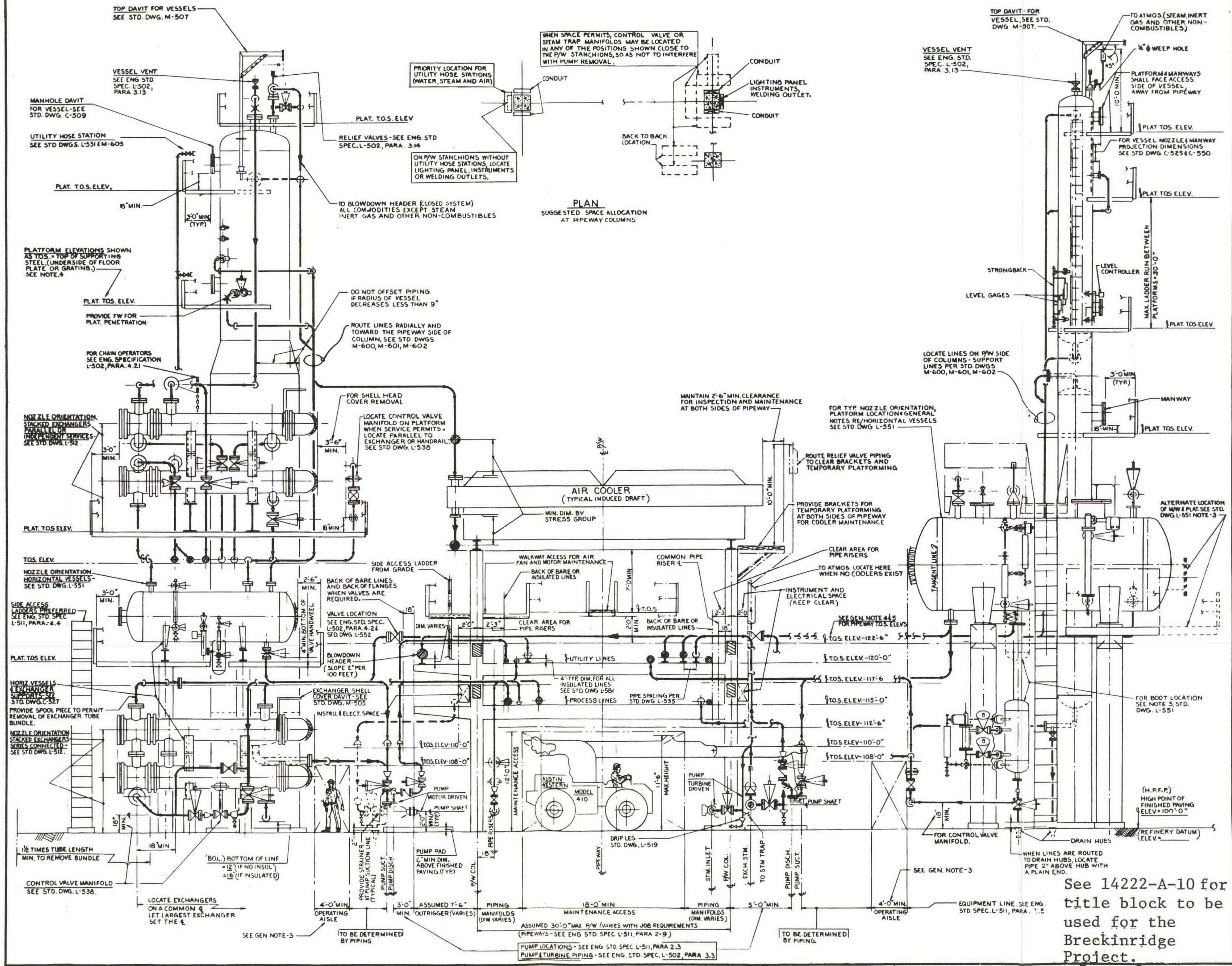
MINIMUM SPACING REQUIREMENTS
OF EQUIPMENT IN PROCESS AND
OFF-PLOT TANKAGE AREAS

JOB No. STANDARD | DRAWING No. A-521 | REV. 2

SIZE E

GENERAL NOTES

1. THE PURPOSE OF THIS PLANNING DRAWING IS TO:
   1.1 PROVIDE GUIDANCE FOR JOB PLANNING.
   1.2 PROVIDE SOME MINIMUM REQUIREMENTS FOR CLEARANCES AND ACCESS FOR PIPING AND EQUIPMENT LAYOUT AS PRESCRIBED BY:
      a) (OSHA) OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPT. OF LABOR-FEDERAL REGISTER.
      b) (OIA) OIL INSURANCE ASSOCIATION.
      c) GOOD LAYOUT PRACTICE RECOMMENDED BY THE FOLLOWING ENGINEERING STD. SPECIFICATIONS:
         - L-502, PLANT DESIGN, PIPING LAYOUT.
         - L-511, PLANT DESIGN, EQUIPMENT LAYOUT.
2. THIS DRAWING ILLUSTRATES PIPEWAY LAYOUT REQUIREMENTS FOR:
   - PIPEWAYS <u>WITH OUTRIGGERS.</u>
   - PIPEWAYS <u>WITHOUT OUTRIGGERS.</u>
3. OPERATING AISLES BETWEEN PUMPS AND EQUIPMENT NEED NOT BE IN A CONTINUOUS LINE. WHERE NECESSARY, OFFSET AISLES MAY BE USED PROVIDING THE 4-0 MIN. WIDTH IS MAINTAINED.
4. a) STRUCTURES INCLUDING PIPEWAYS
   T.O.S. - TOP OF STEEL OR TOP OF CONCRETE ELEVATION
   b) PLATFORM ELEVATION
   T.O.S. - TOP OF SUPPORTING STEEL
   (UNDERSIDE OF FLOOR PLATE OR GRATING)
5. PIPEWAYS T.O.S. ELEVATIONS ARE BASED ON MINIMUM 2' 6" INCREMENTS AND MUST BE REVIEWED FOR PIPE SIZE REQUIREMENTS ON EACH PROJECT.



See 14222-A-10 for title block to be used for the Breckinridge Project.

REFERENCE DRAWINGS

MIN. SPACE REQUIRE. OF EQUIP. IN PROCESS & OFF-PLOT AREAS	A-521
MANHOLE DAVITS FOR VESSELS	C-509
NOZZLE & MANWAYS FOR PRESSURE VESSELS	C-525
SUPPORTS FOR HORIZ. VESSELS & EXCHANGERS	C-527
NOZ. SIZE & LOCATION LIMITATIONS FOR PRESS VESSELS	C-550
STANDARD SPECIFICATION FOR STRUCTURES	M-502
HEAD HANDLING DAVIT FOR EXCHANGERS	M-505
TOP DAVIT FOR PROCESS VESSELS	M-507
SUPPORTS FOR RADIALLY LOCATED LINES AT COLUMNS	M-600
SUPPORTS FOR TANGENT. LOCATED LINES AT COLUMNS	M-601
GUIDES FOR LINES AT COLUMNS	M-602
SUPPORTS FOR UTILITY LINES, (HOSE STA.) AT COLUMNS	M-603
EXCHANGER DIMENSIONS	L-512
UTILITY HOSE STATIONS	L-531
PIPE SPACING FOR LINES WITH OR WITHOUT FLANGES	L-535
CONTROL VALVE MANIFOLDS	L-538
TYPICAL ORIENTATION FOR HORIZ. VESSELS	L-551
DESIGN GUIDE FOR VALVE INSTALLATIONS	L-552
SHOE HEIGHT FOR HOT INSULATED LINES	L-581

FOR ADDITIONAL INFORMATION AND REFERENCES REGARDING PIPING AND EQUIPMENT LAYOUT, SEE ENGINEERING STD. SPECIFICATIONS L-502 AND L-511.

△								
△								
△								
4	1/74	REVISED & REDRAWN	GF LS	H.G.				
3	6/6/63	GENERAL REVISION	GF					
NO.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV	ENGR	PROJ ENGR	APPD

SCALE NONE
DESIGNED HAG, GF
DRAWN STUMPS
CHIEF ENGR

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

CROSS SECTION
TYPICAL PROCESS UNIT

JOB No. STD
DRAWING No. A-522
REV. 4

34 x 44 "E" SIZE

ENGINEERING CHANGE ORDER PROCEDURE

1.0 SCOPE

This document establishes the procedure for processing an Engineering Change Order (ECO) for the Breckinridge Project.

An ECO is a document signed by the Client approving a change in the scope of work as defined in the Contract or Scope Definition documents.

Changes are not to be made until approved inaccordance with the terms of the agreement, Contract No.BC-01, by the ASFI Contracts Manager and the Bechtel Project Manager.

2.0 SUMMARY OF PROCEDURE

The procedure consists of six steps. These steps are clarified in the following sections of this procedure.

- Initiate Request.
- Define Scope.
- Approval by Client to proceed with Estimate.
- Estimate Cost Change and effect on Schedule.
- Approvals.
- Distribution of Documents.

3.0 STEP 1: INITIATE REQUEST

3.1 Any form or letter may be used as long as it is properly signed by the Contracts Manager or Project Manager of the originating entity.

3.2 Requests for changes originating with any of the Client's organization will be transmitted through the Client's Project Manager in Houston.

3.3 Requests for changes originating with any other organization shall be transmitted through the Bechtel Project Manager in Houston. This shall include all subcontractors.

3.4 The impact of the proposed change shall be stated in the original document to the degree that it is known.

2	3/81	CORPORATE NAME CHANGE, SH. 5, 11, 12, 13, 14			
1	[illegible]	ISSUED FOR PHASE ZERO			
0	3/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATION
ENGINEERING CHANGE ORDER PROCEDURE

JOB NO. 14222
SPECIFICATION 14222-A-6
REV 2

4.0 STEP 2: DEFINE SCOPE

4.1 Originating documents will be assembled by the Bechtel (Houston) Project Engineering Manager who will be responsible for the subsequent development of the ECO.

4.2 An ECO number will be assigned and entered in the Change Order Control for H-263 which is attached to this specification (14222-A-8 Sheet 4 of 14).

4.3 The Change Order Control Log will be maintained by the Project Engineering Manager. Each step of the procedure will be logged as shown on the form.

4.4 The log will be issued monthly.

4.5 The first two sections of the Breckinridge Project - Engineering Change Order Form which is attached to this specification (14222-A-8 Sheet 5 of 14), will be completed and signed by the Project Engineering Manager.

The first section is labelled, "A. Proposed Change."

The second section is labelled, "B. Effect On." Order of magnitude approximation shall be given here prior to thorough evaluation. This will minimize lost time if the the ASFI Contracts Manager decides not to proceed further.

5.0 STEP 3: APPROVAL BY THE CLIENT TO ESTIMATE

The ASFI Contracts Manager will then sign the same Engineering Change Order form as shown under the heading, "C. Authorization." Approval of any or all further estimating will be made at this time.

5.2 If approval is given, the Project Engineering Manager will then release the Estimating Department, the disciplines, and others, to make more precise evaluations of costs and scheduling impacts.

Further input may also be required from the subcontractors if the impact on them is not completely stated in the initiating documents.

6.0 STEP 4: ESTIMATE COST AND EFFECT ON SCHEDULE

6.1 Two estimates of home office manhours will be made:

- Manhours required to do the estimate.
- Manhours required to change the design. Form H-439 titled, "Technical Manhour Estimate" (14222-A-8 Sheet 6 of 14). will be used.

6.2 Other forms to be used by Engineering are:

- Form H-438 "Scope Check List" (14222-A-8 Sheet 7 of 14).
- Form H-440 "Current Technical Manhour Budget Adjusted for ECOs" (14222-A-8 Sheet 8 of 14). To be completed after approval by Client.
- ECO Document Index (14222-A-8 Sheet 9 of 14).

6.3 Estimating will receive the documents listed in Paragraph 6.1 and 6.2 from Engineering and prepare the Estimate using the forms listed below.

- General Estimating Work Sheet (14222-A-8 Sheet 10 of 14).
- ECO Backup Sheet (14222-A-8 Sheet 11 of 14).
- Cost Summary (14222-A-8 Sheet 12 of 14.
- Form HouEst E-1. Interoffice Memorandum (14222-A-8 Sheet 13 of 14).

7.0 STEP 5: APPROVALS

7.1 The Engineering Change Order Form (see paragraph 4.5) Section "D. Contract Price, Completion Schedule" will be completed from the data transmitted by Estimating to the Project Engineering Manager.

7.2 The ECO Form shall be reviewed and signed by the Bechtel Project Manager. The ASFI Contracts Manager will then sign the ECO Form.

7.3 Instructions in writing will then be made authorizing the changes to be made.

8.0 DISTRIBUTION

8.1 Distribution of instructions to proceed will be made in accordance with the Distribution of Documents matrix under the headings, "Project Controls - Change Orders."

8.2 The Bechtel Legal Department will be informed by Contract Change Order Form (14222-A-8 Sheet 14 of 14). The Project Engineering Manager shall assure that the transmittal is made. If the ECO Form is signed by the Client and Bechtel in accordance with Paragraph 7.2, the transmittal to the Bechtel Legal Department need not be signed.

CHANGE ORDER CONTROL

PROJECT ______________________

JOB NO ________

DATE ISSUED ________

PAGE _____ OF _____

NO.	DESCRIPTION	PLANT NO.	ORIGINATED		DATE TO ESTIM	DATE FROM ESTIM.	ESTIMATE TO CLIENT		CLIENT'S APPROVAL REC'D		ESTIMATE		ENG. COST		REMARKS AND DATE
			REF.	DATE			REF.	DATE	REF.	DATE	INCR.	DECR.			

FORM H-202 8/66

ISSUE DATE ____________________

THE BRECKINRIDGE PROJECT
ENGINEERING CHANGE ORDER
BECHTEL PETROLEUM, INC.

A. PROPOSED CHANGE

JOB NO. ________ PLANT NO. ________ ECO NO. ________ REV. NO. ________

TITLE ______________________________ REFERENCE OR AUTHORITY ________________

DESCRIPTION:

B. EFFECT ON:

Scheduled Job Completion ________

Engineering Costs ________

Field Costs ________

BECHTEL TO TAKE ACTION INDICATED:

Prepare Engineering Estimate Data for Estimating by ____________________________, 19___.

Prepare Cost Estimate by ________________, 19__.

____
Bechtel Project Engineer

C. AUTHORIZATION:

	Yes	No	CLIENT
Proceed with Engineering Estimate and Data for Estimating			Signed ____________________
Proceed with Engineering and Procurement			Signed ____________________
Proceed with Construction			Signed ____________________

D. CONTRACT PRICE:

Increase (Decrease) $ __________

COMPLETION SCHEDULE:

Previous Date ____________________

New Date ____________________

Increase (Decrease) in Time ______________ days

E. The completion date and Contract Price of the above-referenced Contract are hereby adjusted as shown above and shall not be further adjusted by reason of the above described change. All of the terms, covenants, and conditions of the above-referenced Contract, except as duly modified by this and previous Change Orders, if any, remain in full force and effect.

Accepted by ASFI: J. B. Grant

By ________________________

Title ________________________

Date ________________________

BECHTEL PETROLEUM, INC.: J. R. Bruner

By ________________________

Title ________________________

Date ________________________

JOB NO. ______ PLANT NO. ______

HOUSTON ENGINEERING DEPARTMENT

TECHNICAL MANHOUR ESTIMATE

ECO NO. ______

ACTIVITY CODE	DESCRIPTION	MANHOURS REQUIRED	
		EST. PREP.	TO DO DESIGN
310	Engineering Management		
322	Process Engineering		
331	Project Engineering		
332	Plan. & Sched.		
333	Mech. Engr. Specialists		
341	P&ID		
342/343/344	Piping Design, Model & Mat'ls		
351	Civil		
352	Structural & Fdn.		
353	Architectural		
354	Stress Analysis		
355	Columns & Vessels		
356	Pipe Supports		
360	Instruments		
370	Electrical		
380	Unassigned		
392	Mat'l Requisition & Control		
	TOTALS		

Approved: Date:

Project Engineer ______

Project Sponsor ______

Form H-439 1/9/67

JOB NO._____ PLANT NO._____

HOUSTON ENGINEERING DEPARTMENT

SCOPE CHECK LIST

ECO NO. _____

MAJOR EQUIPMENT	"C"	"D"	"E"	"F"	"G"	"H"	"K"	"T"	"V"
Added Equipment	☐	☐	☐	☐	☐	☐	☐	☐	☐
Deleted Equipment	☐	☐	☐	☐	☐	☐	☐	☐	☐
Size	☐	☐	☐	☐	☐	☐	☐	☐	☐
Materials	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wall Thickness	☐	☐	☐	☐				☐	☐
Stress Relief	☐	☐	☐	☐				☐	☐
X-Ray	☐	☐	☐	☐				☐	☐
Nozzles	☐	☐	☐	☐	☐	☐	☐	☐	☐
Internals	☐	☐	☐	☐	☐		☐	☐	☐
Equipment Supports	☐	☐	☐						
Driver Size			☐		☐		☐	☐	☐
Driver Type			☐		☐		☐	☐	☐
Auxiliaries		☐	☐	☐	☐	☐	☐	☐	☐
Shipping Method	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mode of Field Erection	☐	☐	☐	☐	☐	☐	☐	☐	☐

OTHER DIRECT MATERIAL & SUBCONTRACTS

J Instruments ☐
L Piping ☐
M Structures ☐
N Insulation ☐
N Fireproofing ☐
P Electrical ☐
Q Fdn./Piling ☐
R Buildings ☐
S Site Improvements ☐
U Catalyst & Chemicals ☐
X Painting ☐

GENERAL

Plot Plan Revise ☐
Schedule Increase ☐ Decrease ☐

REMARKS

____
____
____
____
____
____

Approved: Date

____________________ ____________
Project Engineer

Form #H-438

Form # H-440

Approved by Client

700

Manhours

JOB NO. ________ PLANT NO. ________

HOUSTON ENGINEERING DEPARTMENT

Issue No. ________
Date ________
Sheet ____ of ____

CURRENT TECHNICAL MANHOUR BUDGET ADJUSTED FOR ECO's

* Current Budget = Original Budget + Approved

Act. Code		310	322	331	332	333	341	342/3	351	352	353	354	355	356	360	370	380	392	TOT/
ECO	Rev	ENGR. MNGMT	PROCESS	PROJECT	P&I'S	MECH. SPEC.	P&ID	PIPE DES. & MODELS	CIVIL	STRUCT. & FDN.	ARCH.	STRESS ANAL.	COLUMN & VESSEL	PIPE SUPPT.	INSTR.	ELEC.		M/R & SPECS.	
MH (Pend)																			
MH (Appvd)																			
Orig.Budget																			

ECO DOCUMENT INDEX

Job No. _____ Plant No. _____

ECO No. _____ From ____________________

Reference or Authority ____________________

Bechtel Group Letter __________

Item	DESCRIPTION	Attachment Identification
1	Change Line No. _____ from 4 to 6"	Dwg # Spec # Equip # MR #

ORIGINALLY FROM UNIT PROJ. ENGRS. AND DESIGN GROUPS TO PROJ. ENGR.

PROJ. ENGR TRANSFERS INDEX WITH ATTACHMENTS TO PACKAGE SENT TO ESTIMATING

Specification No. 14222-A-8 Rev. 2

Sheet 10 of 14

BECHTEL RCE-10A
2/72

JOB NO. & TITLE ______________________

CLIENT ______________________

JOB LOCATION ______________________

TAKEOFF ____________

PRICED ____________

CHECKED ____________

APPROVED ____________

DATE ____________

SHEET ____ OF ____

GENERAL ESTIMATING WORKSHEET

ITEM & DESCRIPTION	QTY.	UNIT	UNIT COST		MANHOURS			TOTAL COST			
			MAT'L	S/C	UNIT	TOTAL	$/MH	MATERIAL	LABOR	SUBCONTRACT	TOTAL

SHEET NO.

ACCOUNT ____________

BECHTEL PETROLEUM, INC.

SHEET _____ OF ____

JOB NO ____________________

BY. ____________________

DATE ____________________

ECO BACKUP SHEET

BY: ____________
CHECKED: ____________
APPROVED: ____________
DATE: ____________

ECO# ____________

FIELD DIRECTS | FIELD DISTRIB. | HOME OFFICE

DIRECT MAT'L
SALES TAX 3% of D.M.
SUBTOTAL
FRT. 2%

"A" MATERIAL COST!
MAT'L O.H. (3% of Mat'l)

"B" SUBCONTRACT COSTS
SUBCONTRACT O.H. 5%

"C" MANUAL FIELD LABOR
DIR. LABOR M.H.
DIST. LABOR M.H.
MANUAL LABOR
P/R ADDS @ 20% of M.L.

× 8%

TOTAL MANUAL FLD. LABOR
OTHER DIST. @ 30% "C" NOTE #1

×60%
×40%

"D" CONSTRUCTION EQUIP.

TOTAL CONST. EQUIP.

"E" ENG. & EST.

	Prep Est.	Exc.	TOTAL
ENG. MH			
EST. MH			
SUBTOTAL			
BURDEN - 75% x LABOR			
ENG'R & EST. MAT'L			

LABOR

MAT'L

TOTAL ENG'G & EST.

"F" SUPERVISORY TRAVEL & SUBSISTENCE

TOTALS

S U M M A R Y

	M/H	MAT'L	LABOR	S/C	TOTAL
PLANT #2 Reimb. - TARGET PRICE					
SUBTOTAL					
TOTAL DIRECTS W/TAX & FRT.					
FIELD DISTRIBUTABLES					
TOTAL FIELD COSTS					
HOME OFFICE COSTS					
SUBTOTAL					
FEE @ 3.02%					
LESS REIMBURSABLE COSTS					
NET CHANGE IN T/P & FEE					
LESS FEE					
NET CHANGE IN T/P					

NOTE #1 - INCLUDES SMALL TOOLS-SUPPLIES SUPERVISION - FIELD OFFICE STAFF. AND USE OF TEMPORARY FACILITIES 60% WAGES - 40% MAT'L

BECHTEL PETROLEUM, INC.

CONTRACT CHANGE ORDER NO.

PROJECT: BECHTEL JOB NO.

Plant No. ____

Sheet ____ of ____

COST SUMMARY

Cost Items	Reimbursable Costs	Contract Target Price	Total Costs
DIRECT FIELD COSTS			
A. Material Costs	$	$	$
3% of A Total			
B. Subcontract Costs			
5% of B Total			
C. Manual Field Labor (includes P/R additives)			
30% of C Total			
D. Construction Equipment			
HOME OFFICE			
E. Home Office Engineering Costs			
F. Travel and Subsistance Costs			
TOTALS excluding Fee	$		
FEE			
G. Fixed Fee at 3.82%			
TOTAL PROJECT COSTS:			$

The cost of Engineering for preparing this Change Order, which is included above in "E" is $________.

COST DISTRIBUTION BY PLANTS

	Plant 1	Plant 2	Plant 3
Reimbursable Costs	$	$	$
Contract Target Price			
Fee			
TOTAL	$	$	$

Bechtel Petroleum, Inc.

Interoffice Memorandum

To

Date

Subject Job

From

Of Estimating

Copies to

At Houston Ext.

Change Order No. ________

Description of Change Order: ______________________________

A copy of the cost summary of subject change order is transmitted herewith. In addition, we are attaching a copy of the ECO backup sheet and a copy of the detailed estimate.

FORM HOU EST E-1

Specification No. 14222-A-8 Rev. 2 Sheet 13 of 14

BECHTEL PETROLEUM, INC.

CONTRACT CHANGE ORDER NO.

Project: ______________________ Contract No.: __________

Subject of Change: ______________________

Job No. __________ Spec. No. __________ Sheet ______ of ______

The above-referenced Contract is hereby amended to incorporate the following change:

Description of change:

Basis of Compensation:

(Increase)
(Decrease) in Contract Price $ ______________

(Increase)
(Decrease) in time for completion: __________ days

Previous completion date: __________ New completion date: __________

The completion date and Contract Price of the above-referenced Contract are hereby adjusted as shown above and shall not be further adjusted by reason of the above-described change. All of the terms, convenants and conditions of the above-referenced Contract, except as duly modified by this and previous Change Orders, if any, remain in full force and effect.

Accepted by:

______________________	BECHTEL PETROLEUM, INC.
By ______________________	By ______________________
Title ______________________	Title ______________________
Date ______________________	Date ______________________

PHASE ZERO - PROJECT FILE INDEX

1.0 CONTRACTUAL

1.1 Prime Contract
1.2 Prime Contract Correspondence
1.3 Engineering Subcontracts & License Agreements
1.4 Engineering Subcontracts & License Agreements Correspondence
1.5 Secrecy Agreements
1.6 Entity Agreements and Interdivision Agreements
1.7 Consultant Agreements
1.8 Accounting Releases
1.9 Unit Completion Notices

2.0 INSTRUCTIONS & PROCEDURES

2.1 Project Procedures
2.2 Job Instructions
2.3 Basic Design Data
2.4 Design Information & Criteria
2.5 Approval Authority

3.0 FISCAL MATTERS

3.1 Code of Accounts
3.2 Budgets
3.3 Financial Forecasts (Folder for each Forecast)
3.4 Preliminary Estimates (Trend Base)
3.5 Cost Trend Reports
3.6 Trend Notices
3.7 Definitive Estimate
3.8 Cost Study Index (Folder for each Study)
3.9 Engineering Design Adjustments (EDA's)
3.10 Engineering Change Order Control (ECO's)

FORM H-292 7-66

12/9/80	ISSUED FOR GENERAL REVISION	HS	SRB	
10/7 80	ISSUED FOR GENERAL REVISION	HS	SRB	
9/02/80	ISSUED FOR PHASE ZERO	HS	SRB	
2/22/80	ISSUED FOR REFERENCE			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
PHASE ZERO - PROJECT FILE INDEX

JOB NO. 14222

SPECIFICATION	REV
14222-A-9	3

SHEET 1 OF 11

3.11	Engineering Change Orders (Folder for each ECO with backup)
3.12	Field Change Orders
3.13.A	Computer Billings Support (Bechtel - 13141-001)
3.13.B	Computer Billings Support (Bechtel - 13141-002)
3.13.C	Computer Billings Support (Bechtel - 14222-000)
3.13.D	Computer Billings Support (Bechtel - 14222-100)
3.13.E	Computer Billings Support (UOP)
3.13.F	Computer Billings Support (AIRCO)
3.13.G	Computer Billings Support (Texaco)
3.13.H	Computer Billings Support (Davy-McKee)
3.13.I	Computer Billings Support (Roberts & Schaefer)
3.13.J	Computer Billings Support (Others)
3.14	Material & S/C Cost & Commitment Report
3.15	Overtime Authorizations

4.0 MANPOWER

4.1	Organization Charts
4.2	Weekly Labor Distribution
4.3	Project Manhour Summary
4.4	Engineering Manhour Forecast
4.5	Engineering Manhour Budget by Plant & Group
4.6	Personnel Assignment Dates
4.7	Travel authorization & Itineraries
4.8	Vacation & Leave Schedules
4.9	Reimbursable Manhour
4.10	Resumes
4.11	Office Space

5.0 SCHEDULES & CONTROLS

5.1 Objective Schedule
5.2 Master Project Schedule (Milestone)
5.3 Engineering Summary Schedules
5.4 90-Day Schedules
5.5 Construction Summary Schedule
5.6 Major Equipment Summary Schedule
5.7 Drawing Control
5.8 Drawing Control Supplement
5.9 Material Requisition Index
5.10 Field M/R Index
5.11 Specification Index
5.12 Vendor Print Index
5.13 Studies Issued Index
5.14 Technical Services Agreements Register
△3 5.15 Equipment List

6.0 REPORTS

△2 6.1 Weekly Progress Reports - H.O.
6.1.1 Weekly Progress Meetings - H.O.
6.2 Monthly Progress Reports - H.O.
△3 6.2.1 Reliability Report
6.3 Construction Progress Report
6.4 Status of Major Equipment (Buck Sheet)
6.5 Procurement Status Report (Heckle Sheet)
6.6 Subcontract Status Report (Heckle Sheet)
6.7 Departmental Reports
6.8 Exception Reports
6.9 Model Reports
6.10 Staff Meeting Reports
6.11 Site Visits and Trip Reports
6.12 Soil Survey Reports
6.13 Consultant Reports
6.14 Bidders List
6.15 Current Lead Time Reports
6.16 Surplus Material Reports
6.17 Need Lists
6.18 Want Lists
6.19 Weekly Review
△2 6.20 Weekly Schedule Report

	6.20.1	Draft Narratives Report #1
△3	6.20.2	" " " #2
△3	6.20.3	" " " #3
△3	6.20.4	" " " #4
△3	6.20.5	" " " #5
△3	6.20.6	" " " #6
△3	6.20.7	" " " #7
△3	6.20.8	" " " #8
△3	6.20.9	" " " #9
	6.20.10	" " " #10
	6.20.11	" " " #11
	6.20.12	" " " #12

7.0 CONFERENCE NOTES

	7.1	Bechtel-ASFI (CN-BA)
	7.2	ASFI with DOE (ASFI-DOE)
	7.3	With HRI
	7.4	With UOP
	7.5	With Airco
	7.6	With Texaco
	7.7	With Davy McKee
	7.8	With Roberts & Schaefer
△2	7.9	Other Licensors & Subcontractors
	7.9.1	Division Management
	7.9.2	Project Management
	7.9.3	Business Development
	7.9.4	H.O. Construction
	7.9.5	Purchasing & Expediting
	7.9.6	Engineering
	7.9.7	Inspection
	7.9.8	Traffic
	7.9.9	Legal
	7.9.10	Financing & Accounting
	7.9.11	Cost Engineering
	7.9.12	Planning & Scheduling
	7.9.13	Process
	7.9.14	M&Q's
	7.9.15	Pipeline
	7.9.16	M&M
	7.9.17	H.O. Startup
	7.9.18	Environmental
	7.9.19	Miscellaneous

8.0 CORRESPONDENCE

8.1 Letters to Client (BA)
8.2.A letters from Client (AB) Ashland
8.2.B Letters from Client (AB) San Francisco (Essentially Closed)
8.2.C Letters from Client (AB) Houston
8.3 Telegrams to Client (XBA)
8.4 Telegrams from Client (XAB)
△3 8.5 Transmittals to ASFI (TBA)
△3 8.6 Transmittals from ASFI (TAB)
△3 8.7 Letters ASFI to DOE
△3 8.8 Letters DOE to ASFI
△3 8.9 Letters Bechtel to DOE

9.0 CORRESPONDENCE WITH HRI

9.1 Letters to HRI (BH)
9.2 Letters from HRI (HB)
9.3 Telegrams to HRI (XBH)
9.4 Telegrams from HRI (XHB)
9.5 Transmittals to HRI (TBH)
9.6 Transmittals from HRI (THB)
9.7 ASFI/HRI Correspondence
9.8 ASFI/HRI Conference Notes
△2 9.9 Delete

10.0 CORRESPONDENCE WITH UOP

10.1 Letters to UOP (BU)
10.2 Letters from UOP (UB)
10.3 Telegrams to UOP XBU)
10.4 Telegrams from UOP (XUB)
10.5 Transmittals to UOP (TBU)
10.6 Transmittals from UOP (TUB)
10.7 ASFI/UOP Correspondence
10.8 ASFI/UOP fference Notes
△2 10.9 Delete

11.0 CORRESPONDENCE WITH AIRCO

11.1 Letters to Airco (BR)
11.2 Letters from Airco (RB)
11.3 Telegrams to Airco (XBR)
11.4 Telegrams from Airco (XRB)
11.5 Transmittals to Airco (TBR)
11.6 Transmittals from Airco (TRB)
11.7 ASFI/Airco Correspondence
11.8 ASFI/Airco Conference Notes
△2 11.9 Delete

12.0 CORRESPONDENCE WITH TEXACO

12.1 Letters to Texaco (BT)
12.2 Letters from Texaco (TB)
12.3 Telegrams to Texaco (XBT)
12.4 Telegrams from Texaco (XTB)
12.5 Transmittals to Texaco (TBT)
12.6 Transmittals from Texaco (TTB)
12.7 ASFI/Texaco Correspondence
12.8 ASFI/Texaco Conference Notes
△2 12.9 Delete

13.0 CORRESPONDENCE WITH DAVY-McKEE

13.1 Letters to Davy-McKee (BD)
13.2 Letters from Davy-McKee (DB)
13.3 Telegrams to Davy-McKee (XBD)
13.4 Telegrams from Davy-McKee (XDB)
13.5 Transmittals to Davy-McKee (TBD)
13.6 Transmittals from Davy-McKee (TDB)
13.7 ASFI/Davy-McKee Correspondence
13.8 ASFI/Davy-McKee Conference Notes
△2 13.9 Delete

14.0 CORRESPONDENCE WITH ROBERTS & SCHAEFER

14.1 Letters to Roberts & Schaefer (BS)
14.2 Letters from Roberts & Schaefer(SB)
14.3 Telegrams to Roberts & Schaefer (XBS)
14.4 Telegrams from Roberts & Schaefer (XSB)
14.5 Transmittals to Roberts & Schaefer (TBS)
14.6 Transmittals from Roberts & Schaefer (TSB)
14.7 ASFI/Roberts & Schaefer Correspondence
14.8 ASFI/Roberts & Schaefer Conference Notes
△2 14.9 Delete

15.0 CORRESPONDENCE WITH BECHTEL INTERNAL (IOM's) SF & HOUSTON

15.1 Division Management
15.2 Project Management
15.3 Business Development
15.4 H.O. Construction
15.5 Purchasing
15.6 Expediting
15.7 Inspection
15.8 Traffic
15.9 Legal
15.10 Finance & Accounting
15.11 Cost Engineering
15.12 Planning & Scheduling
15.13 Process
15.14 M&Q's
15.15 Pipeline
15.16 M&M
15.17 H.O. Startup
15.18 Environmental
15.19 Engineering
15.20 Miscellaneous
15.21 Draft Requisitions for Office Supplies and Materials
15.22 Draft Requisitions for Office Furniture
15.23 Budget
15.24 Assignment Sheets for Personnel (Offices)
△2 15.25 LAPD
△2 15.26 EPC Planning
△2 15.27 Coal Technology

16.0 CORRESPONDENCE - MISCELLANEOUS

16.1 Other Bechtel Offices
16.2 Letters to Haldor Topsoe
16.2.1 Letters from Haldor Topsoe
16.3 Pilot Plant
△2 16.4 Coal Supply
16.5 Prospective Suppliers

17.0 REGULATORY ITEMS

17.1 Environmental Report
17.2 Air Pollution Control
17.3 Water Pollution Control
17.4 Licensing
17.5 Building Permits
17.6 Noise Control
17.7 OSHA
17.8 Codes & Standards
17.9 Government Regulations
17.10 Union Label Requirements
17.11 Aircraft Warning
17.12 Engineering Registration

18.0 TECHNICAL SUBJECT FILES - GENERAL

(If Correspondence is specific to a unit, it must be filed with Unit Correspondence 19.0 - Unit Subject Files)

18.A.01 General
18.A.02 Definitions

	18.A.03	Corrosion
	18.A.04	Fire Protection
	18.A.05	Sanitary Systems
	18.A.06	Steam & Condensate
	18.A.07	Cooling Water System
	18.A.08	Other Utilities
	18.A.09	Utility Guarantees
	18.A.10	Material Selection
	18.A.11	Meteorology
	18.A.12	Design Calculations Index & File
	18.A.13	Surplus Material
	18.A.14	Spare Parts
	18.A.15	Tie-Ins & Battery Limits Data
	18.A.16	Startup & Testing
	18.A.17	News Items & Public Relations
	18.A.18	Field Revisions & As-Built Drawings
	18.A.19	Record Book Data
	18.A.20	Operating Manuals
	18.A.21	Metallurgy & Welding
	18.A.22	P&ID Model Review Data
	18.A.23	Construction Photographs
	18.A.24	Soils Investigations & Tests, Site Flooding
	18.A.25	Plant Turnover, Acceptance & Completion Records (Field to ASFI)
	18.A.26	Patent & Disclosures
	18.A.27	Heating, Ventilating & Air-Conditioning
	18.A.28	Computer-Aided Drafting
	18.A.29	Coal Data
	18.A.30	Site Plan
	18.B.01*	Process
	18.C.01*	Columns & Pressure Vessels
	18.D.01*	Tanks
	18.E.01*	Exchangers
	18.F.01*	Fired Heaters
	18.G.01*	Pumps & Drivers
	18.H.01*	Vacuum Equipment
	18.I.01*	
	18.J.01*	Instruments
	18.K.01*	Compressors & Drivers
△3	18.L.01*	Piping
△3	18.M.01*	Structures
△3	18.N.01*	Insulation
△3	18.O.01*	
△3	18.P.01*	Electrical
△3	18.Q.01*	Foundations
	18.R.01*	Buildings
	18.S.01*	Site Improvements
	18.T.01*	Material Handling Equipment

	18.U.01*	Expendables
	18.V.01*	Package Units
△3	18.W.01*	Welding & Metal Processing
△3	18.X.01*	Painting
△3	18.Y.01*	Processing Equipment
	18.Z.01*	Water & Waste Treatment

△2 * and up

19.0 PLANT SUBJECT FILES

	19.1	Coal Drying & Pulverizing
	19.2	Coal Slurry Preparation
	19.3	H-Coal Preheating & Reaction
	19.4	H-Coal Primary Separation
	19.5	H-Coal Recycle Slurry Preparation
	19.6	H-Coal Recycle Hydrogen Concentration & Compression
△2	19.7	Delete
	19.7.1	Gas Compression & Rich Oil Stripping
	19.7.2	Acid Gas Scrubbing
	19.7.3	Product Sweeting
	19.7.4	Saturate Gas Plant
△2	19.7.5	Feed Gas Compression
△2	19.7.6	DEA
△2	19.7.7	Feed Dehydration
△2	19.7.8	Liquid Recovery & Product Fractionation
△2	19.7.9	Product Treating
△2	19.7.10	Program Refrigeration
	19.8	Cryogenic Hydrogen Purification
△2	19.9	Delete
	19.9.1	Sour Water Processing
	19.9.2	Ammonia Recovery
△2	19.9.3	Phenol Removal
	19.10	Sulfur Plant
△2	19.11	Open
	19.12	Delete
	19.12.1	Vacum Bottom Gassification (Texaco)
	19.12.2	Shift Conversion
△2	19.12.3	H_2 Selexol Purification
	19.12.4	Fuel Gas Selexol Purification H_2 Compression
△2	19.13	Open
	19.14	Open
	19.15	Oxygen Plant
△2	19.16	Open
	19.17	Distillate Separation
	19.18	Naphtha Treating & Reforming
	19.19	Flare System
	19.20.1	Intermediate Storage
	19.20.2	Product Storage
△2	19.20.3	Delete

	19.21	Interconnecting Piping
	19.22	River Facilities
	19.23	Rail, Truck, Pipeline
2	19.24	Open
	19.25	Open
	19.26	Run of Mine Coal Receiving & Bulk Storage
	19.27	Coal Washing & Secondary Crushing
	19.28	Open
2	19.29	Open
2	19.30	Electrical Distribution
	19.31	Delete
	19.31.1	Steam Generation (Boiler Plant)
	19.31.2	BFW Treating
2	19.32	Delete
	19.32.1	Water Systems, Raw
	19.32.2	Water Systems, Potable
	19.32.3	Water Systems, Cooling Water
	19.33	Fire Systems
	19.34.1	Sewers & Drains
	19.34.2	Waste Water Treatment
	19.34.3	Sanitary Systems
	19.35	Stack Gas Scrubbing
3	19.36	Instrument Air Systems
	19.37	Communication Systems
	19.38	Inert Gas Systems
	19.39	Purge & Flush Oil Systems
	19.40	Open
	19.41	Buildings
2	19.41.1	Delete
2	19.41.2	Delete
2	19.41.3	Delete
2	19.41.4	Delete
2	19.41.5	Delete
	19.42	Solid Waste Treatment
	19.43	Settling Ponds
	19.44	Landfill

DRAWING PREPARATION AND MICROFILMING

1.0 SCOPE

Bechtel and subcontractors shall follow these instructions in the preparation of drawings as called for in their contracts. Inform Bechtel Project Management of any cost and schedule impact.
All drawings on this project will be microfilmed. This specification outlines the drafting materials and techniques which will produce drawings of sufficient quality for microfilming.

2.0 DRAWING PRESENTATION

2.1 Drawing Format

Title block formats and drawing sizes shall be in accordance with the attached samples.

2.2 Lettering

2.2.1 All lettering on drawings shall be upper case.

2.2.2 All lettering shall preferably be vertical to maintain maximum consistency of style and legibility. In any case, straight and slant lettering shall not be mixed on the same drawing.

2.2.3 The following are the minimum heights for upper case lettering to be used on drawings:

△1
- 5/16" for titles which appear within the body of a drawing. These titles are to be underlined.

△1
- 1/4" for title blocks.

△1
- 3/16" for all other lettering. (Other than typed material and cad).

2.2.4 Spacing between lines of characters shall be from 1/2 (one-half) to 1 (one) full character height.

2.2.5 Spacing between words shall usually be equal to the height of each character.

2.3 Line Widths

Lines shall be of uniform weight and density. Where thicker lines are required, as on process flow diagrams to designate main

△		
△	9/23/80	DELETE OWNERSHIP NOTE-SHEET 4
△	3/80	ISSUED FOR PHASE ZERO
△	3/80	ISSUED FOR APPROVAL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
DRAWING PREPARATION AND MICROFILMING

JOB NO. 14222
SPECIFICATION 14222-A-10
REV 2

process flows, the contrast should not be extreme. All lines shall be dark enough to print on a reproduction machine, but not soft enough to smear.

△1 2.4 Graphic Indications for Materials

Shading shall not be used. Material indications and hash markings shall be limited and have an open pattern.

2.5 Typing on Drawings: Minimum size lettering to be equivalent to IBM Selectric Orator.
Maximum use shall be made of typing on drawings. In addition to direct typing, an adhesive back, polyester (mylar) sheet material may be used for extensive notes, bills of materials, data sheets, tables, etc. Repetitive material, after being typed or drawn on any translucent drafting medium, may also be processed on a mylar film and readily adhered to the surface of a drawing.

2.6 Revision Location

The areas of a drawing affected by the latest revision issue shall be circled carefully on the back using a sharp china marking crayon. This does not apply to P&IDs where a revision list shall be issued instead for revisions occuring after the drawing has been issued for construction.

3.0 DRAFTING MATERIALS

3.1 Mylar shall be used as the drafting medium for all permanent drawings on the project unless there is a particularly good reason otherwise.

3.2 Plastic leads are the preferred drafting material since, photographically, they give the same effect as ink.

3.3 Graphite leads shall not be used on mylar. Graphite leads may be used only for sketches drawn on vellum or linen which will not be microfilmed.

3.4 Ink and light pencil shall not be used on the same drawing, since the density difference does not permit a usable microfilm to be made. Every effort shall be made to match densities on a drawing.

3.5 Typing ribbons shall be black and new and shall not be used more than once.

3.6 Small project forms (8-1/2" x 11") may be either vellum or mylar.

4.0 ERASING TECHNIQUES

4.1 Erasers and techniques that erase gently shall be used. Abrasive erasers or strenuous rubbing shall be avoided.

4.2 Although erasability is one of the outstanding features of polyester drafting film, the matte surface can easily be damaged through improper handling. The recommended erasing technique is either wet or dry soft white eraser and/or water and a cotton swab with most plastic film leads. Abrasive erasers such as "pink pearl" shall not be used on mylar film.

4.3 Trichloroethane or similar solvents shall not be used on the matte side of mylar film.

4.4 Electric erasing machines shall not be used on any drawings; they can wear through a drawing very quickly if handled improperly.

5.0 COMPUTER-AIDED DRAFTING

5.1 Computer-aided drafting shall be used wherever practical and economical since the drawings normally produced by this method are ideal for microfilming.

5.2 Since computers produce a new original for each revision, the use of mylar is not necessary except where a very wide distribution is necessary or for the final issue for microfilming.

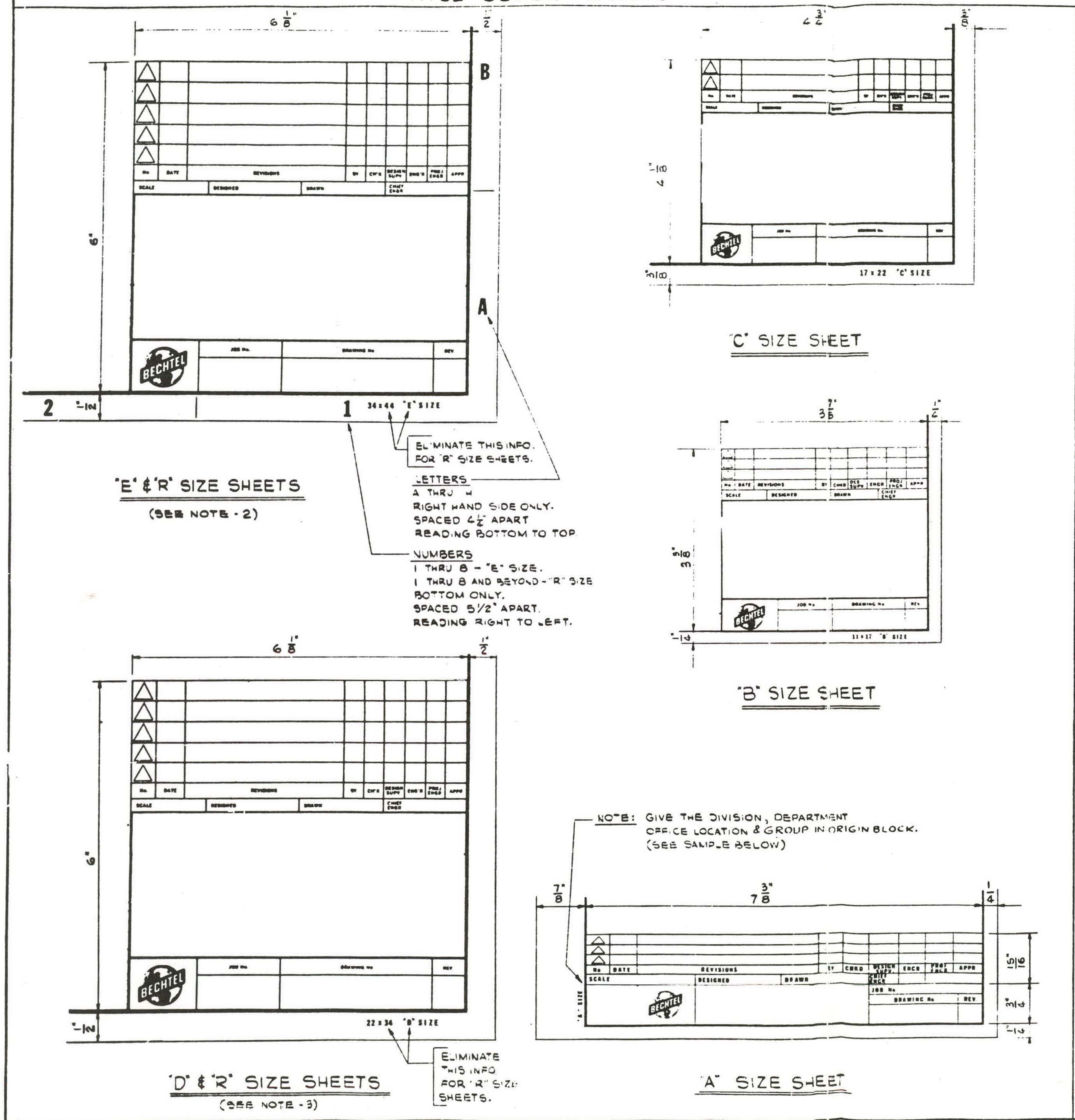
6.0 SCALES

6.1 The following scales are acceptable for engineering drawings:

1:1,10;100;1000;10000
1:2;20;200;2000;20000
1:5;50;500;5000.

6.2 Drawings that are highly congested shall be drawn to a scale not less than 1:50.

TITLE BLOCK FORMATS



ELIMINATE THIS INFO.
FOR "R" SIZE SHEETS.

LETTERS
A THRU H
RIGHT HAND SIDE ONLY.
SPACED 4 1/4" APART
READING BOTTOM TO TOP.

NUMBERS
1 THRU 8 - "E" SIZE.
1 THRU 8 AND BEYOND - "R" SIZE
BOTTOM ONLY.
SPACED 5 1/2" APART.
READING RIGHT TO LEFT.

"E" & "R" SIZE SHEETS
(SEE NOTE - 2)

"C" SIZE SHEET

"B" SIZE SHEET

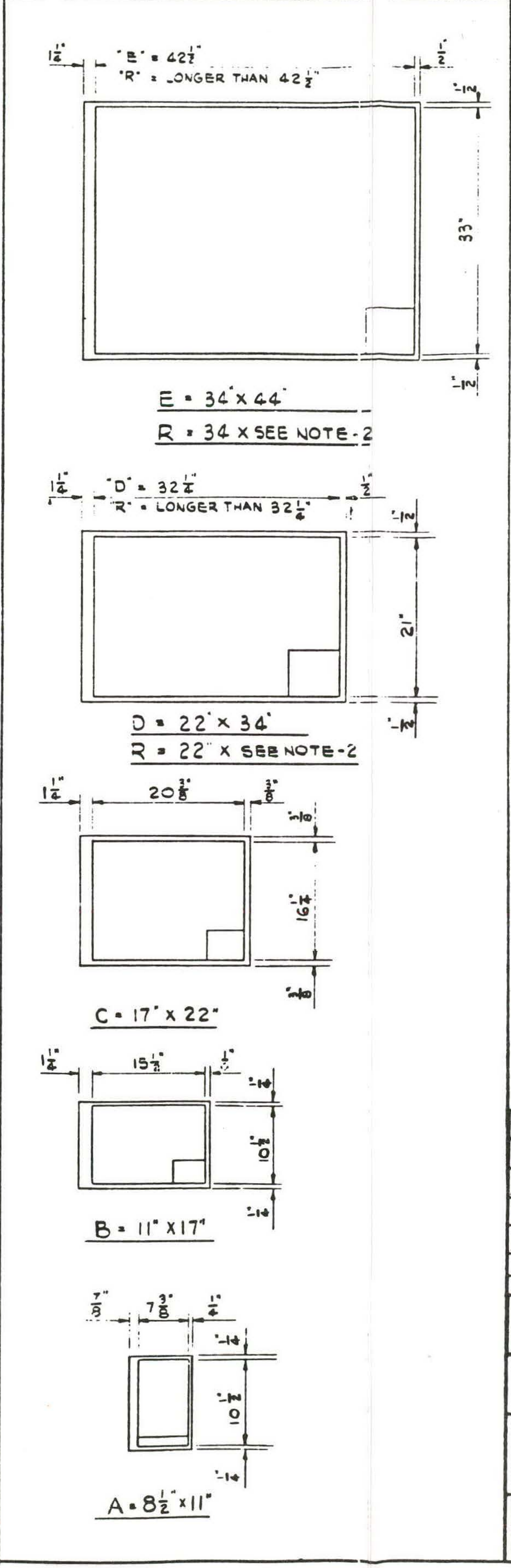
NOTE: GIVE THE DIVISION, DEPARTMENT
OFFICE LOCATION & GROUP IN ORIGIN BLOCK.
(SEE SAMPLE BELOW)

"D" & "R" SIZE SHEETS
(SEE NOTE - 3)

ELIMINATE
THIS INFO
FOR "R" SIZE
SHEETS.

"A" SIZE SHEET

DRAWING SHEET SIZES (SEE NOTES 2 & 3)



E = 34"x 44"
R = 34 x SEE NOTE - 2

D = 22" x 34"
R = 22" x SEE NOTE - 2

C = 17" x 22"

B = 11" x 17"

A = 8 1/2" x 11"

SIZE B

GENERAL NOTES

1. THIS DRAWING SUPERSEDES AND CANCELS THE FOLLOWING DRAWINGS:
   A-505 - STANDARD DWG. SHEET SIZE.
   A-526 - SAMPLE TITLE BLOCK.
2. WHEN DRAWING AREA REQUIRES A "D" OR "E" SIZE WIDTH, BUT EXCEEDS THE "D" OR "E" SIZE LENGTH, USE ADDITIONAL DWGS.
3. THE OUTSIDE DIMENSIONS SHOWN FOR "DRAWING SHEET SIZES" INDICATE THE TRIM LINE BEYOND THE BORDER LINE OF THE FINISHED DRAWING. ADDITIONAL MARGINS OUTSIDE THE TRIM LINE MAY BE PROVIDED ON THE TRACING FOR PROTECTION, AS DESIRED.
4. THE TITLE BLOCKS AS SHOWN ON THIS DRAWING WILL BE USED FOR STANDARDS ORIGINATING WITH THE SAN FRANCISCO OFFICE OF THE REFINERY AND CHEMICAL DIVISION. ON JOBS, THE TITLE BLOCK WILL BE AS OUTLINED IN THE PROJECT SCOPE AND PROCEDURE.

No	DATE	REVISIONS	BY	CH'D	DESIGN SUPV	ENG'R	PROJ ENGR	APPR
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△								
△								
△								
△								

SCALE NONE
DESIGNED H. A. GIUSTI
DRAWN M. SOREM
CHIEF ENGR

BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

DRAWING SHEET SIZES

JOB No.
DRAWING No. -
REV 2

22 x 34 "D" SIZE

ABBREVIATIONS

The following abbreviations shall be used on any document on this project. Full spelling is also acceptable.

Additional abbreviations are also shown in 14222-A-1, Section 2.40. Electrical abbreviations will follow at a later date.

Data Sheets and Drawings	Text	
AMB		Ambient
ATM		Atmosphere, Atmospheric
B, BBL	bbl	Barrel (42 gallons)
BD		Blowdown
BFW		Boiler Feed Water
BHP	bhp	Brake Horsepower
BPSD	BPSD	Barrels per Stream Day
BTU	Btu	British Thermal Units
CF	ft^3	Cubic Feet
CI		Cast Iron
CIRC		Circulate, Circulation
COMP		Component or Composition
COMPR		Compressor
CONC		Concentrate, Concentration
COND		Condensate
CS		Carbon Steel
CW		Cooling Water
DEA		Diethanol Amine
ΔP	ΔP	Differential Pressure
EFF		Effluent, Efficiency
EQPT		Equipment
EXCH		Exchanger
FW		Firewater
GPM	GPM	Gallons per Minute
HC		Hydrocarbons
HHV		Higher Heating Value
HP		High Pressure
IP		Intermediate Pressure

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1	4/80	ISSUED FOR PHASE ZERO			
0	3/3/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AEC:
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
ABBREVIATIONS

JOB NO. 14222
SPECIFICATION 14222-A-11 REV 1

KO		Knock Out
KW	kW	Kilowatts
KWH	kWh	Kilowatt-Hours
LHV		Lower Heating Value
LP		Low Pressure
LPG	LPG	Liquefied Petroleum Gas
LT/D	LT/D	Long Tons per Day
M	10^3	Thousand
MM	10^6	Million
MMSCFD	MMscfd	Million Standard Cubic Feet per Day
MPH	mph	Moles per Hour
MW	mol wt	Molecular Weight
NC		Normally Closed
NO		Normally Open
NNF		Normally No Flow
OPR		Operate, Operator
OVHD		Overhead
PFD		Process Flow Diagram
P&ID	P&ID	Piping and Instrument Diagram
POX		Partial Oxidation
PPM	ppm	Parts per Million
PPMV	ppmV	Parts per Million by Volume
PPMW	ppmW	Parts per Million by Weight
PRESS		Pressure
PSI	psi	Pounds per Square Inch
PSIA	psia	Pounds per Square Inch Absolute
PSIG	psig	Pounds per Square Inch Gauge
QUANT		Quantity
REFR		Refrigeration
SCF	scf	Standard Cubic Feet
SCFM	scfm	Standard Cubic Feet per Minute
SOLN		Solution
SS		Stainless Steel
ST/D	ST/D	Short Tons per Day
STM		Steam
TDS	TDS	Total Dissolved Solids
TEMP		Temperature
TR		Trace
TWR		Tower

CHEMICAL SYMBOLS

AR	Argon
Ca	Calcium
CO_3	Carbonate
Cl, Cl_2	Chloride, Chlorine
CO	Carbon Monoxide
COS	Carbonyl Sulfide
Cr	Chromium
Fe	Iron
H_2	Hydrogen
H_2O	Water
H_2S	Hydrogen Sulfide
K	Potassium
Mg	Magnesium
Mo	Molybdenum
N, N_2	Nitrogen
Na	Sodium
NH_3	Ammonia
Ni	Nickel
NO_3	Nitrate
O, O_2	Oxygen
PO_4	Phosphate
S	Sulfur
Si	Silicon
SiO_2	Silica
SO_4	Sulfate

UTILITY ABBREVIATIONS

Commodity Symbols	P&ID	
DBFW	DBFW	Demineralized Boiler Feed Water (900#)
BFW	BFW	Other Boiler Feed Water
CCW	CCW	Clean Cooling Water (Airco and boiler)
CW	CW	Other Cooling Water
DW	DW	Drinking Water
FW	FW	Fire Water
RW	RW	Raw Water
UW	UW	Utility Water
SW	SW	Sour Water
LS	LP Stm	Low Pressure Steam, 50#
MS	MP Stm	Medium Pressure Steam, 150#
IS	IP Stm	Intermediate Pressure Steam, 600#
HS	HP Stm	High Pressure Steam, 900#
C	COND	Condensate
9C	9 COND	Condensate for 900# BFW
FG	F GAS	Fuel Gas (ethane)
MBG	MBGAS	Medium Btu Gas
FO	F OIL	Fuel Oil
N2	N2	Nitrogen
LN2	LN2	Low Pressure Nitrogen
MN2	MN2	Medium Pressure Nitrogen
HN2	HN2	High Pressure Nitrogen
REFR	REFR	Refrigeration
FS	FLARE	Flare (relief)
FL	FLUSH	Flush Liquid

1.0 SCOPE

1.1 This specification covers all purchased or manufactured industrial equipment which may be a source of noise.

1.2 This specification defines that the permissible noise levels for the equipment be in accordance with the requirements of the project as shown in the individual equipment data sheets attached to the material requisition, and outlines the procedures for testing, reporting, and guaranteeing the noise levels for the equipment supplied.

2.0 REFERENCES

△1 The following publications and documents are to govern:

2.1 ANSI (American National Standards Institute) publications:

S1.2 - Method for Physical Measurements of Sound, 1962 (R1976).

S1.4 - Specifications for Sound Level Meters, 1971 (R1976).

S1.11 - Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets, 1966 (R1975).

S1.13 - Methods for Measurement of Sound Pressure Levels, 1971 (R1976).

S1.21 - Methods for the Determination of Sound Power Level of Small Sources in Reverberation Rooms, 1972.

S5.1 - Test Code for the Measurement of Sound from Pneumatic Equipment, 1971.

2.2 NEMA (National Electrical Manufacturer's Association) Standard:

TR 1-1974 - Transformers, Regulators, and Reactors (Revisions 1-3, 1975-1977).

2.3 API (American Petroleum Institute) publications:

RP-631 - Recommended Practice for Measurement of Sound from Air-Cooled Heat Exchangers.

RP-531 - Recommended Practice for the Measurement of Noise from Process Fired Heaters.

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△1	5/80	ISSUED FOR PHASE ZERO	HS	JRB	JBS
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BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
PROJECT SPECIFICATIONS
NOISE LEVELS OF EQUIPMENT

JOB NO. 14222

SPECIFICATION	REV
14222-A-12	1

3.0 PERMISSIBLE NOISE LEVELS

3.1 The equipment noise control limits of this specification are intended to:

a. Provide maximum combined equipment noise levels of a plant that will satisfy both in-plant and community requirements.

b. Reduce the requirements for special annual noise surveys, hearing tests, and additional record-keeping as may be required under certain governmental regulations.

c. Facilitate compliance with foreseeable lower noise level regulations at reasonable cost and with minimal disruption of plant operations.

3.2 The maximum permissible noise levels for each item or equipment are shown on the individual noise data sheets. The actual noise produced by the equipment shall not exceed these values.

3.3 If the actual noise level in any one octave band exceeds those in the two adjacent bands by more than 5 dB, the permissible noise level for that band shall be 5 dB less than the indicated permissible level.

3.4 The permissible noise levels apply to actual installed conditions for the equipment operating at design load. If acoustical treatments or special methods of installation are proposed to reduce the noise to acceptable values, then the permissible levels may refer to such special conditions provided the treatments are fully described and properly incorporated in the actual installation.

4.0 REPORTING

4.1 The equipment supplier shall state in his quotation the sound pressure levels of each item, by octave bands, in the space provided on the individual equipment noise data sheet attached to the material requisition. This noise performance will be considered in the evaluation of bids in the awarding of an order.

4.2 The reported sound pressure levels shall be based on one of the following:

4.21 Actual measurement in supplier's shop in accordance with referenced standards of 2.0 above.

4.22 Noise test data obtained on a duplicate unit running under similar conditions in an existing plant.

4.23 Noise test data obtained on a duplicate unit at the supplier's plant, in accordance with referenced standards of 2.0 above.

4.24 A categorical and unconditional guarantee that the equipment when operating under design conditions will not produce noise exeeding the permissible levels specified.

4.3 All data shall be certified by persons knowledgeable and experienced in acoustical measurements, or the noise test shall be witnessed by an authorized inspector.

4.4 If available, the sound power level and the directivity of the equipment should be reported in addition to the sound pressure levels.

5.0 DEVIATIONS

5.1 If, in the opinion of the equipment supplier, the specified noise levels cannot be met without extensive reworking of standard equipment thus necessitating a large amount of contingency, he may take the option of so stating and quoting the equipment without including the necessary noise reduction work, but reporting the noise levels he is prepared to guarantee for the equipment he will supply.

5.2 All deviations from this specification shall be clearly described in the bid. The absence of such a list shall be construed as indicating complete compliance with the specification and the referenced standards.

6.0 GUARANTEE

Except when deviations are specifically noted in his quotation, the seller shall guarantee to meet the noise level requirements of this specification and the attached data sheet. Any remedial work performed either by the buyer or the seller as a result of the latter's failure to meet the guaranteed noise levels shall be at the expense of the seller.

PROJECT SPECIFICATIONS:

MAX PERMISSIBLE SOUND PRESSURE LEVEL

db re 0.0002 MICROBAR	OCTAVE BAND CENTER FREQUENCY, HZ								
	31.5	63	125	250	500	1000	2000	4000	8000
		110	103	96	91	88	86	86	88

EQUIPMENT NOISE SHALL BE MEASURED UNDER OPERATING CONDITIONS AT FULL LOAD.

MICROPHONE LOCATION DURING MEASUREMENT SHALL BE:

☐ FT. FROM MAJOR BOUNDING SURFACES.

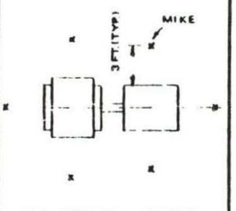
☐ FT. FROM ____________
AND HALF OF EQUIPMENT HEIGHT (3 FT. MIN.) FROM GRADE

☐ AS SHOWN IN SKETCH BELOW.

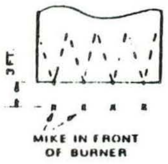
METHOD OF MEASUREMENT, MEASURING INSTRUMENTS, ETC. SHALL BE IN ACCORDANCE WITH ANSI STANDARDS REFERENCED IN NOISE SPEC. 14222-A-12 EXCEPT AS OTHERWISE NOTED HERE.

ADDITIONAL REFERENCES: ____________

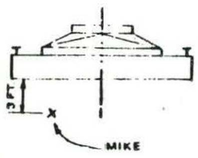
OTHER REQUIREMENTS: ____________



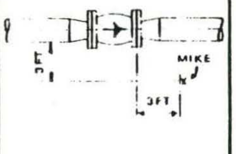
"A" - PUMP, ETC. w/DRIVER



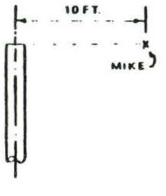
"B" - FURNACE



"C" - AIR COOLER



"D" - VALVE REGULATOR ETC



"E" - VENT

.C. SLF FORM 152 (6/72)

SUPPLIER'S DATA AND GUARANTEE:

EQUIPMENT INFORMATION:

DESCRIPTION ____________

MODEL No. ____________ SIZE ____________

DESIGN CAPACITY ____________

H.P. ____________ SPEED ____________

SOUND PRESSURE LEVEL, dB re 0.0002 MICROBAR

MEASURING POINT	OCTAVE BAND CENTER FREQUENCY, HZ.								
	31.5	63	125	250	500	1000	2000	4000	8000

WE GUARANTEE THAT THE NOISE DUE TO THIS EQUIPMENT

☐ WILL NOT EXCEED THE SPECIFIED MAX. PERMISSIBLE LEVEL.

☐ WILL NOT EXCEED THE LEVELS LISTED IN TABLE ABOVE

OBTAINED BY ☐ ACTUAL TEST ON THE EQUIPMENT.

☐ TEST ON SIMILAR UNIT IN OPERATION.

☐ TEST ON SIMILAR UNIT IN OUR PLANT.

WE TAKE (NO) (FOLLOWING) EXCEPTIONS:

DESCRIPTION OF SPECIAL ACOUSTICAL TREATMENT OR DEVICE INCLUDED IN THE EQUIPMENT:

SOUND POWER LEVEL (re 10⁻¹² WATT) = ____________

DIRECTIVITY: ____________

OTHER REMARKS: ____________

SUPPLIER ____________

REPRESENTED BY ____________ TITLE ____________

SIGNATURE ____________ DATE ____________

GENERAL NOTES:

1. ONE DATA SHEET IS REQUIRED FOR EACH PIECE OF EQUIPMENT.
2. FOR GENERAL INFORMATION, SEE A-511, EQUIPMENT NOISE SPECIFICATION.
3. SUPPLIER SHALL FILL IN MIDDLE SECTION OF THIS DATA SHEET AND ATTACH IT TO HIS QUOTATION.
4. See 14222-A-10 for title block to be used for the Breckinridge Project.

No.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
△								
△								
△0		ISSUED FOR EQUIPMENT PURCHASE						

SCALE | DESIGNED | DRAWN | CHIEF ENGR

BECHTEL
SAN FRANCISCO

EQUIPMENT NOISE DATA SHEET

JOB No	DRAWING No.	REV.

INDEX

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△1	3/30	ISSUED FOR PHASE ZERO			
△0	3/30	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
SHOP PREP. OF MATERIALS FOR SHIPMENT & STORAGE

JOB NO. 14222

SPECIFICATION	**REV**
14222-A-13	1

SHEET 1 **OF** 13

1.0 SCOPE

1.1 This specification defines the minimum acceptable requirements for the Breckinridge Project for Seller's preparation of equipment and materials for shipment to ensure that they will arrive, and can be temporarily stored, at the destination without damage or corrosion.

1.2 Details concerning the construction of packing crates and pallets are not covered by this specification.

1.3 This specification does not apply to the shipment of chemical agents or hazardous materials.

1.4 This specification does not apply to equipment or materials scheduled for shipment by airfreight.

2.0 REFERENCES

The following document is referenced herein.

Project Specifications

14222-X-1 Field Painting-Non-Architectural

14222-X-3 Shop Coatings

3.0 GENERAL

3.1 Seller's equipment and/or material will be shipped either directly to the Breckinridge Project jobsite or to a fabricator for incorporation into a larger assembly, which in turn will be transported to the jobsite. Buyer intends to employ Seller's original shipping containers and packing for temporary storage at jobsite or fabricator.

3.2 Seller's preparation for shipment shall provide protection for a combined transportation and storage time of one full year. A longer period, if required, will be specified by the Buyer in the purchase order documents.

3.3 Additional protection may be required by the technical specifications or the purchase documents. In case of conflict, or if clarification is required, the Seller shall request a written explanation from the Buyer.

3.4 It will be the Seller's responsibility to specify or determine from the equipment manufacturer, if other than the Seller, any additional preparation and packing requirements necessary to provide proper protection from mechanical, physical, and corrosion damage during shipment and storage at the jobsite or module fabrication yard.

3.5 In certain cases, the specific requirements as given in Section 5 may be overly restrictive if applied to equipment or materials having a high corrosion resistance. The Seller may provide alternate packing and preservation methods for the Buyer's review. Use of alternate methods require the written approval of the Buyer on a case-by-case basis.

3.6 Generally, Seller shall pack all items with the presumption that materials and equipment will be stored outdoors in an unsheltered area prior to use. Exceptions to this requirement are instruments, controls, office equipment, control panels, and electrical equipment intended for NEMA 1 or 2 locations, or any other items that are particularly specified by Seller to require special handling or storage. These items shall be stored in an enclosed sheltered area which will be provided with a controlled environment if necessary.

3.7 If Seller must fabricate special handling tools or lifting strongbacks for the movement of finished equipment, these same items shall accompany equipment during shipment in order to ensure the safe handling of equipment.

4.0 PREPARATION FOR SHIPMENT - GENERAL REQUIREMENTS

Protection shall be provided against the entry of dirt, moisture or atmospheric corrosion, and against mechanical damage during land/sea transit, if any, and storage at the jobsite or fabrication yard. This section lists the general sequence of activities required for equipment and material preparation for shipment.

4.1 Initial Equipment Preparation

After inspection and testing, equipment shall be completely free of water, test fluids, fuels and oils, dried and painted in accordance with Specification 14222-X-1. Unpainted metal surfaces must be clean, rust free, and dry. Aliphatic petroleum naphtha or pure gum turpentine shall be used to clean surfaces. Kerosene or gasoline shall not be used.

4.2 Corrosion Preventive

4.2.1 The application of corrosion preventives shall be as follows:

- Type A (oil film)

  Internal surfaces and components of mechanical equipment including bearings, cylinders, cases and gears shall be coated with Type A preventive. The Type A corrosion preventive selected must be compatible with the operating lubricating oil recommended by the Seller.

  Tectyl 502-C Series corrosion preventive satisfies Type A requirements.

- Type B (firm film)

  External machined surfaces such as flanges, where a hard durable finish is desired, shall be coated with Type B corrosion preventive.

  Tectyl 890 corrosion preventive satisfies Type B requirements.

- Type C (soft film)

  External surfaces such as valve rods, shaft extensions, couplings, and where removal of a Type B preventive would be difficult, shall be protected with a Type C corrosion preventive.

  Tectyl 400C corrosion preventive satisfies Type C requirements.

- Type D (grease film)

  External surfaces such as shafts, push rods, and any machined surfaces where a lubricating feature is desired shall be protected with a Type D corrosion preventive.

  Tectyl 858C or Tectyl 437 corrosion preventive satisfies Type D requirements.

- Type E (vapor phase inhibited oil)

  Internal cavities such as crankcases which are enclosed and are not readily accessible for the application of corrosion preventives shall be protected by a vapor phase inhibited oil. Application of vapor phase inhibited oil is subject to the approval of the Seller and/or the equipment manufacturer to ensure its use does not harm equipment or void equipment guarantees.

  Tectyl 859A satisfies Type E requirements.

4.2.2 Application of all corrosion preventives shall be in accordance with the corrosion preventive manufacturer's recommendations.

4.2.3 Application of corrosion preventives to non-corrodible materials is not required and is to be avoided. Application of oil- or grease-based corrosion preventives directly to elastomer components may cause deterioration.

4.2.4 Equipment which normally does not require painting, but must be painted solely for shipping and storage protection, will be specified by the Buyer.

4.2.5 Before shipment, the Seller shall securely attach to the external carton of the equipment a list of the specific rust preventives used, and shall give the manufacturer type number and the locations where each has been applied. This tagging is in addition to the equipment or material identification tagging required in the purchase order.

The Seller shall also include with the above list any special instructions necessary for the removal or replacement of any rust preventive together with any special precautions to be taken in the care of this equipment during the period of storage.

4.2.6 Should the Seller recommend, as a protection measure, that equipment be shipped containing fluids, the fill location shall be clearly tagged to completely identify the fluid and to list precautions to be observed during shipment.

4.3 Equipment Closures

It is preferred that all equipment items be hermetically sealed per Paragraph 4.4; however, this is not practical for certain large equipment items. When the equipment body is to serve as a barrier to prevent the entry of dirt, insects, or corrosive atmosphere, the equipment openings shall be tightly sealed as follows:

- Open flanges - open flanges shall be fitted with a steel cover and an oil resistant rubber or neoprene gasket and bolted with sufficient bolts to provide a weathertight closure. Steel covers shall never be thinner than 3 mm or 2 percent of the cover diameter (whichever is greater).
- Threaded openings - all threaded openings shall be plugged or capped after threads have been coated with a grease base corrosion preventive. Plugs shall be long shank and of the same material as the tapped body.
- Stub openings - all stub openings such as beveled pipe projections shall be sealed by a polyethylene wrap (0.20 mm minimum thickness) secured to the stub by a tight wrapping of "metal duct tape."
- Other openings - other equipment openings such as vents, weep holes, etc, shall be sealed with "metal duct tape" or a combination of polyethylene film secured with "metal duct tape."

4.4 Moisture Barriers

4.4.1 All equipment and materials subject to moisture damage including rotating equipment, electrical equipment, and instrumentation shall be packaged with a moisture barrier to prevent the ingress of moisture during shipment and storage at the jobsite or fabrication yard. The preferred method of meeting this requirement is by wrapping and hermetically sealing the equipment or materials in a fungistatic transparent polyethylene film, 0.20 mm or more in uniform thickness. Alternatives to hermetic sealing must be proposed at the time of quoting.

4.4.2 A sufficient quantity of color indicator type desiccant shall be attached to the inside of the moisture barrier to indicate moisture penetration by visual inspection. Equipment identification tags, nameplates, informational instructions, and other documents that may accompany equipment must be packed to allow access or viewing without destroying the hermetically sealed moisture barrier.

4.4.3 All equipment contained in a hermetically sealed wrap shall be completed encased by crating or boxing to prevent destruction of the wrapping film.

4.5 Packaging Requirements

Packaging needs of equipment and material for shipment will vary depending upon the mode of transportation, the type of equipment and the destination. Detailed requirements concerning the packing, boxing, crating, palletizing, and the marking of containers are contained in other documents included in the purchase order.

5.1 Mechanical Rotating Equipment

5.1.1 Pumps, blowers, gears, etc.

- All internal parts and surfaces, including case bearings, packing and mechanical seal housings, etc, shall be coated by spraying or circulating Type A fluid through the enclosures and rotating the equipment to ensure coating of all parts before draining. A Type E corrosion inhibitor may be used in lieu of Type A if approved by the equipment manufacturer.

- All threaded connections shall be closed with metal plugs or caps after applying Type D corrosion preventitive to the threads.

- The machined surfaces of all flanges shall be coated with Type B or D corrosion preventitive and each fitted with a full-faced metal cover, using an oil resistant rubber or neoprene gasket, and secured with bolts to provide a weathertight closure.

- Equipment shall be overwrapped in accordance with Paragraph 4.4.

5.1.2 Steam turbines and compressors

- The process end of compressors shall be protected in accordance with the manufacturer's recommendations.

- For steam turbines and rotary compressors, the upper casing half shall be removed and all internal surfaces coated with a Type C corrosion preventive. Diaphragm packing, shaft packing, and other auxiliary items shall be removed as necessary and protected by packing in separate containers, labeled, and secured to main frame. The upper half of the casing shall be re-installed.

- All internals of bearing housings and the process end of lubricated reciprocating compressors shall be coated with a Type A corrosion preventive.

- The shaft shall be blocked in a fixed position for shipment.

- All threaded openings shall be closed with long, shank metal plugs or caps.

- Equipment shall be overwrapped in accordance with Paragraph 4.4.

- Each flange shall be protected with a protective cover per Paragraph 4.3.

- When spare rotors are ordered, they shall be suitably prepared for unheated indoor storage for a period of at least three years. The rotor shall be treated with a rust preventive and shall be housed in a vapor barrier envelope with vapor phase inhibitor. The rotor shall be suitably crated for domestic shipment, as specified. Suitable lead sheeting shall be used between the rotor and the cradle at the support areas.

5.1.3 Internal combustion engines

- Final shop running of engine shall be with a Type E oil in the crankcase and corrosion inhibitor in the cooling circuit; oil, water, and fuel shall be drained from the engine prior to shipment.

- Accessories, such as alternators, starters, magnetos, and injection nozzles, which are subject to moisture damage, shall be removed from the engine and hermetically packaged per Paragraph 4.4.

- A small amount of Type A fluid shall be injected into each cylinder and the openings sealed with Type A coated threaded metal plugs or spark plugs.

- Engine intake and exhaust openings shall be sealed with plastic film and "metal duct tape."

5.1.4 Miscellaneous equipment such as hoists, cranes, and elevators shall be protected as follows:

- Rubbing surfaces - Coat with a Type C or D corrosion preventive.

- Roller chains - Clean and soak in Type A corrosion preventive and seal in waterproof container.

- Sheaves and sprockets - Coat with Type C corrosion preventive on grooves and teeth.

- Wire rope - Coat as recommended by Supplier and seal in a container.

- Chain hoists - Coat with a Type A corrosion preventive and seal in a waterproof container.

- Belts - Seal in a waterproof container.

5.1.5 Air Coolers

- Requirements for motor bearings, shafts, hubs, gears, electrical and flanged or threaded openings are covered elsewhere in this specification.
- Tube bundles shall be crated with special care taken to protect fins from damage.
- Fan blades shall be crated with suitable blocking and bracing and with a Type C corrosion preventive coating on finished parts.
- Fan drive belts shall be sealed in a waterproof container.
- Hardware (nuts, bolts, lockwashers) shall be shipped in waterproof containers.

5.1.6 Processing machinery

For complex processing machinery such as compounding machines, mixers, and grinders, Seller shall submit his proposed shop preparation procedures for Buyer's review and acceptance prior to shipment of the equipment. Extent of preassembly will be a factor in determining the correct requirements.

5.2 Pressure Vessels, Heat Exchangers, and Tanks

5.2.1 Heat exchangers, vessels, and tanks shall be cleaned and prepared as follows:

- After testing, the equipment shall be thoroughly cleaned of foreign matter and all inside surfaces completely air-dried. Where exterior sandblasting and painting is required, the vessel shall first be sandblasted and painted and then cleaned.
- All gasket and machined surfaces shall be cleaned with solvent and coated with Type B or Type D corrosion preventive.
- Manholes and nozzles fitted with regular blind flanges shall have the blind flanges installed using the test gaskets.
- All other openings shall be closed per Paragraph 4.3.
- A suitable vent hole shall be provided in one cover for equipment which will not sustain a differential pressure of 2 psia applied externally or internally.

5.2.2 Columns and Trays

All columns shall be cleaned, dried, and prepared for shipment in accordance with Paragraph 5.2.1. In addition, the following surfaces shall be coated with a Type A corrosion preventive.

- Interior carbon steel surfaces of columns.
- Installed carbon steel trays and tray parts. (Surfaces to be "touched up" after installation of trays).
- Carbon steel trays and tray parts shipped separately. (Coating to be performed by tray manufacturer).

  Trays and tray parts shipped separately shall be set on and hermetically enclosed in heavy gauge, polyethylene overwrap film (0.2 mm minimum) and secured in a completely enclosed wooden box. A 75 mm diameter covered opening shall be provided on one side of the box to permit visual inspection of metal surface condition.

5.3 Instruments and Control Equipment

5.3.1 Instruments

- Each instrument item shall be kept in a clean, dry storage room of uniform temperature while being prepared for shipment.
- Loose or moveable parts of the instrument shall be braced against excess movement or vibration.
- Threaded instrument connections shall be protected by either a plastic plug or cap.
- Instruments shall be hermetically sealed in a plastic bag or film before packing or crating per Paragraph 4.4.

5.3.2 Panels

- Panels shall be well braced to prevent any movement.
- All plug-in components of the panel shall be packed separately with proper identification.
- Mounted instruments and their internals shall be braced against excess movement and vibration.
- Printed circuit cards shall be individually packed. These cards are fragile and extra special preservation precautions are required.
- Threaded instrument connections shall be protected either by a plastic plug or cap.
- Moisture-proofing shall be per Paragraph 4.4.

- The panel shall be crated in accordance with the best standard practices to facilitate handling and to protect items from damage.

- Crates shall be marked to show approximate center-of-gravity location to facilitate handling and to designate which end should be up during shipment.

5.3.3 Control Valves and Relief Valves

- Positioners and any other mounted accessories including tubing shall be protected against damage. When valves are shipped with electronic-pneumatic positioners attached, a non-dusting bag of desiccant shall be placed inside the positioner housing and the positioner covered with plastic to prevent entry of moisture.

- Valves shall then be crated in accordance with the best standard practice.

- Particular attention should be given to the protection of valve stems and other exposed moving parts. Seller shall follow the instructions outlined in Paragraph 4.2 for the application of corrosive preventive.

5.4 Piping, Valves, and Fittings

5.4.1 Valves and Fittings

- Bracing, blocking, separators and wood, or plastic caps shall be provided to protect external pipe threads, flange faces, ends prepared for welding, and other external machine-finished surfaces.

- Items 2-inch nominal diameter and smaller shall be shipped in hermetically sealed containers. Threaded connections shall be treated with an oil-based corrosion preventive.

- Items 3-inch and larger may be stored outdoors. Flange facings shall be coated with Type B corrosion preventive and closed with a full face exterior grade plywood or metal protector, using a 3 mm oil resistant rubber or neoprene gasket and secured with bolts or clamps.

- Valves with operators, bypass piping, limit switches, etc, shall be carefully packed and braced to eliminate damage during shipment.

- Valves shall be shipped with wedge or discs lightly seated to prevent entry of dirt to the bonnet and to reduce exposed length of stem.

- All iron and steel pipe fittings shall be Type C coated and boxed or triple sacked.

5.4.2 Piping

- Straight-run pipe shall be bundled on and secured to 150 mm minimum height wooden or metal supports spaced to suit the type and size of pipe involved, but not to exceed 5 meter intervals. The ends of the bundle shall be boxed to provide bundle bracing and to protect pipe ends.
- Shop-primed, galvanized, or other coated straight-run pipe bundles shall be wood stripped to provide about 1/4" clearance between pipes to prevent abrasion of the pipe coating.
- All openings in pipe spools shall be securely closed and flange faces and threaded connections protected with suitable plugs, flange covers, and thread protectors.
- Small branches and flimsy parts shall be adequately braced or otherwise protected to prevent damage in handling, shipment, and storage.
- Ring joint flanges shall have the gasket groove cleaned of all scale, rust, etc, prior to attaching the flange cover.
- Finished pipe ends such as beveled-for-welding or grooved-for-couplings shall be protected with wood, plastic, or soft-metal covers, if method of bundling or crafting does not provide natural protection.

5.4.3 Stainless Steel Pipe, Valves and Fittings

1. Exterior surfaces of austenitic stainless steel piping shall be protected against corrosion from chloride attack during shipment and storage as follows:
    - All pipe ends shall be sealed to prevent ingress of water or other foreign matter. Pipes 12-inch diameter and smaller shall be fitted with plastic end caps. Pipes 14-inch diameter and larger shall have tapered wooden or plastic plugs specially sized to fit the particular diameter, and designed to stay in position during shipment and handling. The diameter of the plugs at their widest point shall be greater than the pipe inside diameter.
    - After the ends are sealed, each length of pipe shall be wrapped with a heavy gauge plastic (0.2 mm minimum) which shall be sealed with tape or heat-sealed to prevent ingress of moisture.
    - Pipes of 12-inch diameter and smaller shall be crated in sturdy wooden crates in a manner which shall not permit the pipes to shift and cause damage to the end caps or plastic wrappings. Larger sizes shall be protected by means of wooden slats attached to the wooden end-plugs. The slatting shall be banded at intervals to prevent damage to the plastic wrapping.

2. Austenitic stainless steel valves and fittings shall be protected by wrapping per Paragraph 4.4. Items for which this is impractical, due to size or other limitations, shall be treated on an individual basis.

3. All austenitic stainless steel materials shall be shipped as below deck cargo when transported by ocean freight.

5.4.4 Aluminum Pipe and Fittings

The Seller of aluminum pipe and fittings shall submit their recommended shipping procedures for Buyer's review and approval. The degree of protection shall be equal or superior to that required of stainless steel pipe and fittings (refer to Paragraph 5.4.3).

5.5 Electrical

5.5.1 Motors

- Shafts and couplings shall be protected per Paragraph 4.2.

- Ventilation openings of waterproof and drip-proof motor enclosures shall be covered with plastic film and sealed with waterproof tape.

- Protection requirements for motors with brushes, commutator, collection rings, etc, shall be in accordance with the manufacturer's recommendations. Motors shall be overwrapped in accordance with Paragraph 4.4.

5.5.2 Transformers

Units designed for indoor installation shall be hermetically enclosed by overwrapping in accordance with Paragraph 4.4. Crating or boxing shall be required to protect the equipment and the overwrap.

5.5.3 Switchgear, Starters, and Control Equipment

Units designed for indoor installation shall be hermetically closed per Paragraph 4.4. Plug-in units (circuit breakers and starters) shall be separately sealed in plastic film with desiccant charge and boxed individually.

5.5.4 Cable and Building Wire

- Building wire reels shall be shipped on pallets or skids to permit forklift truck handling. Non-returnable type reels are preferred for building wire.

- Cable reels shall be provided with wood lagging to permit forklift truck handling. The 35 kV.A cable ends shall be sealed according to manufacturer's standards. All other cable ends shall be sealed with waterproof tape.

5.5.5 Batteries

These shall be dry-charged type with electrolyte, shipped in separate unbreakable containers.

5.6 Stainless Steel Equipment

Austenitic stainless steel equipment shall be prepared and shipped in accordance with Paragraph 5.4.3, Items 2 and 3.

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2	[illegible]	REF. ATM. TEMPERATURES	[illegible]		[illegible]
1	8/80	ISSUED FOR PHASE ZERO	HS	[illegible]	[illegible]
0	3/80	ISSUED FOR APPROVAL	HS	[illegible]	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
GENERAL SPECIFICATION FOR SELLERS

JOB NO. 14222
SPECIFICATION 14222-A-14
REV 2

SHEET 1 OF 8

1.0 SCOPE

The purpose of this specification is to stipulate the general project requirements applicable to Bidder/Sellers of materials, equipment, and services for long lead items as identified in Phase Zero of the Beckinridge Project located in Breckinridge County, Kentucky.

2.0 DESIGN CRITERIA

2.1 The design shall be based upon commercially proven processes and equipment of proven size and performance record. The plant will be designed and constructed to high standards of safety, reliability, and operability.

2.2 New and innovative designs, new technology, including materials of construction, or equipment, having a size or capacity substantially exceeding that previously built or operating, in general, will not be considered by the Buyer. If the Bidder/Seller wishes the Buyer to consider new or scaled-up design, the Bidder/Seller shall obtain prior written approval to offer such designs, and this should be offered as an alternative to a base offer based on approved specifications to allow proper evaluation of all offers. Generally, the Buyer will give this approval only if substantial financial or safety benefits can be demonstrated.

2.3 The design life of this facility shall be 20 years.

2.4 Equipment shall be designed to operate continuously for two years minimum unless scheduled shutdown of shorter intervals are indicated in the specifications.

2.5 Equipment shall be designed for continuous operation outdoors unless otherwise specified.

2.6 Bidder/Seller's design shall be based upon the design requirements specified in the bid/purchase documents without any consideration or allowance for possible future capacity increase.

3.0 STANDARDIZATION

3.1 It is imperative that the maximum economic standardization and interchangeability of equipment, and thus spare parts, and materials be achieved for this project.

3.2 The Buyer expects the Bidder/Seller to advise of standardization and interchangeability possibilities based on the Bidder/Seller's expertise and experience. The Bidder/Seller shall advise Buyer of cost and schedule impact if the standardization recommendations are implemented. The Buyer will make the final evaluation.

4.0 ECONOMIC CONSIDERATIONS

Economic factors, if required, will be supplied to the Bidder/Seller, separately from this specification.

5.0 BASIC DESIGN DATA

5.1 Atmospheric Temperatures

△2 5.1.1 Recorded data: Maximum 108°F
Minimum -16°F

△2 5.1.2 Design dry bulb temperature for mechanical design of systems not exposed to long periods of sun shall be 96°F.

5.1.3 For components exposed to the sun, the design must consider temperatures up to 140°F.

5.1.4 Design atmospheric pressure is 14.4 psia.

5.2 Rainfall

Yearly average - 42.5 inches
24-Hour Maximum - 4.5 inches
Design 15-minute intensity - 1.1 inches

5.3 Design must consider occasional lightning.

5.4 Earthquake design shall be per Uniform Building Code, 1973 Edition, Zone 2.

5.5 Other required design data such as design dry and wet bulb temperatures for air cooler rating, cooling water, and steam conditions, etc, will be shown on data sheets or in technical specifications.

6.0 CODES AND STANDARDS

6.1 All equipment, materials, and services provided for this project must comply with all applicable local and U.S. codes, standards, regulations, and the like. The Seller shall determine what codes, standards, etc, apply to items within the Seller's scope.

6.2 Specific applicable industry codes and standards including the revision or date of issue to be used, will be shown on data sheets or project specifications.

6.3 Code stamps for items designed and fabricated per ASME Section VIII are required.

6.4 Code stamps for items designed per ASME Section I are required.

6.5 Underwriters labels are not mandatory.

6.6 For the fire protection system, certification must be provided for items requiring "Underwriters approval".

7.0 DOCUMENT ORDER OF PRECEDENCE

In the event of conflict between purchase documents, the order of precedence is as follows:

1. Purchase Order
2. Data Sheets
3. Project Specifications
4. Pertinent Codes or Standards
5. Secondary Standards or Codes referenced in above.

Notwithstanding the foregoing, if the Seller discovers any discrepancy in the purchase order, the Seller shall request written clarification from the Buyer. Any work performed before Buyer's written response will be at the Seller's risk.

8.0 UNITS OF MEASUREMENT

8.1 English units of measurement (as used in the United States) are to be used on this project.

8.2 English system units in accordance with ANSI Standards shall be used for the following items: pipe sizes, wall thickness and corrosion allowance; flange ratings; pipe threads; anchor bolts; rebar sizes; electrical conduit sizes; wire sizes; bolting and structural steel sizes and weights depending upon source of supply.

9.0 MICROFILMING

9.1 All drawings and data on this project will be microfilmed. It is imperative that the Seller's presentations are of sufficient quality to obtain clear reproducibles from the microfilm. Any added costs incurred by Buyer as a result of poor drawings will be backcharged to the Seller.

9.2 Special requirements:

△2 1. Drawings larger than 24" x 36" are not acceptable without Buyer's specific written approval.

2. Second, third, etc, generation reproducibles are not acceptable.

3. Shading shall not be used.

4. Minimum lettering height is 1/8" except for typed material.

5. For scaled drawings a graphic scale must be shown.

6. For drawings that must not be scaled a distinctive "Do not Scale" notation shall be shown.

9.3 Guidelines

1. Use upper case vertical lettering.
2. All lines and lettering to be close to even weight and density.
3. Maximize typing and use for computer-aided drafting.

10.0 Drawings and Data

10.1 All drawing and data requirements will be specified on Form ________ and shall be fulfilled before rendering final invoices.

10.2 All final drawings and data submitted must be certified.

10.3 In order to minimize the number of drawings and documents, Seller shall use the same drawings for like items to the maximum extent possible.

10.4 All drawings larger than 8-1/2" x 11-3/4" must be reproducibles. Prints are not acceptable without Buyer's written approval.

10.5 Any fabrication, installation, or construction work done prior to Buyer's review of drawings and permission to proceed shall be at Seller's risk. However, Buyer's review of Seller's drawings shall not be held to relieve the Seller of any obligations under the purchase order.

10.6 All documents must show Bechtel's job, equipment, and purchase order numbers, Seller's title, drawing, and revision numbers, all preferably in the lower right-hand corner.

10.7 Drawings or data returned to the Seller for revision must be resubmitted within ten working days after receipt.

10.8 The Buyer will return Seller's drawings within 20 working days from receipt.

10.9 Once a drawing has been submitted to the Buyer the Seller's drawing number shall not be changed. If it is absolutely necessary to change the drawing number, the drawing transmittal must clearly show that the drawing number has been changed. The transmittal and the drawing must show both the old and the new number.

10.10 If a drawing has been revised, the revision block and the drawing must clearly indicate the changes made. No changes shall be made on a drawing without assigning a new revision number.

10.11 Transmittals accompanying revised drawings and data must show Buyer's vendor print (V.P.) number.

10.12 Transmittals forwarding drawings and data shall be used for that purpose only, and shall not contain extra charge information, schedule data, technical questions or clarifications, etc. These items are to be covered in separate correspondence.

10.13 Seller shall maintain and submit a drawing index for all purchase orders which require more than ten drawings.

10.14 The Seller must complete the Buyer's data sheets.

10.15 Erection drawings and bills of material must be supplied for items to be erected or assembled in the module yard or on the jobsite.

10.16 Instruction Manuals

Installation, operating, and maintenance manuals must be complete and in great detail, and must cover all items within the Seller's scope of supply (including all items obtained from sub-suppliers).

If the Seller is furnishing similar equipment on several orders for the project, a composite instruction manual may be provided.

Drawings included in the manuals which require folding in more than one direction shall be reduced. "Pocket" drawings are not acceptable. Bound manuals shall be assembled in such a manner that sections or pages can be removed easily. Three-ring or post binders are preferred.

Three copies of the manual shall be sent to the Buyer for review. Only after this review and after the Seller has incorporated the Buyer's comments, if any, shall the Seller forward the required number of copies.

10.17 See Paragraph 11.3 for Spare Parts List requirements.

11.0 Spare Parts

11.1 Definitions:

1. Construction and precommissioning spares: Equipment that could be damaged or need replacement prior to turnover of plant to ASI-AECI; i.e, gaskets, etc.

2. Major Capital Spares

   Spares for specialized equipment, i.e, major compressor rotors, etc. Purchased with original equipment.

3. General Capital Spares

   Start-up spares and spares required for normal service of two years. Purchased separately and packaged separately from original equipment.

11.2 Seller shall submit with the quotation, a supplementary quotation for each category of spare.

11.3 Spare Parts List

The Seller may use any format that is adaptable to his particular needs; but must include the following and a minimum:

1. Sufficient detail to order: size, material, model number, etc.

2. Quantity of like project: in equipment, all equipment on project.

3. Unit and total costs, deliveries, stock locations.

4. Purchase order number: or numbers for like equipment.

5. Expiration date of price quotation.

6. Special requirement in each inquiry or purchase order.

12.0 SERVICE REPRESENTATIVES

Seller's erection supervisors, technical specialists, and start-up personnel may be required at the jobsite. Procurement documents will define scope, schedule, and other pertinent data.

13.0 SPECIAL TOOLS

Special tool requirements will be described in the procurement documents. Special tools are defined as "any tool which is manufactured specifically for use on Seller's equipment or materials and is required for installation, operation, or maintenance of any items furnished by the Seller". Instrument calibration equipment is not normally included in the above.

14.0 NAMEPLATES AND TAGGING

14.1 A readily visible nameplate shall be attached to each item of equipment showing item number, service, purchase order number, manufacturer's name, design conditions, and other items as required by applicable codes or standards.

14.2 Nameplates shall be made of corrosion-resistant material such as 18-8 CrNi SS or Monel, and shall be attached so as to avoid the possibility of atmospheric corrosion of the equipment beneath the plate. Plates with arrows indicating direction shall also meet these requirements.

14.3 All instruments, valves, fittings, specialty piping items, and all other items for which the Buyer has assigned tag or code numbers shall be identified by nameplates or other permanent tagging methods approved by the Buyer.

14.4 Other detailed tagging requirements, such as wire and terminal marking, color coding of pipe and structural steel (if required), will be described in the applicable specifications.

15.0 TESTING - GENERAL

15.1 Prior to pressure testing, equipment and piping shall be thoroughly cleaned internally and external surfaces shall be free of weld spatter, scale, and other foreign material. Gasket compounds other than graphite and oil, or grease, shall not be used.

15.2 For hydrostatic tests or surface inspections of equipment, all exterior surfaces and welds subject to pressure shall be unpainted, clean and dry.

15.3 New gaskets shall be installed in equipment joints that are opened for any reason after assembly or pressure test, except that ring-type joint gaskets may be reused if undamaged.

15.4 Test and witnessed test requirements will be shown on data sheets, specifications, or in the purchase order.

16.0 SHIPPING PREPARATION AND PACKAGING

16.1 Specification 14222-A-13, "Shop Prep. of Materials for Shipment and Storage", describes the minimum requirements. Special requirements, if any, will be shown on individual purchase orders or on equipment data sheets.

16.2 Packaging and marking for shipment requirements are described in the procurement documents. Special requirements, if any, will be shown on individual equipment data sheets or specifications.

17.0 REFERENCES

Specifications

14222-A-13	Shop Prep. of Materials for Shipment and Storage.

MODEL

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△		
△2	[illegible]	REVISED AS NOTED
△1	3/80	ISSUED FOR PHASE ZERO
△0	3/80	ISSUED FOR APPROVAL

ASFI THE BRECKINRIDGE PROJECT AECI U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717 PROJECT SPECIFICATION MODELS	JOB NO. 14222	
	SPECIFICATION	REV
	14222-A-15	2

SHEET 1 OF 7

1.0 SCOPE

This instruction outlines the model requirements for the Breckinridge Project.

2.0 INTENT

Design and review of models shall assure plant maximum quality in the following areas:

- Accessibility
- Operability
- Constructibility
- Economy
- Clearances
- Safety
- Maintenance
- Foundations and Underground
- Code Compliance
- Community Relations
- Aesthetics
- Specific Client Requirements.

3.0 MODEL REQUIREMENTS

Three levels of models are required:

△2

- Site Plan Model (1" = 100 feet) Phase 0
- Preliminary Model (1/8" = 1 foot) - EPC Phase.
- Final Model (3/8" = 1 foot) - EPC Phase.

4.0 SITE PLAN MODEL

4.1 Model shall be prepared by Bechtel for entire project - in Phase 0.

4.2 Objective shall be to locate entire plants and major systems.

4.3 Each plant shall be represented by a styrofoam block or other similar easily-formed material.

4.4 Plant sizes will be estimated initially.

4.5 Site development plan for Phase 0 shall be based on this initial layout after approval by Client.

4.6 Subcontractor shall inform Bechtel of final plant sizes as soon as preliminary models (see Section 5.0) and plant plot plans are sufficiently defined.

5.0 PRELIMINARY MODEL: EQUIPMENT ARRANGEMENT

5.1 Shall be prepared by Bechtel at a single location and as unified facility with uniformity of detail and appearance throughout.

5.2 This model will be used for plant layout studies. Alternate arrangements, recorded photographically, will minimize drafting.

5.3 Preliminary models should start on receipt of the following information:

- Process Flow Diagram (preliminary issue).
- A list of vessels, towers, exchangers, heaters, compressors, etc; giving their approximate sizes.
- Approval of site plan model (Section 4.0).

5.4 A scale of 1/8"=1'-0" shall be used.

5.5 Several alternate arrangements may be made until an acceptable plot plan arrangement is developed. Photographs shall be made of each alternate arrangement.

5.6 Plant layout optimization shall be developed to substantiate selected layout.

6.0 FINAL MODEL

6.1 Final model shall include all equipment, structures, piping, valves and fittings, instrumentation, lighting, and other features deemed desirable for clarifying the design. Movable cranes shall be modeled to evaluate construction access.

6.2 Major model features and input sketches are listed below. Other model contents shall be provided as necessary to meet the Intent (Section 2.0).

a. 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.
    1.1 Reference: Commonwealth land title insurance company, Philadelphia, Pennsylvania file № K-055292.

△2 b. Site high point of paving elevation shall be 415 feet (MSL).

c. Piping studies shall be at 3/8"=1 foot scale. These studies are the basis for final design and line installation and generally yield the exact final dimensional relationships between equipment.

d. The line routing diagram shall be made on an overlay of the plot plan. This drawing is purely diagrammatic and serves to determine pipeway width.

e. Tower and vessel orientation design sketches shall be prepared to 3/8"=1 foot scale and shall include nozzles and manways; tower and vessel piping; platform and ladder size, orientation and location; level instrument orientation and location; height of tower and vessel skirts.

f. Top of grout elevation for all equipment foundations and pads shall be 101'-0" for pumps and 100'-6" for towers and skirts.

g. Pipeway widths, bent spacing, and top of support elevation of main pipe racks shall all be shown.

h. Allocation of space for electrical, instrument racks, analyzer houses, switch gear, utility hose stations, and all other physical access obstructions shall be indicated.

i. Location of all main structural columns shall be shown.

j. Elevations of structural levels and extent of platforms required shall be indicated.

k. Major field welds and test blind locations shall be indicated. These should be reviewed with the Construction Department.

l. The centerline of all top discharge pump nozzles must be aligned.

m. The ends of all pump foundations should be lined up where possible without extensive foundation being required.

n. Orientation of other major equipment nozzles, i.e, exchangers, compressors, furnaces, etc. shall be indicated.

o. Location of conveyors, drivers, and transitions shall be shown.

6.3 In summary, the final model shall be a true representation of the plant as intended at mechanical acceptance. Above all, it shall enable the preparation of accurate piping isometric drawings for all lines 1" and above, suitable for fabrication and installation without reference to other data.

7.0 FINAL MODEL CONSTRUCTION & REPRESENTATIONS

7.1 SCALE

The model scale shall be 3/8"=1'-0".

Accuracy shall be within 2 scale inches on piping and 4 scale inches overall on equipment at 3/8"=1'0".

7.2 COLOR CODING

Piping

Carbon steel piping shall be colored yellow.
Alloy or other special pipe shall be colored red.
Heavy wall carbon steel pipe shall be colored blue.

Instrument - Pink

Includes tubing rack, level controllers and alarms, gauge glasses, pressure points, orifice flanges, temperature points (other than thermocouples), instrument housing, control panels, pneumatic junction boxes, rotameters, and other inline metering devices.

Adhesive stickers shall be used to show the function and instrument number where a locally-mounted instrument is of such a size that a three-dimensional model facsimile is not warranted. Orientation of a sticker on the model shall be the same as the side of the instrument where readings will be made.

Electrical - Green

Includes switchgear, conduit racks, thermocouple points, lights, substations, and transformers.

ROUND pressure sensitive stickers with an identifying code shall be used to represent telephones, welding receptacles, small junction boxes, etc, where these items are of such size that a three-dimensional model facsimile is not warranted.

Grade and/or Underground -Tapes

Roads shall be represented by Black & White Tapes.
Plot Limit shall be represented by solid brown tapes.
Building walls shall be represented by cross hatched Black & White Tapes.
Trenches, sewers, catch basins, etc. shall be represented by solid black tapes.

All underground piping and electrical conduit shall be in the same colors as used above grade, but shall be dashed to indicate it is below the surface.

Structures

Reinforced concrete or fireproof steel shall be white.
Structural steel shall be Gray.

7.3 EQUIPMENT AND STRUCTURAL DETAIL

Accurate scale sizes shall be used for Towers,horizontal vessels, tanks, exchangers, equipment support pads, structures, and buildings.

Accurate scale sizes but simplified equipment shapes shall be used for pumps, drivers, and compressors.

Equipment nozzle locations shall be to scale.

7.4 PIPING

Pipe, valves, and fittings shall be replica scale sizes.

Handwheels for valves 2" diameter and over shall be shown.

All welded line two inches and larger shall be represented complete with valves, fittings, etc.

Piping insulation shall be designated by a white snap-on patch.

Light blue snap-on patches shall be used to indicate lines which are steam traced.

Light green snap-on patches shall be used to indicate lines which are electrically traced.

7.5 PLATFORMS, LADDERS, AND SUPPORTS

Platforms support brackets, handrails, toe plates, and ladder cages shall not be shown.

Pipe supports other than main overhead pipeways will be used as model supports only and actual supports shall not be shown.

Overhead pipeway supports made with clear plastic will be used as model supports only and will not indicate actual supports.

7.6 ELEVATION TAGS

Elevation tags shall relate to high point of grade, 100'-0" and be shown on all vessel nozzles and wherever else necessary, such as top of steel, platforms, manways, nozzles, etc.

7.7 Take-off points and destination points with line numbers shall be shown for piping systems which do no require complete representation on the model, such as the following:

- Utility stations at grade.
- Auxiliary piping for pumps and turbines.
- Compressor auxiliary piping, two inches and smaller.
- Tracing (steam and electric).
- Instrument piping one inch and smaller - except level instruments.

8.0 MODEL REVIEWS

8.1 Model reviews for the purpose of approval by the Client and project management shall be conducted in a controlled manner:

- Referenced drawing record copies shall be maintained - "yellowed"-up and with comments.

  Every line, symbol, and description must be marked.

- A recorder of the model review will be appointed by project engineering. A detailed log of corrections and investigations to be made shall be maintained showing the name of the specific individual who must take suitable action.

- Model shall be flagged with problem number.

  Disposition of problems or corrections must also be recorded and distributed to all participants within ten working days.

- Subcontractors with detailed engineering responsibilities in Phase I must have a Bechtel representative present at formal model reviews to assure uniformity of design and constructibility.

9.0 REFERENCES

Project Specification 14222-A-7: Plot Plans.
General Design Specification 14222-A-4: Piping Design and Layout.
General Design Specification 14222-A-9: Equipment Layout.

CONFIDENTIAL AND SECRET DOCUMENTS

1.0 SCOPE

1.1 This procedure shall be followed for the control of Confidential and Secret Documents generated by subcontractors and licensors on the Breckinridge Project. The primary purpose is to prevent the release of classified material to anyone or any agency not bound by secrecy agreement with the subscontractors and licensors concerned and preserve the material for eventual return or other disposition. It is intended that the classifed material will be available to all Task Force Personnel with minimal constraints consistent with that primary purpose.

1.2 Transmittals to Bechtel must be identified by ASFI, subcontractors, and licensors with the notation of "CONFIDENTIAL" or "SECRET" if so classified.

1.3 Subcontractors or licensors who provide documents which contain little confidential or secret informatiom compared to the content of the whole document, shall be requested to remove that information to a separate document. Reference to the confidential document shall be made on the unclassified document.

2.0 CONFIDENTIALITY COORDINATOR

2.1 One member of the Bechtel task force will be assigned the responsibility to receive and control confidential and secret documents. That person shall be designated the Confidentiality Coordinator (CC).

2.2 The CC will stamp the document "Confidential" upon receipt and will log it into a Confidential Document Record Book as follows:

1. Serial Number - affixed to each document.
2. Name of Originating Company.
3. Description or Title of Document.
4. Date of Document.
5. Number of Copies Received.
6. Number of Copies Reproduced.
7. Name of each person to whom document is distributed.

2.3 Each recipient of confidential information will be required to review these procedures and will be personally responsible for compliance.

FORM H-292 7-66

△					
△					
△	8/80	ISSUED FOR PHASE 0			
△	3/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80020717
PROJECT SPECIFICATION
CONFIDENTIAL AND SECRET DOCUMENT

JOB NO. 14222

SPECIFICATION	REV
14222-A-16	1

SHEET 1 OF [illegible]

Documents will be handled as described below:

- Secure in a locked desk or cabinet at the end of each day.
- Return each piece of data to the CC when no longer needed.
- Reproduction will only be made by the CC and then only if permitted by the Secrecy Agreement.
- CC to store secret data in a locked file.
- CC is to periodically review the files and destroy or return documents no longer needed.
- Originals will be retained by the CC for disposition at the end of the contract.
- Whenever a confidential document is destroyed or returned, that information will be recorded in the Confidential Record Book.

3.0 REQUESTS FOR CONFIDENTIAL INFORMATION

3.1 Requests for confidential information will require the CC to do the following:

- Determine that the need to know is genuine.
- Determine the exact data need.
- Execute a Secrecy Agreement through the Bechtel Project Manager.

3.2 Requests for comfidential information from other Bechtel personnel will be reviewed by the Bechtel Project Manager.

Any information given will be entered into the Confidential Record Book.

3.3 ASFI shall be the only entity on the Breckinridge Project to provide any government or 3rd party organization with any confidential or secret information.

1.0 SCOPE

1.1 A primary objective during Phase Zero is to prepare a preliminary estimate of the constructed cost of the facilities of the Breckinridge Project. Specific information on Major Equipment Data Sheets is required to estimate the cost of the major equipment.

1.2 This specification establishes the Major Equipment Data Sheets that must be prepared during Phase Zero and the specific information that must be compiled on each data sheet.

2.0 MAJOR EQUIPMENT DATA SHEETS REQUIRED

2.1 The Major Equipment Data Sheets which must be prepared are listed as follows:

	Description	Group	Form
△2	Vessel Design Data Sheet	C	256
	Vessel Design Data Sheet	C	875
	Tank Data & List of Appurtenances	D	173
	Heat Exchanger Specification Sheet	E	158
	Air Cooled Heat Exchanger Specification Sheet	E	318
	Cooling Tower Data Sheet	E	160
	Surface Condenser Data Sheet	E	908
	Flare Stack Data Sheet	F	909
	Fired Heater Data Sheet	F	376A
	Centrifugal Pump Data Sheet	G	130
△2	Deleted		
	Proportioning Pump Data Sheet	G	222
	Rotary Pump Data Sheet	G	221
	Special Purpose Steam Turbine Data Sheet	G	8
	Steam Jet Liquid Educator Data Sheet	H	120
	Centrifugal Compressor Data Sheet	K	187
△2	Deleted		
	Reciprocating Compressor Data Sheet	K	268
△2	Fan/Blower Data Sheet	K	250
	Tank Mixers	Y	191
△2	Deleted		
△2	Deleted		
△2	Deleted		

2.1 Each Data Sheet refers to a specific item of equipment which is identified by a group letter and an assigned number. For example, a vessel might be numbered, C-101. A definition of these group letters is found in Standard Specification Number 14222-A-20 Page 4 of 4, "Group Letters for Drawing Indexes and Material Requisitions."

FORM H-292 7-66

△					
△	12/18/80	ISSUED FOR GENERAL REVISION			
△	8/27/80	ISSUED FOR PHASE ZERO			
△	4/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S.DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATION
MAJOR EQUIPMENT DATA SHEETS FOR PHASE ZERO

JOB NO. 14222
SPECIFICATION 14222-A-17
REV 2

SHEET 1 OF 48

3.0 DATA SHEET INFORMATION REQUIREMENTS

3.1 The attached copies of the above listed data sheets have been marked with a heavy black dot to indicate the minimum data required for each item of major equipment. Additional data that is readily available should also be recorded.

3.2 The data sheets should be numbered in accordance with Specification Number 14222-A-20.

CODE	*	
SPEC.	*	
OPER. COND.	PRESS.	*
	TEMP.	*
DES. COND.	PRESS.	*
	TEMP.	*
MATERIALS	SHELL & HDS	*
	SKIRT	*
	FORGING	*
	PIPING	
	STRUCTURAL	
	BOLTS	
C.A. OR CLAD	*	
PWHT		

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

	MK	NO.	SIZE	RATING	SERVICE
NOZZLES & MANWAYS					

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

REF. DWGS.

NO.	DATE	REVISION	DESIGN	DWN.	CHK.	APPR.	APPR.
	△2	* REQUIRED FOR PHASE 0 ESTIMATE					

BECHTEL

FORM 875, 4/79

JOB NO.

DRAWING NO.	REV.
	2

DESIGN REQUIREMENTS

* 1. ASME SECTION VIII, DIV. ___ 19 ___ EDITION, ______________________ ADDENDA
* 2. SPECIFICATION ______________________
3. MATERIALS ASME
SHELL AND HEADS * ______________ PIPING: ______________
SUPPORTS: * ______________ STRUCTURAL: ______________
FORGINGS. * ______________ BOLTS: ______________
* 4. INTERNAL DESIGN PRESSURE _____ psig @ _____ °F (OPERATING _____ psig @ _____ °F)
5 EXTERNAL DESIGN PRESSURE _____ psi @ _____ °F
* 6 CORROSION ALLOWANCE ______________
* 7. RADIOGRAPHY ______________ JOINT EFFICIENCY ______________
8. PWHT ______________ REQUIRED BY (CODE) (______________)
9 CODE HYDROSTATIC TEST PER UG-99 (c) = ______________ psig @ top (VERT) (HORIZ.)

NO.	DATE	REVISION	BY	CHK.	APP.	APP.

SIZE B
FORM 256. 4 79

OTHER REQUIREMENTS

EXAM/TEST: UT ________, MT ______, PT ________, CHARPY V-NOTCH @ _____ °F.
WELD SAMPLING PER SPEC C-503 ______________, HARDNESS MAX. BHN ______________
CLIPS PER C-529 : A ____ B ____ C ____ D ____ E ____ F ____ G ____ H ____ J ____
INSULATION: THICKNESS ______________
PAINTING:
VESSEL CAPACITY ______________ CU. FT., EMPTY WT. * _____ KIPS, TEST WT. _____ KIPS

* REQUIRED FOR PHASE 0 ESTIMATE

NOZZLE DATA

NOZZLE	SIZE	NO. REQD	RATING	FACING	SERVICE	REMARKS

REFERENCE DRAWINGS

SPECIFICATION 14222-A-17 Rev. 2

BECHTEL

JOB NO.
DRAWING NO. C..
REV. 2

TANK DATA	TANK NO. *	
	SIZE, DIA. X HEIGHT *	
	CAPACITY (42 GAL. BBLS) *	
	ROOF TYPE *	
	BOTTOM TYPE	
	FILLING RATE-BPH	
	EMPTYING RATE-BPH	
	BEARING PLATES	
	DRAW-OFF SUMP	
	WATER DRAW CONN.	
	STORAGE TEMP. °F △2 *	
	CORROSION ALLOWANCE △2 *	
	DESIGN METAL TEMP. – °F MIN MAX. *	△2
	DESIGN SPECIFIC GRAVITY △2 *	
	TOTAL NET WORKING CAP. – MBBLS	
	MINIMUM NO. OF TANKS △2 *	
	GAS BLANKET – MIN./MAX. IN. WATER	
SHELL APPURTENANCES	SUCTION NOZZLE	
	SUCTION NOZZLE W/1" COUPLING	
	FILL NOZZLE	
	FILL NOZZLE W/1" COUPLING	
	STEAM NOZZLE – DOUBLE FLANGED	
	CONDENSATE NOZZLE – DOUBLE FLGD.	
	ROOF DRAIN NOZZLE – DOUBLE FLGD.	
	FOAM CHAMBER	
	FOAM TROUGHS	
	MANHOLES – 20" OR 24" DIA.	
	MIXER NOZZLE	
	MIXER NOZZLE – W/BLIND FLG. (MH)	
	FLUSH TYPE CLEANOUT, 3' X 4'	
	SAMPLE CONNECTION – 1" COUPLING	
	TEMP. GAUGE CONN. – 1" COUPLING	
	PRESSURE GAUGE CONN.	
	TEMP. CONTROLLER CONN. – 1" CPLG.	
	SUCTION NOZZLE – DBL. FLG. W/1" CPLG.	
	SPECIAL CONNECTIONS	
	HIGH & LOW LEVEL ALARMS	
	LEVEL GAUGE CONNS.	
	HIGH & LOW PRESS. ALARMS	
GENERAL	PAINTING *	
	BOTTOM PLATE COATING	
	WINDGIRDERS	
	TANK STRAPPING	
	SPECIFICATIONS *	
	FOUNDATION *	

ROOF APPURTENANCES	VENT NOZZLE	
	RIM VENTS	
	MANHOLE – 20"	
	MANHOLE – COMB. EMER. RELIEF	
	PONTOON MANHOLE – 20"	
	GAUGE HATCH NOZZLE	
	ROOF DRAIN, FLEX. PIPE	
	BLANKET GAS INLET – 2" FLG.	
	GAS BLANKET PC 2" FLG. NOZZLE	
	AUTOMATIC BLEEDER VENT	
	AUTO. GAUGE FLOAT WELL & COVER	
	AUTO. GAUGE INSPECT. OPEN. & COVER	
	LEVEL GAUGE CONNS.	
	AVERAGING TEMP. BULB CONN.	
	AUTO. GAUGE FLOAT STILLING WELL	
MISCELLANEOUS APPURTENANCES	LADDER W/CAGE	
	CIRCUMFERENTIAL STAIRS	
	PLATFORM	
	ROLLING LADDER W/SELF-LEVEL TRDS.	
	GROUNDING LUGS	
	MIXER SUPPORT LUGS	
	LEVEL GAUGE SUPPORTS	
	FOAM LINE SUPPORTS	
	INSULATION SUPPORTS △2 *	
	CATHODIC PROTECTION	
	AUTO. LEVEL GAUGE	
	AUTO. LEVEL GAUGE, REMOTE	
	AUTO. LEVEL GAUGE, REMOTE PRESS.	
	TARGET LEVEL GAUGE	
	TARGET LEVEL GAUGE, W/ALARM	
	TARGET LEV. GA., W/LIQ. SEAL, ALARM	
	TEMPERATURE GAUGE	
	FOAM GENERATOR	
	TANK HEATER (INSTALL BY	
	HEATER MANIFOLDS (INSTALL BY	
	PRESSURE VACUUM RELIEF VALVE	
	OPEN VENT (WITH RETURN BEND)	
	OPEN VENT (MUSHROOM)	
	INSULATION	
	SAMPLE COOLER	
	CENTER PIN FOR PAINTER'S TROLLEY	

△		
△		
△		
△		
△		* REQUIRED FOR PHASE O
△		

BECHTEL

TANK DATA &
LIST OF APPURTENANCES

JOB No.	DRAWING No.	REV
	D	2

HEAT EXCHANGER SPECIFICATION SHEET

1	CUSTOMER AND PROJECT LOCATION *		EXCHANGER MANUFACTURER	
2	PLANT *	EXCH. NO. *	REQ. NO.	
3	SERVICE OF UNIT *		ITEM NO.	
4	SIZE * TYPE *	(HORIZ/VERT) CONNECTED IN *	SERIES *	PARALLEL
5	SURF./UNIT (EFF/GROSS)	SHELLS/UNIT *	SURF/SHELL (EFF/GROSS) *	

6 PERFORMANCE OF ONE UNIT

7	FLUID ALLOCATION		SHELLSIDE		TUBESIDE	
8	FLUID CIRCULATED *					
9	TOTAL FLUID ENTERING *	LB/HR				
10			IN	OUT	IN	OUT
11	LIQUID *					
12	VAPOR *	LB/HR, MW				
13	NONCONC *	LB/HR, MW				
14	STEAM *					
15	WATER *					
16	FLUID VAPORIZED/CONDENSED *					
17	GRAVITY, LIQ. *					
18	VISCOSITY, LIQ. (VAP.) *					
19	THERM. COND., LIQ. (VAP.) *					
20	SPECIFIC HEAT, LIQ. (VAP.) *					
21						
22	TEMPERATURE *	°F				
23	OPERATING PRESS. *	(PSIA) (PSIG)				
24	NO. PASSES/SHELL					
25	VELOCITY	FT/SEC				
26	PRESS. DROP, ALLOW/CALC. *	PSI	/		/	
27	FOULING RESISTANCE *					

28 HEAT EXCHANGED * BTU/HR; MTD (CORR) (WTD) * °F

29 TRANSFER RATE, SERVICE * CLEAN BTU/HR. SQ. FT. °F

30 CONSTRUCTION

31				SHELLSIDE	TUBESIDE
32	DESIGN/TEST PRESS. *		PSIG	/	/
33	DESIGN TEMPERATURE *		°F		
34	CORROSION ALLOWANCE *		IN		
△2 35	CONNECTIONS	INLET			
△2 36	SIZE	OUTLET			
37	RATING				

38	TUBES NO.	OD	THK (MIN/AVG)	LENGTH	PITCH FLOW ——► ◁ △ ◇ ▢
39	TUBE MATERIAL *			TUBE-TUBESHEET JOINT	
40	SHELL *	ID	OD	SHELL COVER	(INTEG.) (REMOV)
41	CHANNEL/BONNET			CHANNEL COVER	
42	TUBESHEET-STATIONARY			TUBESHEET FLOATING	
43	FLOATING HEAD COVER			IMPINGEMENT PLATE (YES) (NO)	
44	BAFFLES-CROSS	TYPE		% CUT (DIA/AREA)	SPACING
45	BAFFLES-LONG	SEAL TYPE		TUBE SUPPORTS	
46	INSUL. THK.: SHELL	CHAN.		EXPANSION JOINT	
47	GASKETS				
48	CODE REQUIREMENTS	STAMP (YES) (NO)		TEMA CLASS	SPECS
49	WEIGHT: EACH SHELL	BUNDLE		FULL OF WATER	
50	REMARKS. MARK (SR) AND PERCENT (RT) AS REQUIRED				
51					
52					
53	* REQUIRED FOR PHASE O ESTIMATE				
54					

REV	△	DATE		JOB NO.	DRWG. NO.	REV.
	△				DS - E	2
	△					

AIR-COOLED HEAT EXCHANGER SPECIFICATION SHEET

1	Customer and Plant Location *		Manufacturer:	
2	Plant *	Exch. No. *	Req. No.	
3	Service *		Item No.	
△2 4	Size & Type *		(Induced)(Forced) Draft	No. of Bays
△2 5	Surface per Unit-Finned Tube *	ft^2	Bare Tube *	ft^2
△2 6	Heat Exchanged *	Btu/h	MTD, Eff. *	°F
△2 7	Transfer Rate-Finned Tube *	;Bare Tube, Service *	Clean	Btu/h-ft^2°F

8 PERFORMANCE DATA—TUBE SIDE

9	Fluid Name *			Lethal Service(Yes)(No) *	IN	OUT	
10	Total Fluid Entering * lb/h			Density, Liquid * lb/ft^3			
11		IN	OUT	Specific Heat Capacity * Btu/lb °F			
12	Temperature * °F			Cond.(Liq.)(Vap.) * Btu/h-ft °F			
13	Liquid * lb/h			(Pour)(Freeze)Point * °F	WHEN A PROBLEM		△2
14	Vapor * lb/h, mol. wt.			Bubble Point °F			△2
15	Noncond. * lb/h, mol. wt.			Latent Heat Btu/lb			△2
16	Steam * lb/h			Inlet Pressure *(psig)(psia)			
17	Water * lb/h			Pressure Drop. Allow./Calc. * psi			
18	Viscosity(Liq.)(Vap.) * cP			Fouling Resist., Inside h-ft^2 °F/Btu			△2

19 PERFORMANCE DATA—AIR SIDE

△2 20	Air Quantity, Total * (lb/h)(std.ft^3/min)		Altitude above Sea Level * ft.
△2 21	Air Quantity/Fan * act. ft^3/min		Temperature In(Design Dry Bulb) * °F
△2 22	Actual Static Pressure * in. water		Temperature Out * °F
△2 23	Face Velocity * std. ft/min	Mass Velocity(Net Free Area) lb/h-ft^2	Minimum Design Ambient °F

24 DESIGN—MATERIALS—CONSTRUCTION

25	Design Pressure * psig	Test Pressure psig	Design Temperature * °F
26	TUBE BUNDLE	HEADER, Type	TUBE, Material *
△2 27	Size	Material *	(Seamless)(Welded)
28	No./Bay No. Tube Rows	No. Passes* Slope in./ft	OD in. Min. Thick. in.
29	Arrangement	Plug Material	No./Bundle Length ft.
△2 30	Bundles * In Parallel In Series	Gasket Material	Pitch in.△
△2 31	Bays * In Parallel In Series	Corrosion Allowance * in.	FIN, Type *
△2 32	Bundle Frame	No., Size Inlet Nozzle in.	Material *
33	MISCELLANEOUS	No., Size Outlet Nozzle in.	OD in. Stock Thick. in.
34	Struct. Mount.(Grade)(Piperack) c/c	Special Nozzles in.	No./in. Fin Design Temp. °F
35	Surface Preparation	Rating & Facing	Code-ASME VIII, Div. 1 Stamp(Yes)(No)
36	Louvers Auto Manual	TI PI	SPECS.
37	Vibration Switches	Chem. Cleaning	

38 MECHANICAL EQUIPMENT

△2 39	FAN, Mfr. & Model		DRIVER, Type *	SPEED REDUCER, Type
△2 40	No./Bay *	rev/min	Mfr.	Mfr. & Model
△2 41	Dia. * ft	No. Blades	No./Bay * hp/Driver *	No./Bay
△2 42	Pitch * Adj. Auto	Angle	rev/min	AGMA Rating hp Ratio /1
△2 43	Material, Blade	Hub	Enclosure	Support(Structure)(Pedestal)
△2 44	hp/Fan, Des.	Minimum Amb.	Volt;Phase;Cycle *	

△2 45 Control Action on Air Failure-Fan Pitch (Minimum)(Maximum)(Lockup) ; Louvers (Open)(Close)(Lockup)

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

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

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

49

50

51

52

53

54 * REQUIRED FOR PHASE 0 ESTIMATE

55

56 Plot Area | Weight—Bundle lb Shipping lb

BECHTEL	REV.	△	DATE	JOB NO.	DRWG. NO.	REV.
		△			DS- E	
		△				

FORM 318 (6/78)

COOLING TOWER DATA SHEET

1 Customer ____ Manufacturer ____
2 Location * ____ Equip. No. * ____
3 Unit * ____ SC No. ____
4 Number Required * ____ Item No. ____

5 GENERAL
6 Selection ____
7 Tower Model ____
8 * Type ____
9 DESIGN & OPERATING CONDITIONS
△2 10 * *Circulating Water Flow, lb/h ____
△2 11 * *Hot (inlet) Water Temp °F ____
△2 12 * *Cold (outlet) Water Temp °F ____
13 *Wet Bulb Temp., Inlet °F ____
14 Ambient * △2 °F ____
15 Tower Pump Head, ft ____
16 Total Fan B.H.P., (Driver Output) * △2 ____
17 Drift Loss, % of circulating flow ____
18 Evaporation Loss (at design) ____
19 *Design Wind Load, lbs/sq ft ____
20 ML/hr ____
21 *Design Seismic Load, %G ____
22 *Tower Site (ground level, roof, etc) ____
23 *Elevation Above Sea Level, ft ____
24 *Tower Exposure ____
25 ____
26 ____
27 ____
28 STRUCTURAL DETAILS ____
29 * Number of Cells ____
△2 30 * Fans per Cell ____
△2 31 * Total Number of Fans ____
△2 32 * Nominal Cell Dimen. LxW, ft ____
33 * Overall Tower Dimension, LxW ft ____
34 * Height-Basin Curb to Fan Deck, ft ____
△2 35 Fan Stack Height, ft ____
36 * Overall Tower Height, ft ____
37 * Inside Basin Dimensions, ft ____
38 *Column Extensions, Perimeter, below ____
39 basin curb, ft ____
40 Internal, below curb, ft ____
41 Anchorage ____
42 Hot Water Inlet-Number ____
43 Nom. Diameter, in ____
44 Description ____

45 ____
46 ____
47 ____
48 ____
49

REV.			JOB NO.	
△			DATA SHEET	REV.
△				
△		* REQUIRED FOR PHASE C	E	2
△				

FORM 160 (11/79)

Specification 14222-A-17

SHEET 8 of 48

50 Height Inlet Above Basin Curb . . . ft ____

51 *Access to Top of Tower . . . ____

△2 52 Shipping Weight . . . lb ____

53 Operating Weight . . . lb ____

54 ____

55 ____

56 ____

57 ____

△2 58 MATERIALS OF CONSTRUCTION

59 * Framework Members . . . ____

60 Casing . . . ____

61 Filling . . . ____

62 Support . . . ____

63 Drift Eliminators . . . ____

64 Spacer . . . ____

65 Fan Stacks . . . ____

△2 66 * Louvers, Material . . . ____

67 Partitions . . . ____

68 Fan Deck . . . ____

69 Water Distribution-Type . . . ____

70 Material . . . ____

△2 71 * Lumber Pre-Treatment . . . ____

72 Type of Treatment . . . ____

73 Items Treated . . . ____

74 Splashers or Spray Nozzles . . . ____

75 Stairway and Handrail . . . ____

76 Structural Connectors . . . ____

77 Ring Joint Connectors . . . ____

78 Bolts, Nuts, Washers . . . ____

79 Anchor Connectors . . . ____

80 Nails . . . ____

81 Mechanical Equipment Support . . . ____

82 *Anchor Bolts-Material . . . ____

83 Furnished By . . . ____

84 *Cold Water Basin-Material . . . ____

85 Furnished By . . . ____

86 *Basin Accessories, by Mfg . . . ____

87 ____

88 ____

89 ____

90 MECHANICAL EQUIPMENT

91 Fans

92 Number . . . ____

93 Type or Model . . . ____

94 Manufacturer . . . ____

95 Diameter . . . ft ____

96 Number of Blades . . . ____

△2 97 Fan Speed . . . rpm ____

98 Tip Speed . . . fpm ____

99 BHP per fan, driver output . . . ____

100 Blade Material . . . ____

101 Hub Material . . . ____

102 Total Static Pressure . . . in H_2O ____

△2 103 Velocity Pressure . . . in H_2O ____

△2 104 Air Delivery per Fan . . . acfm ____

Fan Static Efficiency . . . . %

Speed Reducer

Number

Type

Model

Manufacturer

Reduction Ratio

AGMA Mechanical H.P. Rating

Service Factor at Rated H.P. of Driver

No. of Reductions

Drive Shaft

Number

Type

Model

Manufacturer

Rated H.P

Drive Shaft Material

Coupling Material

Driver

△2 * Number

*Kind

* *Type

Manufacturer

* Full Load Speed . . . . rpm

*Elec. Char.-phase/cycles/volts

* Rated H.P

VIBRATION SWITCH

MANUFACTURER

MODEL

ADDITIONAL DATA:

Symbol * = information to be filled in by Bechtel.

Data Sheet reprinted from Cooling Tower Institute Standard.

SURFACE CONDENSER DATA SHEET

1	Customer		
2	Project Location *		Manufacturer
3	Plant *	Conc No *	Req. No
4	Service Of Unit *		Item No
5	Size *	Horizontal	No. Required *
6	Surf (Eff/Gross.	ft² *	

PERFORMANCE

7							
8	Fluid Allocation			Shellside		Tubeside	
9	Fluid Circulated			Wet Steam			
10	Total Fluid Entering		lb/h				
11				Design	Normal	Design	Normal
△2 12	Water	*	lb/h				
△2 13	Steam	*	lb/h, MW				
△2 14	Steam Condensed	*	lb/h				
△2 15	Density, Liq.	*	lb/ft³				
△2 16	Viscosity, Liq. (Vap.)	*	cP				
△2 17	Therm. Cond., Liq. (Vap.)	*	Btu/h-ft² °F				
△2 18	Specific Heat, Liq. (Vap.)	*	Btu/lb °F				
19	Latent Heat, Vap.		Btu/lb				
△2 20	Temperature In/Out	*	°F	/	/	/	/
△2 21	Operating Press.	*	(Psia) (Psig)				
22	No. Passes			One	One		
23	Velocity Allow/Calc.		ft/sec	/	/	/	/
△2 24	Press. Drop, Allow	*	psi	/	/	/	/
25	Cleanliness Factor						
△2 26	Heat Exchanged	*		Btu/h, MTD *			°F
△2 27	Transfer Rate, Service	*		Clean			Btu/h-ft² °F

CONSTRUCTION

28		
29	Tubes	Hotwell: lb
30	Main Condensing Sections:	Type: Capacity:
△2 31	No.: OD: in. Thk: BWG	Material:
32	Length, effective. ft. Overall. * ft	Thickness
△2 33	Material: * Tube Pitch: in	Tube sheets
34	Gas Removal Sections:	Number and size:
35	No.: OD: in. Thk.: BWG	Material: Thickness. in.
36	Length, effective: ft Overall ft	
37	Material: Tube Pitch: in	Tube support plates
38	Impingement 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): *	Connection to shell – (Flanged) or (Welded) Turbine – (Flanged) or (Welded)
45	Material (Covers):	Height – top of water box flange to turbine Exhaust Including
46	Divided or non-divided	expansion joint (if any)
47	Design pressure: * psig Temperature * °F	Provision for vertical expansion (condenser hung):
48	Nozzles Number and Size – Inlet. Outlet:	(spring supports) (expansion joint):
49	Shell	Spring supports Type:
50	Material. *	Expansion joint Type.
△2 51	Thickness in Number of sections	Material.
52	Provision for tube expansion	Height. Ends – (Flanged) (Welded
53	Number and size of vent [illegible] connections.	
54	Design pressure * psig Temperature * °F And Full Vacuum	

REV.			JOB NO.	DRWG. NO	REV.
	△				
	△		-	DS- E	2
	△	•			

SURFACE CONDENSER DATA SHEET (CONTINUED)

55 Steam Jet Air Ejector(s)

56 Total number of Ejector Units:

57 Size and type: No. of elements: No. of stages:

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-condensible gases other than air leakage: lb per h

64 Associated saturated water vapor: lb per h Total gas-vapor mixture: lb per h

65 Design capacity each element: per cent

66 Number of elements operating for 100% capacity:

67 Curve(s) of approximate capacity vs. suction pressure:

68 Steam conditions —

69 Maximum initial pressure: 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 Surfacesq ft: Inter-Condenser After-Condenser

74 Heat Exchanged Btu/h Inter-Condenser After-Condenser

75 Tubes. No: OD in Thk BWG: Length (Effective-overall) ft

76 Tube-Tubesheet Joint:

77 Cooling Water (condensate) (raw water):

78 Minimum flow required at: per cent design capacity: lb/h

79 Maximum design flow: lb/h

80 Pressure drop allowable/calculated psig

81 Shell/Water boxes — Design pressure * / psig Design Temperature * / °F

82 Materials:

83 Suction chambers: Condenser shells: *

84 Diffusers: Water chambers:

85 Steam nozzles: Tube sheets:

86 Steam chests (nozzle heads): Tubes: *

87 Fittings and Accessories included

88 Air leakage meter.

89 Other:

90 Hogging Ejectors

△2 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 psig

97

98 Fittings and accessories included:

99 Priming Ejector(s)

△2 100 (Steam) (Air) (Water) Operated. * Size *

101 Operating Conditions and Performance

102 Capacity: * lb per h dry air at in. Hg abs Suction Pressure

103 Steam consumption: lb per h at psig °F

104 Maximum design steam conditions: psig °F

105 Consumption. Air SCFM at psig Water lb/h at psig

106

107 Approximate weight:

108 Condenser Dry lb. Ejectors: Priming lb.

109 Flooded lb. Hogging lb

110 Air lb.

111

FLARE STACK DATA SHEET

1 Customer ______ Manufacturer ______
2 Location * ______ Equip. No. * ______
3 Unit * ______ Reg. No. ______
4 Number Required * ______ Item No. ______

5 **PROCESS DESIGN CONDITIONS**

6		MAXIMUM	MINIMUM	
△2 7 Flow Rate . . . . *	lb/h			
8 Specific Gravity				
△2 9 Molecular Weight . *				
10 Net Heating Valve	Btu/lb, Btu/ft^3			
11 Ratio of Specific Heat	C_P/C_V			
12 Supply Pressure	Psig			
13 Gas Composition	MOL%			
14 C1				
15 C2				
16 C3				
17 iC4				
18 nC4				
19 iC5				
20 nC5				
21 ≥C6				
22 N2				
23 CO_2				
24 H_2S				
25 SO_2				
26				
27 Flare Gas Temperature	°F			

28 **CONSTRUCTION**

29 Stack:
30 Height Above Grade * ______ ft. Guyed/Self Supporting * ______
31 Outside Diameter * ______ in. Number of Guys ______
32 Stack Plate Thickness * ______ in. Guy Wire Diameter ______
33 ______ in. Guy Wire Material ______
34 ______ in. Stack Plate Material * ______
35 Flare Tip: Stack Plate Design Temperature * ______
36 Overall Length * ______ ft Flare Tip Material * ______
37 Outside Diameter * ______ in. Flare Tip Refractory * ______
38 Connection To Stack ______ Refractory Anchor ______
39 Ignition System Description: * ______
40 Platform And Ladder Description : ______
41 ______
42 Piping Description:
43 Pilot And Ignition Gas ______
44 Steam ______
45 Seal Description: * ______
46 ______
47 Seal Purge Gas Requirement: ______
48

REV.	△						JOB NO.	
	△						DATA SHEET	REV.
	△		* REQUIRED FOR PHASE	0			DS F	2
	△							

FIRED HEATER DATA SHEET

Customer	*	Manufacturer	
Location	*	Equip. No	*
Unit	*	Req. No.	
Number Required	*	Item No.	
Total Heat Absorbed mm Btu/h	*	Type of Heater	*

HEATER PERFORMANCE

	Heater Section				
	Service				
*	Fluid Name				
*	Heat Absorption	mm Btu/h			
*	Flow Rate	lb/h			
*	Pressure Drop (Allowable - Clean/Fouled)	psi			
	Pressure Drop (Calculated - Clean/Fouled)	psi			
	Coking Allowance	in			
	Average Radiant Flux Density (Allowable)	Btu/h-sq ft			
	Average Radiant Flux Density (Calculated)	Btu/h-sq ft			
*	Maximum Radiant Flux Density	Btu/h-sq ft			
	Average Convection Flux Density	Btu/h-sq ft			
	Velocity Limitation	ft/sec			
	Maximum Allowable Inside Film Temperature	°F			
	Fouling Resistance Inside	h-ft^2-°F/Btu			
	Inlet Conditions:				
*	Temperature	°F			
*	Pressure	(psig)(psia)			
	Liquid Flow	lb/h			
*	Vapor Flow	lb/h			
	Density, Liquid (Vapor) At P&T	lb/cu ft			
	Gravity, Liquid	Sp Gr at 60 °F			
*	Vapor	mol wt			
	Viscosity, Liquid (Vapor)	CP			
	Specific Heat, Liquid (Vapor)	Btu/lb- °F			
	Conductivity, Liquid (Vapor)	Btu-ft/h-ft^2 °F			
	Outlet Conditions:				
*	Temperature	°F			
*	Pressure	(psig)(psia)			
	Liquid Flow	lb/h			
*	Vapor Flow	lb/h			
*	Density, Liquid (Vapor) At P&T	lb/cu ft			
	Gravity, Liquid	(Sp Gr at 60°F)			
*	Vapor	mol wt			
	Viscosity, Liquid (Vapor)	CP			
	Specific Heat, Liquid (Vapor)	Btu/lb-°F			
	Conductivity, Liquid (Vapor)	Btu-ft/h-ft^2 °F			

Remarks and Special Requirements:

Data sheet reference for vaporization curve.

* REQUIRED FOR PHASE 0 ESTIMATE

REV.	△		JOB NO.	
	△		DATA SHEET	REV.
	△		DS F	2
	△			

COMBUSTION AND FUEL DATA

51.	* Type of Fuel				
52.	Excess Air	%			
53.	Calculated Heat Release	mm Btu/h(LHV)			
54.	Calculated Efficiency, Percent (LHV)				
55.	Guaranteed Efficiency, Percent (LHV) See Note				
56.	Radiation Loss, Percent of Heat Release (LHV)				
57.	Flue Gas Temp. Leaving Radiant Section	°F			
58.	Flue Gas Temp. Leaving Convection Section	°F			
59.	Flue Gas Temp. (Uncorr) Leaving Air Heater	°F			
60.	Flue Gas Mass Velocity-Conv. Section	lb/sq ft-sec			
61.	Volumetric Heat Release	Btu/h-cu ft			
62.	Altitude Above Sea Level	ft			
63.	Air Temperature, Combustion	°F			
64.	Air Temperature, Draft	°F			
65.	Minimum Furnace Draft/Location	in H_2O			
66.	Draft at Burners	in H_2O			

67. Note: A Fuel Savings of ______ mm Btu/h Fuel Value $ ______
68. Will Offset a $1000 increase in mm Btu
69. Furnace Cost (Erected)

70. Fuel Characteristics

71.	* Heating Value	HHV			
72.	Heating Value	LLV			
73.	Specific Gravity				
74.	Molecular Weight				
75.	Viscosity, At ______ °F	SSU			
76.	Viscosity, At ______ °F	SSU			
77.	Fuel Pressure Available at Burner	psig			
78.	Atomizing Steam Pressure	psig			
79.	Composition:				
80.	Vanadium	ppm			
81.	Sodium	ppm			
82.	Salt Content	ppm			
83.	Ash	% wt			
84.	* Sulfur	% wt	-O-		
85.	Hydrogen	% wt			
86.	Carbon	% wt			
87.	Nitrogen	% wt/% vol			
88.	Oxygen	% wt			
89.	CH_4	% vol			
90.	C_2H_4	% vol			
91.	C_2H_6	% vol			
92.	C_3H_8	% vol			
93.	H_2S	% vol			
94.	H_2O	% vol			
95.					
96.					
97.					
98.					
99.					
100.					
101.					
102.					
103.					

MECHANICAL DESIGN
COIL DATA

General:

Plot Limitations ____________ Minimum Stack Height ____________

Tube Length Limitations ____________

Coil:

Coil Design:

Heater Section

Design Basis for Wall Thickness

Design Life

* Design Pressure psig

* Corrosion Allowance, Tubes in

Weld Stress Relieve

Weld Inspection Requirements X-ray or Others

Maximum Wall Temperature (Calculated-Clean) °F

Maximum Wall Temperature (Design-Fouled) °F

Inside Film Coefficient Btu/h—°F sq ft

Overall Heat Transfer Coefficient Btu/h—°F sq ft

Corrected Mean Temperature Difference °F

Bare Tubes, Total Exposed Surface sq ft

Extended Surface Tubes, Total Exposed Surface sq ft

Coil Configuration:

Tubes, Vertical or Horizontal

Number of Flow Passes/Tubes Per Pass

Effective Tube Length ft

Bare Tubes, Number

Extended Surface Tubes, Number

Tube Spacing, Center to Center (Staggered) (In Line) in

Tube Center to Furnace Wall in

Tubes:

* Material (ASTM Specification and Grade)

Outside Diameter in

Wall Thickness (Minimum) (Average) in

Overall Tube Length ft - in

Description of Extended Surface:

Type

Fin or Stud Material

Fin or Stud Material

Fin or Stud Dimensions in

Fin or Stud Dimensions in

Fin or Stud Spacing per in

Fin or Stud Spacing per in

Maximum Fin or Stud Temperature °F

Maximum Fin or Stud Temperature °F

Plug-Type Headers:

Location

Manufacturer and Type

Nominal Rating

Welded or Rolled Joint

MECHANICAL DESIGN
(COIL DATA)

161. Return Bends:
162. Location ______ ______ ______
163. Material (ASTM Specification and Grade) ______ ______ ______
164. Wall Thickness or Schedule ______ ______ ______
165. Crossovers:
166. Location (Internal) (External) ______ ______ ______
167. Pipe Material (ASTM Specification and Grade) ______ ______ ______
168. Wall Thickness (Minimum) (Average) in ______ ______ ______
169. Flange Material (ASTM Specification and Grade) ______ ______ ______
170. Flange Size and Rating ______ ______ ______

171. Terminals or Manifolds:
172. Location ______ ______ ______
173. (Welded) (Flanged) ______ ______ ______
174. Wall Thickness (Minimum) (Average) in ______ ______ ______
175. Flange Material (ASTM Specification and Grade) ______ ______ ______
176. Flange Size and Rating ______ ______ ______

177. Tube Supports:
178. Location (End) (Top) (Bottom) ______ ______ ______
179. Material (ASTM Specification and Grade) ______ ______ ______
180. Web Thickness in ______ ______ ______
181. Insulation, Type and Thickness ______ ______ ______
182. Anchor Type and Material ______ ______ ______
183. Immediate Tube Supports:
184. Material (ASTM Specification and Grade) ______ ______ ______
185. Spacing ft ______ ______ ______
186. Coating, Type and Thickness ______ ______ ______

187. Tube Guides:
188. Location (Top) (Bottom) (Intermediate) ______ ______ ______
189. Material (ASTM Specification and Grade) ______ ______ ______

190. Coil Terminal Movements and Forces:
191. Nozzle Movement in ______ ______ ______
192. Direction ______ ______ ______
193. External Nozzle Load lb ______ ______ ______
194. Direction ______ ______ ______
195. Pipe Load Supported by Heater ______ ______ ______
196. Special Support Brackets Required ______ ______ ______
197. Notes ______________________________
198. ______________________________
199. ______________________________
200. ______________________________
201. ______________________________
202. ______________________________
203. ______________________________
204. ______________________________
205. ______________________________
206. ______________________________
207. ______________________________
208. ______________________________
209. ______________________________

MECHANICAL DESIGN
CONSTRUCTION DATA

211. Settings:
212. Floor:
213. Refractory: Thickness ________ Hot Face Temp: Calculated ________ °F Design ________ °F
214. Construction ________________________________
215. ________________________________
216. Casing: Thickness ________ Material ________________ Temperature ________ °F

217. Exposed Vertical Walls:
218. Refractory: Thickness ________ Hot Face Temp: Calculated ________ °F Design ________ °F
219. Construction ________________________________
220. ________________________________
221. Anchor Type and Material ________________________________
222. Method of Attaching Anchor to Casing ________________________________
223. Casing: Thickness ________ Material ________________ Temperature ________ °F

224. Shielded Vertical Walls:
225. Refractory: Thickness ________ Hot Face Temp: Calculated ________ °F Design ________ °F
226. Construction ________________________________
227. ________________________________
228. Anchor Type and Material ________________________________
229. Method of Attaching Anchor to Casing ________________________________
230. Casing: Thickness ________ Material ________________ Temperature ________ °F

231. Arch:
232. Refractory: Thickness ________ Hot Face Temp: Calculated ________ °F Design ________ °F
233. Construction ________________________________
234. ________________________________
235. Anchor Type and Material ________________________________
236. Method of Attaching Anchor to Casing ________________________________
237. Casing: Thickness ________ Material ________________ Temperature ________ °F
238. Convection Sidewalls:
239. Refractory: Thickness ________ Hot Face Temp: Calculated ________ °F Design ________ °F
240. Construction ________________________________
241. ________________________________
242. Anchor Type and Material ________________________________
243. Method of Attaching Anchor to Casing ________________________________
244. Casing: Thickness ________ Material ________________ Temperature ________ °F

245. Breeching:
246. Refractory: Thickness ________ Hot Face Temp: Calculated ________ °F Design ________ °F
247. Construction ________________________________
248. ________________________________
249. Anchor Type and Material ________________________________
250. Method of Attaching Anchor to Casing ________________________________
251. Casing: Thickness ________ Material ________________ Temperature ________ °F

252. Bridgewall:
253. Thickness ________ Height ________ Material ________________________________
254. Notes: ________________________________
255. ________________________________
256. ________________________________
257. ________________________________
258. ________________________________
259. ________________________________

MECHANICAL DESIGN
CONSTRUCTION DATA

261. Flue Gas Duct:
262. Refractory: Thickness ____ Material ____ Hot Face Temp. Design ____ °F
263. Anchor Type and Material ____
264. Method of Attaching Anchor to Casing ____
265. Casing: Thickness ____ Material ____ Temperature ____ °F

266. Combustion Air Duct:
267. Lining: Thickness ____ Material ____
268. Anchor Type and Material ____
269. Method of Attaching Anchor to Casing ____
270. Casing: Thickness ____ Material ____ Temperature ____ °F

271. Header Boxes:
272. Location ____ Doors, Bolted-Hinged ____
273. Refractory: Thickness ____ Material ____
274. Anchor Type and Material ____
275. Casing and Door: Thickness ____ Material ____

276. Plenum Chamber:
277. Location ____
278. Lining: Thickness ____ Material ____
279. Anchor Type and Material ____
280. Method of Attaching Anchor to Casing ____
281. Casing: Thickness ____ Material ____

282. Stack:
283. Location ____ Number ____
284. Lining: Thickness ____ Material ____
285. Extent of Lining ____
286. Anchor Type and Material ____
287. Method of Attaching Anchor to Casing ____
288. Plate: Thickness ____ Material ____ Corrosion Allow. ____
289. Outside Metal Diameter ____ Stack Length ____ ft Height Above Grade ____ ft

290. Dampers:
291. Location ____
292. Material: Blade ____ Shaft ____
293. Multiple or Single Leaf ____
294. Description of Provision for Operation From Grade ____
295. ____

296. Notes ____
297. ____
298. ____
299. ____
300. ____
301. ____
302. ____
303. ____
304. ____
305. ____
306. ____
307. ____

MECHANICAL DESIGN
CONSTRUCTION DATA

Miscellaneous:

Platforms:

Type of Flooring ____

Radiant Section, Width and Location ____

____

Convection Section, Width and Location ____

____

____

Stairs, Width and Location ____

Ladders, Location ____

____

Doors:

Radiant, Access, Size and Location ____

Convection/Stack, Access, Size and Location ____

Observation, Size and Location ____

Tube Removal, Size and Location ____

Explosion, Size and Location ____

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

Painting and Galvanizing Requirements ____

____

____

Auxiliary Equipment:

Burners:

Manufacturer and Type ____ Quantity ____

Design and Size ____ Location and Orientation ____

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

Minimum ____ Normal ____ Maximum ____

Design Draft Loss Across Burners, in H_2O ____

Burner Pilot:

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

Type of Ignition ____

Special Requirements (Flame Detection Devices) Etc. ____

____

Sootblowers

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

____

____

____

____

____

MECHANICAL DESIGN CONSTRUCTION DATA

364. Painters Trolley and Rail Included
365. Extent of Tube Handling Facilities
366. Thermocouples, Number and Location
367.
368. Thermowells, Number and Location
369.

370. Air Heater

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

381. Sootblower
382. Water Wash Facilities

383. Materials of Construction
384.
385. Cold Air Bypass Description
386.
387. Fans:

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

408. Damper Actuators
409. Type-Size

CENTRIFUGAL PUMP DATA SHEET

APPLICABLE TO: PROPOSALS ○ PURCHASE ○ AS BUILT ○

NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER:

☐ BY MANUFACTURER

JOB NO. * ITEM NO. *

PURCHASE ORDER NO.

REQUISITION NO.

INQUIRY NO.

DATE REVISION

FOR * SITE *

UNIT * SERVICE *

NO. PUMPS REQ'D * NO. MOTORS REQ'D * ITEM NO. PROVIDED BY MTD BY

NO. TURBINES REQ'D * ITEM NO. PROVIDED BY MTD BY

PUMP MFR SIZE AND TYPE STAGES SERIAL NO.

OPERATING CONDITIONS, EACH PUMP

LIQUID * U.S. GPM at PT. NOR. * RATED *

DISCH. PRESS. PSIG *

PT. F. NOR * MAX. SUCT. PRESS. PSIG MAX * RATED *

SP. GR. at PT * DIFF. PRESS. PSI *

VAP. PRESS. at PT. PSIA * DIFF. HEAD, FT *

VIS. at PT. Ssu * CP NPSHA, FT *

△2 △2 CORR/EROS. CAUSED BY * HYD. HP *

PERFORMANCE

PROPOSAL CURVE NO.

RPM NPSHR (WATER)

EFF * BHP RATED * △2

MAX BHP RATED IMP

MAX. HEAD RATED IMP

MIN. CONTINUOUS GPM

ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

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

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

PRESS: ☐ MAX. ALLOW. PSIG °F: ☐ HYDRO TEST PSIG

CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE

IMPELLER DIA.: ☐ RATED ☐ MAX ☐ TYPE

MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG ☐ WEAR. RG. DIAM./CLRNC.

BEARINGS-TYPE: ☐ RADIAL ☐ THRUST

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

COUPLING: ☐ MFR ☐ MODEL

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

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

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

☐ MFR CODE

SHOP TESTS △2

○ NON-WIT. PERF. ○ WIT. PERF.

○ NON-WIT. HYDRO ○ WIT. HYDRO

○ NPSH REQ'D. ○ WIT. NPSH

○ SHOP INSPECTION

○ DISMANT. & INSP. AFTER TEST

○ OTHER

MATERIALS △2

API CASE/TRIM CLASS ○ * △2

BASEPLATE: ☐

AUXILIARY PIPING

○ C.W. PIPE PLAN ○ CU: ○ S.S.: ○ TUBING: ○ PIPE

☐ TOTAL COOLING WATER REQ'D, GPM ○ SIGHT F.I. REQ'D

○ PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG

○ SEAL FLUSH PIPE PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE

○ EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG

○ AUXILIARY SEAL PLAN ○ C.S. ○ S.S. ○ TUBING ○ PIPE

○ AUX. SEAL QUENCH FLUID

VERTICAL PUMPS △2

PIT OR SUMP DEPTH ○ * △2

MIN. SUBMERGENCE REQ'D. ☐ * △2

COLUMN PIPE: ☐ FLANGED ☐ THREADED

LINE SHAFT: ☐ OPEN ☐ ENCLOSED

BRGS: ☐ BOWL ☐ LINE SHAFT

BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE

FLOAT & ROD ○ C.S. ○ S.S. ○ BRZ ○ NONE

FLOAT SWITCH ☐

PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

△2 △2 HP * RPM * FRAME VOLTS/PHASE/CYCLES *

MFR BEARINGS LUBE

TYPE INSUL FULL LOAD AMPS

ENC TEMP RISE, C LOCKED ROTOR AMPS

○ VHS ○ VSS VERT. THRUST CAP., LB. SERVICE FACTOR

* TURBINE DRIVER

APPROX. WT. PUMP & BASE

MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED

* REQUIRED FOR PHASE O ESTIMATE

BECHTEL

							JOB NO.	DRAWING NO.	REV.
								G	2
NO.	DATE						SHEET	OF	

PUMP NO. *

A. SERVICE

B. LIQUID CHARACTERISTICS

1. LIQUID PUMPED *
2. GPM AT FLOW TEMP. *
3. SPEC. GRAV. AT FLOW TEMP. *
4. FLOW TEMP. °F *
5. VISCOSITY AT FLOW TEMP. (SUS) *
6. VAPOR. PRESS AT FLOW TEMP. (LBS./SQ. IN. ABS.)

C. PRESSURES: (LBS./SQ IN *

1. SUCTION AT PUMP (INCL. C-5). ABSOLUTE
2. DIFFERENTIAL
3. DISCHARGE * ABSOLUTE
4. HYDROSTATIC TEST ON CASE 1-½ x D-5 GAUGE
5. NET POSITIVE SUCTION HEAD (LBS./SQ. IN.) *

D. OPERATION

1. EFFICIENCY AT RATING
2. BHP AT RATING *
3. RPM OF PUMP DRIVE SHAFT *
4. DIRECTION OF ROTATION: CW ____ CCW (FACING PUMP COUPLING)
5. MAX. CASING WORKING PRESS (LBS./SQ. IN. GA.) (SUPPLIER TO FILL OUT C-4)

E. CONSTRUCTION AND MATERIAL

STATE EXTRA COST, IF ANY, FOR EACH ITEM

1. CASE *
2. SHAFT
3. ROTORS *
4. PACKING: NO. OF RINGS
5. LANTERN RING
6. THROAT BUSHING
7. CASING GASKET
8. CASING STUDS
9. GLAND BOLTS
10. FLEXIBLE COUPLING
11. BASE PLATE
12. GLANDS
13. COUPLING GUARD
14. STUFFING BOXES (JACKETED OR PLAIN)
15. STUFFING BOXES - LENGTH ____ INCHES
16. STUFFING BOXES - INSIDE DIAM. ____ INCHES
17. DIAM. SHAFT SLEEVE ____ INCHES
18. WIDTH OF LANTERN RING ____ INCHES
29. C. L. LANTERN RING TO OPEN END OF STUFF. BOX, IN.
20. SIZE OF PACKING ____ IN.
21. BUILT-IN RELIEF VALVE (YES OR NO)
22. RELIEF VALVE SETTING, PSI

F. MANUFACTURER

MANUFACTURER SIZE & TYPE PUMP

1. MODEL NUMBER
2. TYPE (GEAR, VANE, LOBE, SCREW)

G. BEARINGS AND LUBRICATION

STATE EXTRA COST, IF ANY, FOR EACH ITEM

Type & Make

1. THRUST: (STATE SAE NO. ON FINAL DATA SHEET)
2. RADIAL: (STATE SAE NO. ON FINAL DATA SHEET)

3.	GREASE PACKED	FLOOD OILING	RING OILING
THRUST	A	B	C
RADIAL	A	B	C

4. TYPE OF CLOSURES
5. METHOD OF SEALING
6. VISIBLE LUBRICATORS: TYPE
7. VISIBLE LUBRICATORS: CAPACITY

H. CONNECTIONS

1. SUCTION: SIZE
2. SUCTION: RATING
3. SUCTION: FACING
4. DISCHARGE: SIZE
5. DISCHARGE. RATING
6. DISCHARGE. FACING
7. VENTS AND DRAING 1/2" MIMIMUM

I. TESTING

STATE EXTRA COST, IF ANY, FOR EACH ITEM

1. DYNAMIC BALANCING OF ROTORS
2. WITNESSED PERFORMANCE TEST
3. HYDROSTATIC TEST
4. INSPECTION
5. RUNNING TEST WITH ACTUAL DRIVER

J. MISCELLANEOUS

1. PRICE EACH FOB FAS
2. WEIGHT (LBS.) *
3. SHIPMENT FROM RCPT. OF ORDER, WEEKS
4. DRIVER HP *
5. TYPE OF DRIVER: MOTOR OR TURBINE *
6. DRIVER: INTEGRAL, COUPLED
7. TYPE OF DRIVE (DIRECT CONNECTED, GEAR HEAD MOTOR, GEAR REDUCER, VEE BELT)
8. PERFORMANCE CURVE
9. OUTLINE DRAWING
10. CROSS SECTION DWG
11. STATE MFRS. SERIAL NUMBER (ON FINAL DATA SHEET)

NOTE: If each column is not filled out for each pump, bid will be considered incomplete.

Specification No. 14222-A-11 REV 2

This sheet is part of Specification/M/R No.

B. M. No.

FORM H-281 9/66

NO	DATE	REVISIONS	BY	ENGR	CHIEF ENGR	CLIENT
		* REQUIRED FOR PHASE O				

BECHTEL INCORPORATED
HOUSTON

ROTARY PUMP DATA SHEET

JOB NO.	DRAWING NO.	REV.
	G	2

Sheet 23 of 48

CHEMICAL FEED OR PROPORTIONING PUMP DATA SHEET

SPEC. NO. G

REQ'N. NO. ______

PUMP NUMBER					
* PLANT EQUIPMENT NUMBER					
* SERVICE					
CORROSIVE / TOXIC	/	/	/	/	/
LIQUID PUMPED					
* FLOW TEMPERATURE					
* SPECIFIC GRAVITY @ FLOW TEMPERATURE F°					
* VISCOSITY AT FLOW TEMPERATURE (CP)(CS)(SSU)					
VAPOR - PRESS. AT FLOW TEMP. PSIA					
* CAPACITY - GAL/HR @ FLOW TEMPERATURE					
CAPACITY RANGE MAX/MIN	/	/	/	/	/
* SUCTION PRESSURE AT PUMP PSIA					
* DIFFERENTIAL PRESS PSI					
* DISCHARGE PRESS PSIA					
NPSH - AVAILABLE / REQUIRED FT	/	/	/	/	/
* SPEED AT RATING RPM					
CAPACITY ADJUSTABLE WHILE RUNNING					
TYPE CAPACITY ADJUSTMENT					
* BRAKE H.P. - RATING / MAX	/	/	/	/	/
PISTON SPEED AT RATING FT/MIN					
DRIVER - FURNISHED BY:					
* TYPE (MOTOR) (TURBINE) (ETC.)					
* BHP					
* SPEED RPM					
DRIVER DATA SHEET					
GEARS - INTEGRAL OR SEPARATE UNIT					
* CONSTRUCTION - CYL. MATERIAL					
PLUNGER MATERIAL					
GLANDS					
PACKING TYPE					
VALVES - NO SUCTION / NO DISCH.	/	/	/	/	/
VALVE TYPE					
VALVE MATERIAL					
VALVE SEAT MATERIAL					
VALVE SPRINGS					
LANTERN RING					
BASE PLATE					
COUPLING & MECHANISM GUARDS					
COUPLING - MAKE, TYPE & MATERIAL					
DIAPHRAGM MATERIAL					
ELECTRIC SUPPLY ___ V ___ ø ___ ~					

MANUFACTURER					
MFR'S. TYPE & SIZE DESIGNATION					
DIAMETER OF PISTON OR PLUNGER / MAX STROKE	/	/	/	/	/
HORIZONTAL OR VERTICAL					
NUMBER OF CYLINDERS					
SINGLE OR DOUBLE ACTING					
MAXIMUM ALLOWABLE SPEED RPM					
MAX. ALLOWABLE PRESS. WITH PROPOSED DRIVER PSI					
MAX. PRESSURE WITH MAX. DRIVER PSI					
SUCTION VALVE AREA IN^2					
PRESSURE TO LIFT VALVES PSI					
VALVE SEATS RENEWABLE					
TYPE OF DRIVER COUPLING					
BEARINGS - TYPE					
LUBRICATION					
BEARING CLOSURES					
GEAR LUBRICATION					
CONNECTION - SIZE SUCTION/DISCHARGE IN	/	/	/	/	/
TYPE OR FACING SUCTION/DISCHARGE	/	/	/	/	/
PRESSURE RATING SUCTION/DISCHARGE	/	/	/	/	/
SIZE OF VENTS/DRAINS	/	/	/	/	/
PACKING - SIZE / NO. RINGS PER BOX	/	/	/	/	/
STUFFING BOX LENGTH / ID IN	/	/	/	/	/
NUMBER OF BOXES PER PUMP					
RECOMMENDED PACKING					
SIZE & LOCATION FLUSHING CONNECTION					
HYDROSTATIC TEST PSI					
RUNNING TEST REQ'D.					
SHIPPING WEIGHT, EACH LB.					
* REQUIRED FOR PHASE 0					

BECHTEL

REV. & DATE 2 / 1 / 0

NOTES:

SPECIFICATION No. 14222-A-17 REV.2

PUMP FOR ______ PLANT

______ PROJECT

JOB NO.	REV.
G	2

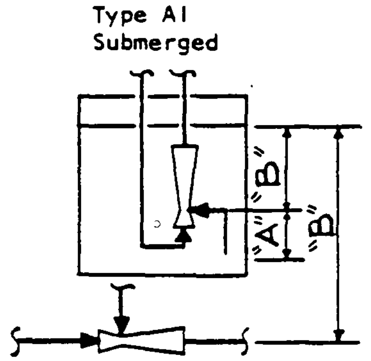
Sheet 24 of 48

FORM H-222 9-66

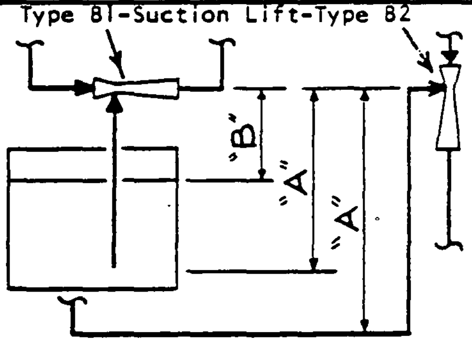
SERVICE:	STEAM JET LIQUID EDUCTOR NO.		
MATERIAL HANDLED:			REMARKS

OPERATING CONDITIONS	Volume Flow (MIN) (AVG)	GPM	*	
	Mass Flow	LB/HR	*	
	Suction Temp.	°F	*	
	Sp. Grav. @ Flow Temp. Norm/Des.			
	Vapor Press. @ T = °F	PSIA		
	@ T = °F	PSIA		
	Spec. Heat	BTU/LB °F	*	
	Viscosity @ T = °F	CP		
	Norm Boil. Pt. @ PSIA	°F		
	Manufacturer	*		
	Model No./Throat Diam.	*		
	Discharge Temp.	°F*	*	
	Actual Capacity Start/Finish	GPM*	*	
	Steam or Water Rate @ Spec. Press	LB/HR*		
	Motive Fluid/PSIG (operating)			
Suction Condi-tions	Suction Line Loss (Line Size ")	FT		
	Suction Lift Start/Finish (B/A)	FT		
	Total Lift Start/Finish	FT		
	NPSH Available Start/Finish	FT		
Disch. Des. Cond.	Discharge Line Loss (Line Size ")	FT		
	Discharge Lift	FT		
	Total Discharge Head (inc. static press)	FT		
Con-nec-tions	Suction Size/Rating	*		
	Discharge Size/Rating	*		
	Motive Fluid Size/Rating	*		
Materials of Construction	Body/Jet		*	
	Diffuser			
Corrosion Allowance	Int/Ext			
Installation Diagram Type				

* By Seller



Type A2-Flooded Suction



A - Suction Lift, Design (Max.) (Fin)
B - Suction Lift (Min.) (Start)

R&C SFE FORM 120 (3/72)

NO.	DATE	REVISIONS	BY	CHK D	DESIGN SUPV	ENG R	PROJ ENGR	APPR
△								
△								
△		* REQUIRED FOR PHASE O						

SCALE	DESIGNED	DRAWN	CHIEF ENGR
ORIGIN	BECHTEL	STEAM JET LIQUID EDUCTOR DATA SHEET	JOB No.
			DRAWING No. H
			REV. 2

"A" SIZE

APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT DATE ____________ REVISION ____________
FOR * ____________ UNIT * ____________
SITE * ____________ SERIAL NO. ____________
SERVICE * ____________ NO. REQUIRED * ____________
MANUFACTURER ____________ MODEL ____________ DRIVER * ____________
NOTE ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER: ☐ BY MANUFACTURER

OPERATING CONDITIONS

		*	OTHER CONDITIONS			
(ALL DATA ON PER UNIT BASIS) △2	NORMAL	RATED	A	B	C	D
○ GAS HANDLED (ALSO SEE PAGE ____) △2 *						
○ MMSCFD/SCFM (14.7 PSIA & 60°F DRY) △2 *						
○ WEIGHT FLOW, #/MIN (WET) (DRY) △2 *						
INLET CONDITIONS:						
○ PRESSURE (PSIA) △2 *						
○ TEMPERATURE (°F) △2 *						
○ RELATIVE HUMIDITY (%) △2 *						
○ MOLECULAR WEIGHT (M) △2 *						
☐ $C_p/C_v (K_1)$ OR (K_{AVG}) △2 *						
☐ COMPRESSIBILITY (Z_1) OR (Z_{AVG}) △2 *						
☐ INLET VOLUME, (CFM-WET) △2 *						
DISCHARGE CONDITIONS:						
○ PRESSURE (PSIA) △2 *						
☐ TEMPERATURE (°F) △2 *						
☐ $C_p/C_v (K_2)$ OR (K_{AVG}) △2 *						
☐ COMPRESSIBILITY (Z_2) OR (Z_{AVG}) △2 *						
☐ BHP REQUIRED (ALL LOSSES INCL) △2 *						
☐ SPEED (RPM) △2 *						
☐ ESTIMATED SURGE, ICFM (AT SPEED ABOVE)						
☐ POLYTROPIC HEAD (FT)						
☐ POLYTROPIC EFFICIENCY (%)						
○ GUARANTEE POINT						
☐ PERFORMANCE CURVE NO.						

△2 PROCESS CONTROL:

METHOD: ○ BYPASS FROM ____________ TO ____________
○ ANTI-SURGE BYPASS: ○ MANUAL ○ AUTO
○ SUCTION THROTTLING FROM ____________ TO ____________
○ SPEED VARIATION FROM ____________ TO ____________
○ OTHER ____________
SIGNAL: ○ SOURCE ____________
○ TYPE ____________
○ RANGE: FOR PNEUMATIC CONTROL ________ RPM @ ________ PSIG & ________ RPM @ ________ PSIG ________
OTHER ____________

SERVICE: ○ CONTINUOUS ○ INTERMITTENT ○ STAND BY

REMARKS: ____________

* REQUIRED FOR PHASE O

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG'R	PROJ ENGR	APPR
△								
△								
△								

SCALE	DESIGNED	DRAWN	CHIEF ENGR

ORIGIN

BECHTEL

CENTRIFUGAL COMPRESSOR DATA SHEET

JOB No.

DRAWING No.	REV.
DS- K	2

CENTRIFUGAL COMPRESSOR DATA SHEET

△2

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

LOCATION *

○ INDOOR ○ HEATED ○ UNDER ROOF

○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES

○ GRADE ○ MEZZANINE ○ ____

○ ELECTRICAL AREA CLASS GR. ____ DIV. ____

○ WINTERIZATION REQD. ○ TROPICALIZATION REQD.

SITE DATA: △2 SEE 14222-A-3

○ ELEVATION * FT. BAROMETER * PSIA

○ RANGE OF AMBIENT TEMPS.:

	DRY BULB	WET BULB
SITE RATED °F		
NORMAL °F		
MAXIMUM °F *		
MINIMUM °F *		

UNUSUAL CONDITIONS: ○ DUST ○ FUMES

○ OTHER ____

NOISE SPECIFICATIONS: △2

○ APPLICABLE TO MACHINE:

SEE SPECIFICATION 14222-A-3 SH.21

○ APPLICABLE TO NEIGHBORHOOD

SEE SPECIFICATION ____

ACCOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS.

API 617 CENTRIFUGAL COMPR. FOR GEN. REFINERY SERVICES

PAINTING: △2

○ MANUFACTURER'S STD.

○ OTHERS ____

SHIPMENT:

○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD.

○ OUTDOOR STORAGE OVER 6 MONTHS

REMARKS: ____

CENTRIFUGAL COMPRESSOR DATA SHEET

CONSTRUCTION FEATURES

☐ **SPEEDS:**

MAX. CONT ____ RPM TRIP ____ RPM

MAX. TIP SPEEDS: ____ FPS @ RATED SPEED

____ FPS @ MAX. CONT. SPEED

☐ **LATERAL CRITICAL SPEEDS:**

FIRST CRITICAL ____ RPM

DAMPED ____ UNDAMPED ____

MODE SHAPE ____

SECOND CRITICAL ____ RPM

DAMPED ____ UNDAMPED ____

MODE SHAPE ____

THIRD CRITICAL ____ RPM

DAMPED ____ UNDAMPED ____

MODE SHAPE ____

FOURTH CRITICAL ____ RPM

DAMPED ____ UNDAMPED ____

MODE SHAPE ____

LATERAL CRITICAL SPEED — BASIS.

- ☐ DAMPED UNBALANCE RESPONSE ANALYSIS
- ☐ SHOP TEST
- ☐ OTHER TYPE ANALYSIS

☐ **TORSIONAL CRITICAL SPEEDS:**

FIRST CRITICAL ____ RPM

SECOND CRITICAL ____ RPM

THIRD CRITICAL ____ RPM

FOURTH CRITICAL ____ RPM

☐ **VIBRATION:**

ALLOWABLE TEST LEVEL ____ MILS (PEAK TO PEAK)

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

☐ **CASING:**

MODEL ____

CASING SPLIT ____

MATERIAL ____

THICKNESS (IN.) ____ CORR. ALLOW (IN.) ____

MAX WORK PRESS ____ PSIG MAX DESIGN PRESS ____ PSIG

TEST PRESS (PSIG) HELIUM ____ HYDRO ____

MAX OPER TEMP ____ F MIN OPER TEMP ____ F

MAX NO OF IMPELLERS FOR CASING ____

MAX CASING CAPACITY (ICFM) ____

RADIOGRAPH QUALITY ○ YES ____ ○ NO ____

CASING SPLIT SEALING ____

____

☐ **DIAPHRAGMS:**

MATERIAL ____

☐ **IMPELLERS:**

NO ____ DIAMETERS ____

NO VANES EA IMPELLER ____

TYPE (OPEN, ENCLOSED, ETC.) ____

TYPE FABRICATION ____

MATERIAL ____

MAX. YIELD STRENGTH (PSI) ____

BRINNEL HARDNESS. MAX. ____ MIN. ____

SMALLEST TIP INTERNAL WIDTH (IN.) ____

MAX. MACH NO. @ IMPELLER EYE ____

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

☐ **SHAFT:**

MATERIAL ____

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

SHAFT END: ☐ TAPERED ☐ CYLINDRICAL

MAX. YIELD STRENGTH (PSI) ____

☐ **BALANCE PISTON:**

MATERIAL ____ AREA ____ (IN.²)

FIXATION METHOD ____

SHAFT SLEEVES:

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

○ AT SHAFT SEALS ____ ☐ MATL. ____

____

____

☐ **LABYRINTHS:**

INTERSTAGE

TYPE ____ MATERIAL ____

BALANCE PISTON

TYPE ____ MATERIAL ____

SHAFT SEALS:

☐ TYPE ____

○ SEAL SYSTEM TYPE ____

○ SETTLING OUT PRESSURE ____

☐ INNER OIL LEAKAGE GUAR (GAL/DAY/SEAL) ____

○ TYPE BUFFER GAS ____

☐ BUFFER GAS FLOW (PER SEAL) ____

NORMAL ____ #/MIN @ ____ PSI △ P ____

MAX ____ #/MIN @ ____ PSI △ P ____

○ BUFFER GAS REQUIRED FOR

- ☐ START-UP
- ☐ AIR RUN-IN
- ☐ OTHER ____

☐ BUFFER GAS CONTROL

SYSTEM SUPPLIED BY ____

☐ **BEARING HOUSING CONSTRUCTION:**

TYPE (SEPARATE INTEGRAL) ____ SPLIT ____

MATERIAL ____

REMARKS: ____

____

____

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

CONSTRUCTION FEATURES, CONT'D

☐ **RADIAL BEARINGS:**

TYPE ______________ SPAN (IN) ______________
AREA (IN²) ________ LOADING (PSI) ACT ________ ALLOW ________
CENTER PIVOT ______________
OFFSET PIVOT ______________
% ______________
PAD MATERIAL ______________
TYPE BABBITT ______________
BABBITT THICKNESS ______________

☐ **THRUST BEARING:**

LOCATION ______________ TYPE ______________
MFR ______________ AREA (IN²) ______________
LOADING (PSI) ACTUAL ________ ALLOWABLE ________
GAS LOADING (LB) ________ CPLG SLIP LOAD (LB) ________
CPLG COEFF FRICT ________ CPLG GEAR PITCH DIA (IN) ________
BAL PISTON COMPENSATING LOAD ______________ LB
CENTER PIVOT ______________
OFFSET PIVOT ______________
% ______________
PAD MATERIAL ______________
TYPE BABBITT ______________
BABBITT THICKNESS ______________

☐ **MAIN CONNECTIONS:**

	SIZE	ANSI RATING	FACING	POSITION	FLANGE VEL FPS
INLET					
DISCHARGE					
________					
________					
________					
________					

☐ **OTHER CONNECTIONS:**

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

☐ **ALLOWABLE PIPING FORCES AND MOMENTS:**

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

INSTRUMENTATION
PANEL SUPPLIED BY ______________

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

PHASE ANGLE TRANSDUCER
NUMBER ________ LOCATION ______________

VIBRATION DETECTORS:

○ TYPE ______________ ☐ MODEL ______________
○ MFR ______________
○ NO AT EACH SHAFT BEARING ________ TOTAL NO ________
○ OSCILLATOR-DETECTORS SUPPLIED BY ______________
○ MFR ______________ ☐ MODEL ______________
○ MONITOR SUPPLIED BY ______________
○ LOCATION ______________ ENCLOSURE ______________
○ MFR ______________ ☐ MODEL ______________
☐ SCALE RANGE ____ ○ ALARM ☐ SET @ ____________ MILS
○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ____ SEC

AXIAL POSITION DETECTOR:

○ TYPE ______________ ☐ MODEL ______________
○ MFR ______________ ○ NO REQUIRED ________
○ OSCILLATOR-DEMODULATOR SUPPLIED BY ______________
○ MFR. ______________ ☐ MODEL ______________
○ MONITOR SUPPLIED BY ______________
○ LOCATION ______________ ENCLOSURE ______________
○ MFR ______________ ☐ MODEL ______________
☐ SCALE RANGE ____ ○ ALARM ☐ SET @ ____________ MILS
○ SHUTDOWN ☐ SET @ ___ MILS ○ TIME DELAY ____ SEC

CENTRIFUGAL COMPRESSOR DATA SHEET (Cont'd)

CONSTRUCTION FEATURES, CONT'D

COUPLINGS:

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

SHOP INSPECTION AND TESTS:

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

BASEPLATE & SOLEPLATES:

SOLEPLATES FOR. ○ COMPRESSOR ○ GEAR ○ DRIVER

BASEPLATE.

○ COMMON (UNDER COMP , GEAR & DRIVER)

○ UNDER COMP ONLY ○ OTHER ______________

○ DECKED WITH NON-SKID DECK PLATE ○ OPEN CONSTR

○ DRIP RIM ○ WITH OPEN DRAIN

○ HORIZ. ADJUSTING SCREWS FOR EQUIPMENT

○ SUITABLE FOR POINT SUPPORT

○ SUITABLE FOR PERIMETER SUPPORT

○ STAINLESS SHIMS THICKNESS ______________

☐ GROUTING TYPE ______________

☐ WEIGHTS (LB):

COMPR ______ GEAR ______ DRIVER ______ BASE ______

ROTORS. COMPR. ______ DRIVER ______ GEAR ______

COMPR UPPER CASE ______________

L.O CONSOLE ______________ S.O CONSOLE ______________

MAX FOR MAINTENANCE (IDENTIFY) ______________

TOTAL SHIPPING WEIGHT ______________

☐ SPACE REQUIREMENTS (FT & IN.):

COMPLETE UNIT	L ______	W ______	H ______
L.O CONSOLE	L ______	W ______	H ______
S.O CONSOLE.	L ______	W ______	H ______

MISCELLANEOUS:

☐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION ______________

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

○ OPTICAL ALIGNMENT FLATS REQUIRED ON COMPRESSOR, GEAR & DRIVER

○ PROVISION FOR WATER WASHING BEFORE OPENING CASING BY ______________

○ TORSIONAL ANALYSIS REPORT REQUIRED

REMARKS:

CENTRIFUGAL COMPRESSOR DATA SHEET

UTILITIES

UTILITY CONDITIONS:

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

ELECTRICITY: △2

	DRIVERS	HEATING	CONTROL	SHUTDOWN
VOLTAGE	*			
HERTZ	*			
PHASE	*			

COOLING WATER: △2

TEMP INLET * F — MAX RETURN * F

PRESS NORM * PSIG — DESIGN * PSIG

MIN RETURN * PSIG — MAX ALLOW Δ P ______ PSI

WATER SOURCE *

INSTRUMENT AIR:

MAX PRESS ______ PSIG — MIN PRESS ______ PSIG

☐ **TOTAL UTILITY CONSUMPTION:**

COOLING WATER ______ GPM

STEAM, NORMAL ______ #/HR

STEAM, MAX ______ #/HR

INSTRUMENT AIR ______ SCFM

HP (DRIVER) ______ HP

HP (AUXILIARIES) ______ HP

△2 **REMARKS:**

* DRIVER HP

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET

APPLICABLE TO: △ ○ PROPOSAL ○ PURCHASE ○ AS BUILT
FOR ____ * △2 ____ UNIT ____ * △2 ____
SITE ____ * △2 ____ MODEL NO. ____
SERVICE ____ * △2 ____ TYPE ____
MANUFACTURER ____ NO. REQUIRED * △2 ____ SERIAL NO. ____

NOTE: ○ Indicates information to be completed by PURCHASER ☐ by MANUFACTURER

OPERATING CONDITIONS

INDICATE GUARANTEE POINT BY •

	POWER, Hp	SPEED, RPM	STEAM RATE LB/Hp – HR
☐ Rated	____	____	____
☐ Normal	____	____	____
☐	____	____	____

☐ Steam Rates Based on Output Shaft of: ☐ Turb. ☐ Gear
Exhaust Enthalpy @ Rated Point ____ BTU/LB

SPEEDS:
Criticals: 1st ____ RPM 2nd ____ RPM Trip ____ RPM
Max. Continuous ____ RPM

STEAM CONDITIONS:

○ INLET STEAM * △2
Rated (Normal) ____ PSIG ____ °FTT
Maximum ____ PSIG ____ °FTT
Minimum ____ PSIG ____ °FTT

○ EXHAUST STEAM:
Rated (Normal) * △2 ____ PSIG/In. HgA ____ °FTT
Maximum ____ PSIG/In. HgA ____ °FTT
Minimum ____ PSIG/In. HgA ____ °FTT

○ EXTRACTION STEAM ____ Controlled ____ Uncontrolled
Rated (Normal ____ PSIG ____ °FTT
Maximum ____ PSIG ____ °FTT
Minimum ____ PSIG ____ °FTT
Flow (lb/hr) ____ Normal ____ Max ____ Min

○ ADMISSION STEAM ____ Controlled ____ Uncontrolled
Rated (Normal) ____ PSIG ____ °FTT
Maximum ____ PSIG ____ °FTT
Minimum ____ PSIG ____ °FTT
Flow (lb/hr) ____ Normal ____ Max ____ Min

☐ Max Throttle Flow ____ lb/hr
☐ Max. Flow to Condenser ____ lb/hr @ ____ In. HgA
☐ Max. Exhaust Temp in Operation ____ °F
☐ Max BHP Required @ Min/Inlet Max Exh ____ Bhp

DUTY * △2
○ Continuous ○ Intermittent ○ Auto Start

LOCATION: * △2
○ Indoor ○ Heated ○ Under Roof
○ Outdoor ○ Unheated ○ Partial Sides
○ Grade ○ Mezzanine
○ Winterization Req'd ○ Tropicalization Req'd

SITE DATA △2
○ Elevation * ____ Ft. ○ Bar * ____ PSIA/In.HgA
○ Temperature * ____ °F Summer * ____ °F Winter
○ Relative Humidity ____ % Design Wet Bulb * ____ °F

UNUSUAL CONDITIONS
○ Dust ○ Fumes ____
○ Other ____

CONSTRUCTION FEATURES

TURBINE TYPE:
○ Horizontal ○ Vertical ☐ Single-Valve ☐ Multi-Valve
☐ No. Stages: ____ Impulse ____ Reaction
☐ Overspeed Trip Device ____ Mech ____ Elect ____ Hyd
○ Casing Split: ____ Horizontal ____ Vertical
☐ Rotor: ____ Solid ____ Built-Up ____ Combination
☐ Rotation (Facing Gov. End.): ____ CW ____ CCW
☐ Exhaust Flow ____ Single ____ Double

GOVERNOR TYPE:
○ Electronic ○ Hydraulic ○ Oil Relay ○ Direct Acting
○ NEMA Class ____
○ Governor MFR ____ ☐ Model ____
☐ Synch. Motor ____ HP ☐ Oil Cooler ☐ Oil Heater
☐ Power Cylinder ○ Governor Purge Required
○ Stn. Stl. Pins & Bushings in Gov-Linkage
○ Isochronous Control ○ Speed Droop Control
☐ Speed Changer ____ Manual ____ Pneumatic ____ Electronic
☐ Speed Range ____ RPM @ ____ PSIG/mA to
____ RPM @ ____ PSIG/mA

VALVES:

	Cam Lift	Bar Lift	Grid Valve
☐ No. Auto Gov Valves ____	—	—	—
☐ No. Auto Extr Valves ____	—	—	—
☐ No. Auto Adm Valves ____	—	—	—

○ Separate Trip & Throttle Valve ____ Hyd ____ Mech
____ Remote Trip ____ Manual Actuation
____ Spring Support Req'd ____ Manual Excersiser
○ Extraction Non-Return Valve ____ Hyd ____ Mech
____ Remote Trip ____ Manual Actuation
○ Admission Stop Valve ____ Hyd ____ Mech
____ Remote Trip ____ Manual Actuation
○ Auto Valves arranged to close on Trip ____ Yes ____ No

BLADES (BUCKETS):
☐ Max Tip Speed ____ FPS
☐ Final Stage Blade Length ____ in Max Length ____ in
☐ Nozzle Ring ____ % Admission ____ Welded ____ Removable
☐ Blade Root ____ Dovetail ____ "T" ____ Fir Tree
☐ Shrouds: ____ Welded ____ Riveted ____ Wire Damp

△								
△								
△		* REQUIRED FOR PHASE 0						
No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG R	PROJ ENGR	APPR

SCALE · DESIGNED DRAWN CHIEF ENGR

ORIGIN

SPECIAL-PURPOSE STEAM TURBINE DATA SHEET

JOB No.

DRAWING No.	REV.
DS- KT	2

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

CONSTRUCTION FEATURES

BEARING HOUSING CONSTRUCTION:

☐ Type (Separate, Integral) ______________ Split ______________

☐ Material ______________

RADIAL BEARINGS:

☐ Type ______________ Brg. Span (In.) ______________

☐ Area (In^2) ______ Loading (PSI): Act. ______ Allow. ______

THRUST BEARING:

☐ Location ______________ Type ______________

☐ MFR ______________ Area (In^2) ______________

☐ Loading PSI Act. ______ Allow. ______________

PACKING TYPE:

☐ Interstage Gland Seals ______________

☐ End-Gland Seals ______________ No. Per Box ______________

☐ ΔP Per Seal ______________ PSI ☐ Material ______________

○ Insulation ______________ Jacket Material ______________

☐ Total Expected Leakage ______________ Lb/Hr. ______

☐ Labyrinth Type ______________ Stationery ______________ Rotating

GLAND SEALING SYSTEM ○ See Separate Data Sheet Attached

○ Gland Condenser w/Mounting Feet Req'd.

○ Steam Ejector Req'd. ________PSIG ______________°FTT

○ Vacuum Device Req'd. ○ Compound Press. Gauge Req'd.

○ Auto. Pressure Control Valve (Motive Steam) (Sealing Steam)

○ Gld. Cond. Drain: _____ Loop Seal _____ Vertical Leg

_____ Other ______________

☐ Minimum Cond. Drain Height ______________ In.

○ Relief Valve on Sealing Steam Header

CAPABILITIES:

☐ Max. Steam Thru Inlet Valve ______________ lb/hr*

☐ Max. Steam Thru Exhaust Valve ______________ lb/hr*

☐ Steam Inlet Parts:

Max. Allow Press. ________PSIG Temp______________°F

☐ Exhaust End Casing:

Max. Allow. Pressure ______________ PSIG/In. HgA

Max. Allow. Temperature ______________°F

Max. Expected Temp. During No-Load Run-In ______________°F

☐ Sentinel Warning Valve Set @______________PSIG

☐ Hydrostatic Test Pressure:

Steam Inlet Parts ________ PSIG

Exhaust End ______________ PSIG/In. HgA

☐ Future Potential Maximum Horsepower ______________ BHP*

* With Minor Modifications

TURBINE MATERIALS:

☐ High Press. Casing ______________

☐ Exhaust Casing ______________ ☐ Mid Casing ______________

☐ Nozzles ______________ ☐ Blades ______________

☐ Wheel ______________ ☐ Shaft ______________

☐ Steam Chest ______________

☐ Diaphrams ______________

☐ Nozzle Rings ______________

☐ Shrouds ______________

☐ Gov. Valve Trim ______________

☐ Labyrinth Seals ______________

☐ Shaft Materials under Seals ______________

☐ ____ Applied By _____ Spraying _____ Placing _____ Sleeves

MAIN CONNECTIONS:

	SIZE	ANSI RATING	FACING	POSITION
☐ Inlet				
☐ Exhaust				
☐ Extraction				
☐ Admission				

ALLOWABLE PIPING FORCES AND MOMENTS:

	INLET FORCE MOM'T		EXHAUST FORCE MOM'T		EXTR./ADM. FORCE MOM'T	
	LB	FT LB	LB	FT LB	LB	FT LB
☐ Parallel to Shaft						
☐ Vertical						
☐ Horiz 90°						

OTHER CONNECTIONS:

SERVICE	NO.	SIZE	ANSI RATING	FACING
☐ Lube Oil Inlet				
☐ Lube Oil Outlet				
☐ Gland Condenser Conn				
☐ Staging Drains				
☐ Steam Ring Drain				
☐ T&T Valve H.P. Stem Leakoff				
☐ T&T Valve L.P. Stem Leakoff				
☐ T&T Valve Above Seat Drain				
☐ T&T Valve Below Seat Drain				
☐ Cooling Water Conn.				
☐ Purge for Brg Housing				
☐ Exhaust Case				

BASEPLATES & SOLEPLATES:

○ Baseplate By ______________

○ Decked with Non-Skid Deck Plate ○ Open Construction

○ Drip Rim ______________ With Open Drain ______________

○ Under Turbine Only ______ Other ______________

○ Soleplate By ______________

○ Horiz. Adjusting Screws for Equipment ______________

○ Furnish SS Shims

○ Foundation Bolts Furn. By: ________ Vendor ________ Purchaser

☐ Leveling (Chock) Blocks Req'd.

REFERENCE SPECIFICATION:

API 612 SPECIAL PURPOSE STEAM TURBINE

____

____

____

____

____

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

UTILITIES

COOLING WATER: △2

	NORM	MAX	DESIGN
○ Supply Pressure, PSIG	*		
○ Supply Temp., °F	*		
○ Pressure Drop, PSI	*		

○ Max. Temperature Rise Allowed * °F

☐ Quantity Required

____ GPM For ________

____ GPM For ________

AUXILIARY STEAM SUPPLY: * △2

○ Supply Pressure, PSIG

Normal ____ Max ____ Min ____

○ Temperature ____ °F Nor ____ Max ____ Min ____

☐ Quantity Required

____ Lbs/Hr For ________

____ Lbs/Hr For ________

INSTRUMENT AIR SUPPLY: * △2

○ Pressure PSIG ____ Max. ____ Min.

AUXILIARY MOTORS: * △2

○ ____ Volts ____ Phase ____ Hertz

INSTRUMENTATION

Gauge Readout In ☐ English ☐ SI ☐ Dual ☐ Other ________

NOTE: ☐ SUPPLIED BY VENDOR ○ SUPPLIED BY PURCHASER △ LOCATED ON A MACHINE MOUNTED INSTRUMENT BOARD

PRESSURE GAGE REQUIREMENTS:

FUNCTION	LOCALLY MOUNTED	LOCAL PANEL	FUNCTION	LOCALLY MOUNTED	LOCAL PANEL
Lube Oil Pump Discharge	☐ ○ △	☐ ○	1st Stage Steam	☐ ○ △	☐ ○
Lube Oil Filter ΔP	☐ ○ △	☐ ○	Steam Chest	☐ ○ △	☐ ○
Lube Oil Supply	☐ ○ △	☐ ○	Exhaust Steam	☐ ○ △	☐ ○
Gov. Control Oil	☐ ○ △	☐ ○	Extraction Steam	☐ ○ △	☐ ○
Gov. Control Oil ΔP	☐ ○ △	☐ ○	Steam Ejector	☐ ○ △	☐ ○
Coupling Oil ΔP	☐ ○ △	☐ ○	Steam Seal	☐ ○ △	☐ ○
Main Steam Inlet	☐ ○ △	☐ ○		☐ ○ △	☐ ○

TEMPERATURE GAGE REQUIREMENTS:

FUNCTION	LOCALLY MOUNTED	LOCAL PANEL	FUNCTION	LOCALLY MOUNTED	LOCAL PANEL
Lube Oil Discharge From Each	☐ ○ △	☐ ○	Cooler Oil Inlet & Outlet	☐ ○ △	☐ ○
Turbine Journal Bearing	☐ ○ △	☐ ○	Steam Inlet	☐ ○ △	☐ ○
Turbine Thrust Bearing	☐ ○ △	☐ ○	Steam Exhaust	☐ ○ △	☐ ○
Gear Journal Bearing	☐ ○ △	☐ ○		☐ ○ △	☐ ○

ALARM & SHUTDOWN FUNCTIONS

FUNCTION	PRE ALARM	TRIP	FUNCTION	PRE ALARM	TRIP
☐ ○ Low Lube Oil Pressure Ea. Level			☐ ○ Turbine Vibration		
☐ ○ Hi Oil Filter ΔP			☐ ○ Turbine Axial Position		
☐ ○ Aux Lube Oil Pump Start			☐ ○ Trip & Throttle Valve Position		
☐ ○ Hi Oil Cooler Outlet Temp.			☐ ○ Hi Turb. Steam Seal Leakage		
☐ ○ Low Control Oil Pressure			☐ ○ Hi Turb. Exh. Pressure		
☐ ○			☐ ○ Hi Turb. Ext. Pressure		
☐ ○			☐ ○ Turb. Overspeed Trip Operation		

MISCELLANEOUS INSTRUMENTATION:

☐ ○ Turbine Speed Pick-Up Devices ☐ Electronic ☐ Other ________

☐ ○ Turbine Speed Indicators

☐ ○ Turbine Speed Indicators Located On ☐ Local Panel ☐ Main Board Type ☐ Digital ☐ Dial Gauge

☐ ○ Remote Hand Speed Changer – Mounted on Local Panel

☐ ○ Alarm Horn & Acknowledgement Switch on Panel (Local) (Main)

☐ ○ ________

☐ ○ ________

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

COUPLING:

○ Mount 1/2 Coupling ○ Type ___________
☐ MFR ___________
☐ Spacer Req'd ___________
○ Coupling Furnished by ___________
☐ Keyed (1) or (2), or Hydr. Fit ___________
☐ Cplg. Coeff. Frict ___ Cplg. Gear Pitch Dia. _______ in.
Turbine Shaft. _____ Taper _____ Cylindrical
Generator Shaft: _____ Taper _____ Cylindrical
Coupling Guard: _____ Mfr. Std. _____ Other
☐ Lubrication Req'd. ___ Yes ___ No

COMPOSITE TORSIONAL ANALYSIS:

○ Required ○ By ___________

LATERAL CRITICAL SPEED ANALYSIS:

○ Required ○ By ___________

SHOP INSPECTION AND TESTS:

	REQ'D	WITNESS
○ Shop Inspection	○	○
○ Hydrostatic (Piping, Casing, Condenser)	○	○
○ Blade Shaker (Static) – Rows	○	○
○ Rotor Balance: ___ Vacuum Pit ___ Std.	○	○
○ Rotor Thermal Stability	○	○
○ Mechanical Run: ___ w/Job Cplg. 1/2	○	○
○ Run Spare Rotor: ___ w/Job Cplg. 1/2	○	○
○ Performance Test: ___ Part Load ___ Full Load	○	○
○ Functional Test: ___ T & T Valve	○	○
___ Turning-Gear	○	○
___ Gland Condenser	○	○
___ Sealing System	○	○
___ Lube Oil System	○	○
○ Governor Stability	○	○
○ Turb. Run at Overspeed and Trip	○	○
○ Use Shop Lube System	○	○
○ Use Job Lube System	○	○
○ Use Job Vib & Axial Disp. Probes.	○	○
○ Oscillator-Demodulators & Monitor	○	○
○ Use Shop Vibration Probes, etc.	○	○
○ X–Y–Y' Plot	○	○
○ Check Brg. & Seals after Test	○	○
○ Noise Level Test	○	○
○ Preparation for Shipment	○	○
○ FM Tape Recording (Vibration)	○	○
○ Cleanliness Inspection (Para. 4.2.6)	○	○
○ Hardness Tests (Para. 4.2.7)	○	○

OIL REQUIREMENTS:

	CONTROL OIL	LUBE OIL
☐ Max. Quantity, GPM		
☐ Pressure, PSIG		
☐ Temperature, °F		
☐ Total Heat Reject BTU/Hr		

○ Oil Required for ___ T&T Valve ___ Hyd Non-Return Valve
☐ Oil Viscosity _______ SSU @ 100°F

VIBRATION DETECTORS:

○ Type ___________ ☐ Model ___________
○ Mfr. ___________
○ No. at Each Shaft Bearing ___________ Total No. _______
○ Oscillator Demudulators Supplied by ___________
  ○ Mfr. ___________ ☐ Model ___________
○ Monitor Supplied by _______ No. Channels _______
  ○ Location ___________ Enclosure ___________
  ○ Mfr. ___________ ☐ Model ___________
  ☐ Scale Range _______ ○ Alarm ☐ Set @ _____ Mils
  ○ Shutdown ☐ Set @ ___ Mils ○ Time Delay _____ Sec.

AXIAL MOVEMENT DETECTORS:

○ Type ___________ ☐ Model ___________
○ Mfr. ___________ No. Required ___________
○ Oscillator Demodulators Supplied by
  ○ Mfr. ___________ ☐ Model ___________
○ Monitor Supplied by _______ No. Channels _______
  ○ Location ___________ Enclosure ___________
  ○ Mfr. ___________ ☐ Model ___________
  ☐ Scale Range _______ ○ Alarm ☐ Set @ _____ Mils
  ○ Shutdown ☐ Set @ _____ Mils ○ Time Delay _____ Sec.

KAYPHAZOR SENSOR:

○ Type ___________ ☐ Model ___________
○ Mfr. ___________ ○ No. Required ___________
○ Location ___________
○ Oscillator Demodulators Supplied by ___________
  ○ Mfr. ___________ ☐ Model ___________
○ Monitor Supplied by _______ No. Channels _______
  ○ Location ___________ Enclosure ___________
  ○ Mfr. ___________ ☐ Model ___________

BEARING TEMPERATURE DEVICES:

○ Thermistors
  ○ Type ___ Pos. Temp. Coeff. ___ Neg. Temp. Coeff.
  ○ Temp. Switch & Indicator By ___ Purch. ___ Mfr.
○ Thermocouples
  ○ Selector Switch & Indicator By ___ Purch. ___ Mfr.
○ Resistance Temp. Detectors
  ○ Resistance Mat'l ___________ ☐ ___________ OHMS
  ○ Selector Switch & Indicator By: ___ Purch. ___ Mfr.
○ LOCATION – JOURNAL BRG
  No.: ___ Ea. Pad ___ Every Other Pad ___ Per Brg.
  ___ Other ___________
○ LOCATION – THRUST BRG:
  No. (Act): ___ Ea. Pad ___ Every Other Pad ___ Per Brg.
  ___ Other ___________
  No. (Inact.): ___ Ea. Pad ___ Every Other Pad ___ Per Brg.
  ___ Other ___________
☐ Max. Bearing Temps.:
  ___________ °F for Alarm ___________ °F for Shutdown

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

INSTRUMENTATION

EXHAUST RELIEF VALVE REQUIREMENTS:

○ Max. Set Pressure ____________ PSIG Exhaust
○ Steam Flow ____________ Lb/Hr
○ Supplied By ______ Purchaser ______ Vendor

EXTRACTION RELIEF VALVE REQUIREMENTS:

○ Max. Set Pressure ____________ PSIG Extraction
○ Steam Flow ____________ Lb/hr
○ Supplied By ______ Purchaser ______ Vendor

AREA CLASSIFICATION

Class ________ Group ______ Division ______

MOTOR CONTROL & INSTRUMENT VOLTAGE

______ Volts ______ Phase ______ Cycles

ALARM & SHUTDOWN VOLTAGE

______ Volts ______ Phase ______ Cycles or ______ DC
Solenoid Voltage ____________

LOCAL CONTROL PANEL:

Furnished By: ☐ Vendor ☐ Purchaser ☐ Others ____________
☐ Free Standing ☐ Weatherproof ☐ Totally Enclosed ☐ Extra Cutouts
☐ Vibration Isolators ☐ Strip Heaters ☐ Purge Connections ☐ With Doors
☐ Annunciator – Furnished By: ☐ Vendor ☐ Purchaser ☐ Others
☐ Annunciator located on ☐ Local Panel ☐ Main Control Board
☐ Customer connections brought out to terminal boxes by vendor

Remarks: ____________

____

INSTRUMENT SUPPLIERS:

Pressure Gages: MFR. ________ Size & Type ________
Temperature Gages: MFR. ________ Size & Type ________
Level Gages: MFR. ________ Size & Type ________
Diff. Pressure Gages: MFR. ________ Size & Type ________
Pressure Switches: MFR. ________ Size & Type ________
Diff. Pressure Switches: MFR. ________ Size & Type ________
Temperature Switches: MFR. ________ Size & Type ________
Level Switches: MFR. ________ Size & Type ________
Control Valves: MFR. ________ Size & Type ________
Pressure Relief Valves: MFR. ________ Size & Type ________
Thermal Relief Valves: MFR. ________ Size & Type ________
Sight Flow Indicators: MFR. ________ Size & Type ________
Pneu. Pressure Transmitters: MFR. ________ Size & Type ________
Vibration Equipment: MFR. ________ Size & Type ________
Tachometer: MFR. ________ Size & Type ________
Solenoid Valves: MFR. ________ Size & Type ________
Annunciator: MFR. ________ Model & No. Points ________
Thermocouples: MFR. ________ Size & Type ________
Resistance Temp. Detectors: MFR. ________ Size & Type ________
Thermowells: MFR. ________ Size & Type ________
MFR. ________ Size & Type ________
MFR. ________ Size & Type ________
MFR. ________ Size & Type ________

SWITCHES:

Enclosures ○ Explosion Proof ○ Weatherproof ○ Other ____________
Alarm Contacts shall: ☐ Open ☐ Close to Sound Alarm and be Normally ☐ Energized ☐ De-Energized
Shutdown Contacts shall: ☐ Open ☐ Close to Trip and be Normally ☐ Energized ☐ De-Energized
Note: Normal Condition is when Turbine is in Operation

MISCELLANEOUS:

Pre-Alarm and Shutdown Switches shall be separate.
Purchasers Electrical and Instrument Connections within the confines of the Baseplate and Console shall be:
☐ Brought out to Terminal Boxes ☐ Made directly by the Purchaser
Comments Regarding Instrumentation: ____________

____

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

GEAR ○ Separate Data Sheet Attached

○ Special Purpose Gear Required

○ Gear Furnished By ____________________

OIL SYSTEM

Furnished By ○ Turbine Mfr. ☐ Others

○ Separate for Turbine Only

○ Common with Driven Equipment

Turbine Mfr. to Supply:

○ Stainless Steel Oil Supply Header Piping

○ Oil Drain Header Piping

○ Stainless Steel ○ Carbon Steel

____

____

EMERGENCY TURNING GEAR

○ Turning Gear Required ○ Quick Start Required

☐ Mfr. ____________ ☐ Model ____________

☐ Ratio ____________________

☐ Motor: ____ Electric ____ HP ____ Volts ○ AC ○ DC

____ Pneumatic ____ PSIG ____ °F ____ SCFM

____ Auto Engage ____ Manual Engage

PAINTING

○ Manufacturer's Standard

○ Other ____________________

SHIPMENT

○ Domestic ○ Export

○ Export Boxing Required ○ Outdoor Storage over 6 months

○ Water Proof Boxing Required

○ Spare Rotor Assembly Packaged for

○ Horizontal Storage ○ Vertical Storage

WEIGHTS:

☐ Turbine ____________________ lb.

☐ Rotor ____________________ lb.

☐ Turb. Upper 1/2 Casing ____________________ lb.

☐ Maximum for Maintenance (Identify) ____________________

____________________ lb.

☐ Total Shipping Weight ____________________ lb.

SPACE REQUIREMENTS:

☐ Complete Unit: L ________ in. W ________ in. H ________ in.

☐ Control Panel: L ________ in. W ________ in. H ________ in.

____

MISCELLANEOUS:

○ Provisions for Field Balancing

○ Vendor's Review and Comment on Purchaser's Piping and Foundation Drawings are Required

○ Shaft Grounding Devices

○ "Y" Type Strainer

○ Water Washing Connections

○ Optical Alignment Flats

○ Insulation (Lagging) Required

○ Jacket Required

○ Axial Alignment Key

○ Blade Diagrams ____ Campbell ____ Goodman

____ Soderberg ____ Other ____________

○ Metric/English ____ Drawings ____ External Flanges

____ Internal Bolting and Threads

____

____

SKETCH:

REMARKS: ____________________

____

____

____

____

____

____

____

____

____

____

____

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

OPERATING CONDITIONS

	SHELL SIDE		TUBE SIDE	
○ Fluid				
☐ Total Flow LBS/HR				
☐ Specific Gravity	@	°F	@	°F
☐ Thermal Cond. BTU/HR x SQ FT x °F	@	°F	@	°F
☐ Specific Heat — BTU/LB x °F	@	°F	@	°F
☐ Viscosity — SSU	@	°F	@	°F
☐ Operating Temperatures, °F	IN	OUT	IN	OUT
Inlet Pressure, PSIG				
Inlet Velocity, FT/SEC.				
○ Pressure Drop, PSI	ALLOW.	CALC.	ALLOW.	CALC.
☐ Design Temperature, °F				
Pressure, PSIG	MIN.	TEST	MIN.	TEST
Foul Resistance, SQ FT x HR x °F/BTU				
○ Min Corrosion Allowance, In				
☐ Number of Passes Per shell				

CONSTRUCTION DETAILS

☐ Total Area (1), Sq. Ft. ____________

☐ LMTD ____________

☐ Corrected MTD ____________

☐ Transfer Rate, Clean ____________

☐ Transfer Rate, Service ____________

☐ Cross Baffles, Type ____________

○ Code Requirements (2) ________ ASME; TEMA ____________

☐ Weights Ea. Bundle ________ Lbs., Bundle & Shell ________ Lbs., Full of Water ________ Lbs.

☐ Shell, No. x I.D. ________ x ________ IN

☐ Tubes, No. Per Shell ________

☐ O.D. x Length ________ IN. x ________ IN.

☐ Gauge, BWG ________ Avg., Min. Wall

☐ Tube Pitch ________ IN, △ ☐ ◇

☐ Removable Tube Bundle ☐ YES ☐ NO

○ Code Stamp ☐ YES ☐ NO

☐ NOZZLE SIZES

	SHELL SIDE			TUBE SIDE		
	NO.	SIZE	RATING & FACING	NO.	SIZE	RATING & FACING
INLET						
OUTLET						
DRAIN						
VENT						

○ MATERIALS

Tubes ____________

Tube Sheets ____________

Shell ____________

Shell Flanges ____________

Baffles ____________

Channel ____________

Channel Flanges ____________

Channel Nozzle Flanges ____________

REMARKS: ____________

(1) OUTSIDE TUBE AREA EXCLUDING AREA IN TUBE SHEETS

(2) UNITS EXEMPT FROM CODE STAMP SHALL HAVE LONGETUDINAL WELD SEAMS SPOT EXAMINED PER PARA UW-52 OF ASME CODE.

APPLICABLE TO: ○ PROPOSALS ○ PURCHASE ○ AS BUILT PURCHASE ORDER NO. ______ DATE: ______

FOR * ______ UNIT * ______

SITE * ______

SERVICE * ______ NO. REQD. *

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

☐ GENERAL

MANUFACTURER ______ SERIAL NO. ______

TYPE ______ RPM: MAX. ______ RATED ______ MIN. ______

COMPRESSOR THROWS: NO. FURNISHED * MAX. NO. POSSIBLE * MAX. FRAME HP: ______ @ MAX. RPM ______ @ RATED RPM

DRIVER TYPE * DRIVER RATED HP * RPM * DRIVER FURN. BY ○ COMPR. MFR., ○

☐ RATED OPERATING CONDITIONS (EACH MACHINE)

SERVICE/ITEM NO.	*					
STAGE	*					
GAS COMPRESSED	*					
CORROSIVE DUE TO	*					
RELATIVE HUMIDITY						
MOL. WGT., AT INTAKE	*					
C_p/C_v VALUE AT SUCTION	*					
C_p/C_v VALUE AT DISCHARGE						
INLET TEMP. °F.	*					
INLET PRESSURE, PSIA	*					
MIN. ΔP BETWEEN STGS. PSI	*					
ACTUAL DISCH. TEMP. °F.	*					
DISCHARGE PRESS. PSIA	*					
Z @ SUCTION	*					
Z @ DISCHARGE						

EXPECTED (CAPACITY TOLERANCE ±3%; BHP TOLERANCE ±3%)

LBS/HR. WET	*					
INLET CFM (CORRECTED)	*					
MMSCFD/SCFM (14.7 & 60)						
BRAKE HORSEPOWER/STAGE	*					
TOTAL BHP	*					

**RATED PER API (CAPACITY TOLERANCE -0%; BHP TOLERANCE +0%)

LBS/HR. WET					
INLET CFM (CORRECTED)					
MMSCFD/SCFM (14.7 & 60)					
BRAKE HORSEPOWER/STAGE					
TOTAL BHP (W/V-BELT LOSS)					

TOTAL HP REQUIRED BY DRIVER (W/GEAR LOSS INCLUDED) ______

APPLICABLE SPECIFICATIONS

○ API RECIP. COMPR. SPEC. 618 *

○ ______

○ ______

○ ______

ACCESSORIES

COMP. MFR. SHALL FURNISH

○ PULSATION (DAMPERS) (VOLUME BOTTLES) FOR ______

○ INTERSTAGE PIPING & RELIEF VALVES

○ INTER COOLERS ______

○ SEPARATE MOISTURE SEPARATORS W/TRAPS

○ AFTER COOLERS ______

○ COOLING WATER PIPING, SINGLE INLET-OUTLET MANIFOLD ○ W/VALVES

○ INSTRUMENT PANEL ______

○ VENDOR ANALOG STUDY REQUIRED

* ☐ WEIGHTS AND DIMENSIONS

MAX. ERECTION WEIGHT, LBS. ______

MAX. MAINTENANCE WEIGHT, LBS. ______

TOTAL WT., LESS DRIVER & GEAR, LBS. ______

APPROX. FLOOR SPACE

L ______ W ______ H ______

ROD REMOVAL DISTANCE ______

REMARKS ______

* REQUIRED FOR PHASE 0

*S = SUCTION VALVE UNLOADERS H = HEAD END C= CRANK END F = FIXED POCKET OPEN V = VARIABLE POCKET OPEN

** SEE A.P.I. PAR. 35 (NO NEGATIVE TOLERANCE, ETC.)

△								
△								
△								
No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG R	PROJ ENGR	APPR

SCALE DESIGNED DRAWN CHIEF ENGR

ORIGIN

JOB No.

RECIPROCATING COMPRESSOR

DATA SHEET

DATA SHEET NO. DS- K

REV.

RECIPROCATING COMPRESSOR DATA SHEET

☐ CAPACITY CONTROL

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

CAPACITY CONTROL SHALL BE BY:

○ VARIABLE SPEED TO ________ % RATED

○ PURCHASERS BY-PASS

○ MFR. STANDARD AUTOMATIC CONTROL

- ○ START/STOP ○ (2)(3)(5) STEP
- ○ PILOTED BY REC. PRESS.
- ○ PILOTED BY PURCH. INSTR.
- W/ ________________ PSIG AIR SIGNAL

○ CLEARANCE POCKETS, ____________ CYL.

- ○ FIXED ○ VARIABLE
- ○ MANUAL ○ MANUAL PNEU. ○ AUTO.

○ SUCT. VALVE UNLOADERS, ________ CYL.

- TYPE: ○ PLUG ○ FINGER ○ ________
- ○ MANUAL ○ MANUAL PNEU. ○ AUTO.

ON AIR/POWER FAILURE COMPRESSOR SHALL ○ UNLOAD ○ LOAD

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

SKETCH:

RECIPROCATING COMPRESSOR DATA SHEET

○ SITE DATA

ALTITUDE * ____ FT. BAROMETER ____ PSIA
DESIGN TEMP. °F * ____ SUMMER * ____ WINTER MIN.
DESIGN WET BULB TEMP. °F * ____
○ WINTERIZATION REQD. * ○ TROPICALIZATION REQD.
UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER ____

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

COOLING WATER FOR COMP. CYLINDERS:
TYPE WATER * ____
PRESS., PSIG * ____ SUPPLY * ____ RETURN MIN.
TEMP., °F * ____ SUPPLY * ____ RETURN MAX.

COOLING WATER FOR (OIL COOLER)(INTERCOOLERS)(ROD PKG):
TYPE WATER * ____
PRESS., PSIG * ____ SUPPLY * ____ RETURN MIN.
TEMP., °F * ____ SUPPLY * ____ RETURN MAX.

ELECTRIC POWER FOR HEATERS:
____ VOLTS ____ PHASE ____ HERTZ

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

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

☐ UTILITY CONSUMPTION

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

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

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

COOLING WATER	COMP. CYL. JKTS.	ROD PKG.	L.O. COOLER	INTER COOLERS	OTHER
QUANTITY, GPM					
INLET TEMP., °F					
OUTLET TEMP., °F					
INLET PRESS., PSIG					
OUTLET PRESS., PSIG					
MAX. PRESS., PSIG					
TOTAL C.W., GPM					

INSPECTION AND SHOP TESTS

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

PAINTING

○ MANUFACTURER'S STANDARD
○ OTHER ____

SHIPMENT

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

ALARMS AND SHUTDOWNS

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

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

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

REMARKS: ____

RECIPROCATING COMPRESSOR DATA SHEET

☐ CYLINDER DATA * (AS REQUIRED)

ITEM NO./SERVICE					
STAGE					
NO. OF CYL. PER STAGE					
TYPE CYL. COOLING REQD.					
TYPE CYL. (STEP)(TANDEM)					
SINGLE/DOUBLE ACTING					
CYLINDER LINER YES/NO					
CYLINDER LINER WET/DRY					
OUTSIDE DIAM. LINER, INCHES					
BORE, INCHES					
STROKE, INCHES					
PISTON DISPLACEMENT, CFM					
CLEARANCE, %					
VOLUMETRIC EFFICIENCY, %					
API VALVE GAS VELOCITY, FT/MIN.					
NO. INLET/DISCH. VALVES/CYL.					
TYPE OF VALVES					
INLET/DISCH. VALVE LIFT, MILS					
MAX. ALLOW PISTON SPEED, FPM					
NORMAL PISTON SPEED, FPM					
ROD DIAMETER, INCHES					
MAX. ALLOW. ROD LOADING T					
MAX. ALLOW. ROD LOADING C					
ACTUAL ROD LOAD, T (GAS LOAD)					
ACTUAL ROD LOAD, C (GAS LOAD)					
ACTUAL ROD LOAD, T (GAS & INERTIA)					
ACTUAL ROD LOAD, C (GAS & INERTIA)					
DEGREES ROD REVERSAL					
MAX. ALLOW. CYL. WKG. PRESS., PSIG					
MAX. ALLOW. CYL. TEMP. °F					
RECOM. RELIEF VALVE, PSIG					
HYDROSTATIC TEST, PSIG					
SUCTION SIZE/RATING					
FACING					
DISCH. SIZE/RATING					
FACING					
POSITION FROM DRIVER END*					

☐ COMPRESSOR MATERIALS * (AS REQUIRED)

CYLINDERS					
CYLINDER LINERS					
PISTONS					
PISTON RINGS					
RIDER RINGS					
PISTON RODS					
PISTON ROD HARD, (ROCKWELL "C")					
VALVE SEATS					
VALVE STOPS					
VALVE PLATES					
VALVE SPRINGS					
ROD PACKING					

COMPRESSOR PACKING

○ FULL FLOATING VENTED PACKING W/STAINLESS STEEL SPRINGS ____

○ FORCED FEED LUBRICATED ____

○ NON-LUBRICATED ○ TEFLON ○ CARBON ____

☐ WATER COOLED ____

○ PROVISIONS FOR FUTURE (WATER) (OIL) COOLING ____

○ VENTED TO ____

DISTANCE PIECE

○ STANDARD ____

○ EXTRA LONG SINGLE COMPARTMENT ____

○ TWO COMPARTMENT ____

○ SOLID COVER ○ ____

○ VENTED TO ____ ○ DESIGN PRESS., PSIG ____

LUBPICATION

FRAME

○ SPLASH SYSTEM

○ PRESSURE SYSTEM (INCLUDE THE FOLLOWING)

- ○ MAIN OIL PUMP DRIVEN BY (COMP. SHAFT ☐ / ELEC. MOTOR ☐)
- ○ AUX. OIL PUMP DRIVEN BY ELECTRIC MOTOR
- ○ HAND OPERATED PUMP FOR STARTING

☐ SYSTEM OIL CAPACITY ____ GALS.

☐ TYPE OIL ____ GRADE ____

○ ELEC. HTR. W/THERMOSTAT ○ STEAM COIL

TYPE BEARINGS ☐ SLEEVE ☐ BALL ☐ ____

BRG.MATL. ☐ ALUM. ☐ BABBIT ☐ ____

☐ OUTBOARD BEARING INCLUDED ☐ TYPE ____

CYLINDERS

LUBRICATOR TO BE DRIVEN BY:

○ COMPRESSOR SHAFT ○ ELECTRIC MOTOR ○ BOTH

LUBRICATOR CAPACITY ○ 24 HR. ○ ____

☐ TYPE OIL ____ GRADE ____

☐ LUBRICATOR MAKE ____ MODEL ____

○ STEAM COIL ____ ☐ NO. OF COMP. ____

○ ELECTRIC HEATER W/THERMOSTAT

BARRING DEVICE ○ MANUAL ○ PNEU.

☐ **COUPLING** – LOW SPEED

MFR. ____ MODEL ____

TYPE ____

☐ **COUPLING** – HIGH SPEED

MFR. ____ MODEL ____

TYPE ____

☐ **COUPLING** – (MAIN)(AUX) OIL PUMP

MFR. ____ MODEL ____

TYPE ____

TYPE GUARDS ○ CODE ○ STANDARD ○ NON-SPARK

○ STATIC COND.V-BELTS ○ TOT.ENCL. V-BELT GRD.

AIR INTAKE FILTER BY: ○ COMP.MFR. ○ PURCH.

☐ MFR. ____ MODEL ____

☐ TYPE ____ ○ FLANGED OUTLET CONNECTION

REMARKS: ____

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

BECHTEL

ELECTRIC MOTOR DATA SHEET

APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT

FOR ____ * ____ UNIT ____

SITE ____ * ____ DRIVEN EQUIP. * ____

SERVICE ____ * ____ NO. REQUIRED * ____

MANUFACTURER ____ MODEL ____ SERIAL NO. ____

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

MOTOR DESIGN DATA

APPLICABLE SPECIFICATIONS:

○ NEMA ____

○ ____

○ ____

SITE DATA: *

AREA: ○ C.L. ____ GR. ____ DIV. ____ ○ NON-HAZARDOUS

○ ALTITUDE ____ FT. ○ AMBIENT TEMPS: MAX. ____ °F, MIN. ____ °F

UNUSUAL CONDITIONS: ○ DUST ○ FUMES

○ OTHER ____

DRIVE SYSTEM: ○ DIRECT CONNECTED

* ○ GEAR

○ OTHER ____

TYPE MOTOR: *

○ SQUIRREL CAGE INDUCTION ○ NEMA DESIGN ____

○ SYNCHRONOUS ____

○ POWER FACTOR REQD. ____

EXCITATION: ○ BRUSHLESS ○ SLIP RING

○ FIELD DISCHARGE RESISTOR BY MOTOR MFR.

○ WOUND ROTOR INDUCTION

○ ____

ENCLOSURE:

○ CLASS ____, GROUP ____, EXP. PROOF *

○ TEFC

○ TEWAC ○ TEIGF, 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 ____ *

○ FORCED VENTILATED

○ OPEN-DRIPPROOF

○ OPEN

○ ____

○ ____

BASIC DATA:

○ _*_ VOLTS _*_ PHASE _*_ HERTZ

☐ NAMEPLATE HP _*_ SERVICE FACTOR _*_

○ SYNCHRONOUS RPM _*_

○ INSULATION: CLASS ____ TYPE ____

○ TEMP. RISE: ____ °C ABOVE ____ °C BY ____

STARTING:

○ FULL VOLTAGE ○ REDUCED VOLTAGE ____ %

○ LOADED ○ UNLOADED

○ VOLTAGE DIP ____ %

VIBRATION:

○ NEMA STANDARD ○ ____

NOISE:

○ NEMA STANDARD ○ ____

ACCESSORY EQUIPMENT

○ BASEPLATE ○ SOLEPLATE ○ STATOR SHIFT

○ MFR. STD. FANS ○ NON-SPARKING FANS

○ D.C. EXCITATION:

☐ KW REQD ____ VOLTS ____

BY: ○ PURCHASER ○ MANUFACTURER

DESCRIPTION ____

○ ENCLOSED COLLECTOR RINGS:

○ PURGED: MEDIUM ____ PRESS. ____ PSIG.

○ EXPLOSION-RESISTANT NONPURGED

○ FORCED VENTILATION

☐ CFM ____ PRESS. DROP ____ IN. H_2O

○ BEARING TEMP. DEVICES:

☐ LOCATION ____

☐ DESCRIPTION ____

☐ SET @ ____ °C FOR ALARM ____ °C FOR SHUTDOWN

○ SPACE HEATERS:

☐ ____ KW ○ ____ VOLTS ____ PHASE ____ HERTZ

○ MAX. SHEATH TEMP. ____ °C

WINDING TEMPERATURE DETECTORS:

○ THERMISTORS: NO./PHASE ____

TYPE: ○ POS. TEMP. COEFF. ○ NEG. TEMP. COEFF.

TEMPERATURE SWITCH: ○ YES ○ NO

○ RESISTANCE TEMPERATURE DETECTORS: NO./PHASE ____

☐ RESISTANCE MATL. ____ ☐ ____ OHMS

SELECTOR SWITCH & INDICATOR BY: ○ PURCHR. ○ MFR.

☐ MAX. STATOR WINDING TEMPS:

____ °C FOR ALARM ____ °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 ____

○ EXTENDED LEADS ☐ LENGTH ____ FT.

○ SURGE CAPACITORS

○ LIGHTNING ARRESTERS

○ C.T. FOR AMMETER

○ DESCRIPTION ____

MAIN CONDUIT BOX SIZED FOR:

○ MAIN MOTOR LEADS ○ TYPE: ____

○ INSULATED ○ NON-INSULATED

○ C.T.'S FOR DIFF. PROTECTION (MOUNTED BY ____)

○ SURGE CAPACITORS (MOUNTED BY ____)

○ LIGHTNING ARRESTERS (MOUNTED BY ____)

○ C.T. FOR AMMETER (MOUNTED BY ____)

○ SPACE FOR STRESS CONES

○ AIR FILTERS:

☐ MFR ____ ☐ TYPE ____

REMARKS ____

ELECTRIC MOTOR DATA SHEET

☐ MANUFACTURER'S DATA

MANUFACTURER ______

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

EFFICIENCY: F.L. ______ 3/4L ______ 1/2L ______

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

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

LOCKED ROTOR POWER FACTOR ______

LOCKED ROTOR WITHSTAND TIME (COLD START) ______

TORQUES (FT-LBS): FULL LOAD ______

LOCKED ROTOR ______ STARTING (SYN.) ______

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

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

OPEN CIRCUIT TIME CONSTANT (SEC.) ______

SYMMETRICAL CONTRIBUTION TO 3Ø TERMINAL FAULT:

AT 1/2 CYCLES ______ AT 5 CYCLES ______

REACTANCES: SUB-TRANSIENT (X"d) ______

TRANSIENT (X'd) ______ SYNCHRONOUS (X_d) ______

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

RATED KVA ______

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

KVA @ FULL VOLTAGE & 95% SPEED ______ %

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

ACCELERATION TIME (MOTOR ONLY @ RATED VOLT ______ SEC.

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

ROTOR/FIELD WK^2 @ MOTOR SHAFT ($LB\text{-}FT^2$) ______

ROTATION FACING COUPLING END ______

NO. OF STARTS PER HOUR ______

FIELD DISCHARGE RESISTOR ______ OHMS

RATED EXCITATION FIELD VOLTAGE ______ D.C.

RESISTANCE OF EXCITATION FIELD @ 25°C ______ OHMS

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

EXCITATION FIELD AMPS: MAX. ______ MIN. ______

EXCITATION FIELD ☐ RHEOSTAT ☐ FIXED RESISTOR REQD.

SUPPLIED BY ______

BEARING: TYPE ______ LUBR. ______

LUBE OIL REQUIRED: ______ GPM @ ______ PSIG

TOTAL SHAFT END FLOAT ______

LIMIT END FLOAT TO ______

MOTOR ROTOR: ☐ SOLID ☐ SPLIT

MOTOR HUB: ☐ SOLID ☐ SPLIT

FOR TEWAC & TEIGF MOTORS:

COOLING WATER REQD. ______ GPM

C.W. TEMP. RISE ______ °F PRESS. DROP ______ PSI

(AIR) (GAS) REQD. ______ SCFM PRESS. MAINT. ______ IN.H_2O

CURVES REQD. BASED ON MOTOR SATURATION @ RATED VOLTAGE:

- ○ SPEED vs TORQUE (ALSO @ ______ % RATED VOLTAGE)
- ○ SPEED vs POWER FACTOR
- ○ SPEED vs CURRENT

WEIGHTS (LBS):

NET WEIGHT ______ SHIPPING WEIGHT ______

ROTOR WEIGHT ______ MAX. ERECTION WT. ______

MAX. MAINT. WT. (IDENTIFY) ______

DIMENSIONS (FEET & INCHES):

L ______ W ______ H ______

SHOP INSPECTION AND TESTS

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

COUPLING:

○ SUPPLIED BY *

○ MFR. ______ ☐ MODEL ______

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

PAINTING:

○ MANUFACTURER'S STANDARD

○ ______

SHIPMENT

○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQUIRED

○ OUTDOOR STORAGE OVER 3 MONTHS

○ ______

REMARKS: ______

BECHTEL

GAS ENGINE DATA SHEET

GAS ENGINE DATA

RATED HP ____________ RATED RPM ____________

MODEL ____________ BMEP ____________ PSI

☐ INTEGRAL ☐ SEPARATE

BORE ____________ IN. STROKE ____________ IN.

NO. POWER CYLINDERS ________ ENGINE CYCLES ________

FUEL RATE, LHV ____________ BTU/BHP/HR @ RATED LOAD

RPM: MAX. ____________ MIN. ____________

POWER CYLINDERS: ☐ WET ☐ DRY

☐ LINED ☐ UNLINED

☐ TURBOCHARGED ☐ SUPERCHARGED

☐ LOW-FIRE-HAZARD IGNITION ☐ STANDARD IGNITION

GOVERNOR

☐ CONSTANT SPEED ☐ VARIABLE SPEED

RESET BY: ☐ PNEUMATIC SIGNAL

☐ ELECTRONIC SIGNAL

☐ MANUAL

SPEED RANGE, RPM ____________ MAX. ____________ MIN.

SIGNAL RANGE, RPM ____________ MAX. ____________ MIN.

ON SIGNAL FAILURE VALVE TO: ☐ OPEN ☐ CLOSE

GOVERNOR MFR. ____________ TYPE ____________

REGULATION: NEMA CLASS ____________

WEIGHTS AND DIMENSIONS

NET WGT. ____________

MAX. ERECTION WGT. ________ MAX. MAINT. WGT. ________

APPROX. FLOOR SPACE: LENGTH ____________

WIDTH ____________

HEIGHT ____________

ADDITIONAL DISTANCE TO REMOVE POWER RODS ____________

ACCESSORIES

AIR INLET FILTER: ☐ DRY ☐ OIL BATH

MFR. ____________ MODEL ____________

EXHAUST SILENCER:

MFR. ____________ MODEL ____________

☐ HORIZONTAL ☐ VERTICAL ☐ BOTTOM ☐ SIDE

☐ HIGH ☐ LOW

EXHAUST MANIFOLD: ☐ WATERCOOLED ☐ INSULATED

TACHOMETER:

☐ ELEC ________ ENCL ☐ MECH ☐ VIBR REED

TACHOMETER RANGE ____________

FLYWHEEL TURNING BAR AND STAND:

☐ MANUAL ☐ AIR JACK AIR ________ PSIG

☐ FULL-FLOW LUBE OIL FILTER

FUEL GAS SURGE DRUM BY:

☐ PURCHASER ☐ ENGINE MFR.

RECOMMENDED VOLUME ____________ CU. FT.

STARTING AIR COMPRESSOR BY:

☐ PURCHASER ☐ ENGINE MFR.

DRIVER: ☐ MOTOR ☐ GAS ☐ GASOLINE

NO. REQUIRED ________ CAPACITY ________ CFM

MFR. ____________ MODEL ____________

☐ AUTOMATIC START-STOP CONTROL

STARTING AIR RECEIVER BY:

☐ PURCHASER ☐ ENGINE MFR.

NO. RECEIVERS ________ ☐ HORIZONTAL ☐ VERTICAL

RECEIVER CAPACITY ________ CU. FT. PRESS. ________ PSIG

NO. CONSECUTIVE STARTS ________ STARTS/HR. ________

CU. FT. PER START ____________

AUXILIARY SYSTEMS

☐ ENGINE MFR. SHALL FURNISH POWER CYLINDER COOLING WATER PIPING FROM A SINGLE INLET FLANGE TO A SINGLE DISCHARGE FLANGE.

SURGE TANK, ENGINE JACKET COOLER, CIRCULATING PUMP BY: ☐ PURCHASER ☐ ENGINE MFR.

☐ CIRCULATING WATER PUMP DRIVEN BY ENGINE SHAFT

☐ SEPARATELY MOUNTED PUMP AND DRIVER BY: ☐ PURCHASER ☐ ENGINE MFR.

LUBE OIL INTERCONNECTING PIPING AND FITTINGS BY: ☐ PURCHASER ☐ ENGINE MFR.

REMARKS ____________

(Manufacturer to fill in all missing data)

STEAM ENGINE DATA SHEET

STEAM ENGINE DATA

RATED HP ______ RATED RPM ______

MODEL ______ NO. POWER CYLINDERS ______

BORE ______ IN. STROKE ______ IN.

STEAM RATE ______ #/BHP/HR. @ FULL LOAD

TYPE: ☐ SIMPLEX ☐ DUPLEX

☐ CROSS-COMPOUND

RPM: MAX. ______ MIN. ______

MATERIAL: ☐ CAST IRON ☐ STEEL

MAX. ALLOW. WORKING PRESS. ______ PSIG

MAX. ALLOW. WORKING TEMP. ______ F

GOVERNOR

☐ CONSTANT SPEED ☐ VARIABLE SPEED

RESET BY: ☐ PNEUMATIC SIGNAL

☐ ELECTRONIC SIGNAL

☐ MANUAL

SPEED RANGE, RPM ______ MAX. ______ MIN.

SIGNAL RANGE ______ MAX. ______ MIN.

ON SIGNAL FAILURE VALVE TO: ☐ OPEN ☐ CLOSE

GOVERNOR MFR. ______ TYPE ______

REGULATION: NEMA CLASS ______

WEIGHTS AND DIMENSIONS

NET WGT. ______

MAX. ERECTION WGT. ______ MAX. MAINT. WGT. ______

APPROX. FLOOR SPACE: LENGTH ______

WIDTH ______

HEIGHT ______

ADDITIONAL DISTANCE TO REMOVE POWER RODS ______

ACCESSORIES

- ☐ SEPARATE TRIP-THROTTLE VALVE
- ☐ REVOLUTION COUNTER
- ☐ FLYWHEEL GUARD
- ☐ FLYWHEEL TURNING BAR-STAND:
  - ☐ MANUAL ☐ AIR JACK, AIR ______ PSIG
- ☐ ALL NECESSARY STEAM MANIFOLD PIPING BEGINNING AT THE HAND-OPERATED STEAM THROTTLE VALVE AND CONTINUING THROUGH ALL OTHER REQUIRED VALVES TO EACH STEAM CYLINDER
- ☐ GAGE BOARD WITH:
  - ☐ LUBE OIL PRESS. GAGE
  - ☐ LUBE OIL TEMP. GAGE
  - ☐ STEAM INLET PRESS.
  - ☐ STEAM INLET TEMP.
  - ☐ STEAM EXHAUST PRESS.

REMARKS ______

(Manufacturer to fill in all missing data)

POWER VOLTS ____
CYCLES ____ PHASES ____
STEAM P.S.I.G. AT THROTTLE ____
EXHAUST ____

FAN OR BLOWER DATA SHEET

SPECIFICATION NO. ____
B. M. NO ____

INSTRUCTIONS TO BIDDERS - FILL IN EVERY SPACE TO MAKE BID COMPLETE

FLOWSHEET NO
* PLANT EQUIP NO.

A. GAS CHARACTERISTICS SERVICE

1 GAS *
2 S P GR (AIR = 1 0)
3 POUNDS PER HOUR *
4 STD C.F.M @ 60°F & 14 7 PSIA
5 FLOW TEMP °F *
6 CFM AT FLOW TEMP *

B PRESSURES

1 SUCTION *
2 DIFFERENTIAL *
3 DISCHARGE *

C. OPERATION

1 EFFICIENCY AT RATING *
2. B H P. AT RATING *
3. BID IMPELLER DIAM
4. MAX BHP FOR BID IMP DIA
5 R P M OF FAN OR BLOWER
6 R P M OF DRIVER *
7 TIP SPEED
8 OUTLET VELOCITY
9 DIRECTION OF ROTATION CCW FACING COUPLING END CW
10 NUMBER OF STAGES *

D. CONSTRUCTION & MATERIAL

1. CASE MATERIAL *
CONSTRUCTION. HORIZ OR VERT SPLIT
2. IMPELLER *
3 SHAFT MATERIAL
4. SHAFT DIAMETER
5. FLEXIBLE COUPLING
6. COUPLING GUARD
7 BASE PLATE
8 CLASS (FANS)
9. ARRANGEMENT (FANS)
10. INLET SCREEN
11. CLEAN-OUT REQUIRED
12. VARIABLE INLET VANES REQ'D.

MANUFACTURER
MFR'S TYPE & SIZE

FLOWSHEET NO.
PLANT EQUIP. NO.

E. BEARINGS & LUBRICATION SERVICE

1 THRUST (S.A.E NO ON FINAL DATA SHEET)
2 RADIAL (S.A.E. NO. ON FINAL DATA SHEET)

3	GREASE PCKD.	FLOOD OILNG	RING OILNG.
THRUST	A	B	C
RADIAL	A	B	C

4 TYPE OF CLOSURES:
5 METHOD OF SEALING
6 VISIBLE LUBRICATORS TYPE
7 VISIBLE LUBRICATORS CAPACITY
8 BEARINGS WATER COOLED
9 LUBRICATING OIL PUMP
10 LUBRICATING OIL COOLER

F. CONNECTIONS

1A INLET SIZE
1B. INLET RATING
1C. INLET FACING
2A. DISCHARGE SIZE
2B. DISCHARGE RATING
2C DISCHARGE FACING
2D DISCHARGE LOCATION

G. TESTING

STATE EXTRA COST IF ANY FOR EACH

1 DYNAMIC BALANCING OF IMPELLERS
2. WITNESSED PERFORMANCE TEST
3. INSPECTION
4 RUNNING TEST WITH ACTUAL DRIVER

H. MISCELLANEOUS

1 PRICE EACH F.O.B. F.A.S.
2 WEIGHT POUNDS NET *
2A WEIGHT BOXED FOR SHIPMENT
3 SHIPMENT FROM RCPT OF ORDER WEEKS
4. DRIVER H.P. *
5 TYPE OF DRIVER: MOTOR OR TURBINE *
6 DRIVER. COUPLED, V-BELT, GEARED
7. PERFORMANCE CURVE MANUFACTURERS NO
7A. PERFORMANCE CURVE FOREIGN PRINT NO
8. OUTLINE DRAWING MANUFACTURERS NO.
8A OUTLINE DRAWING FOREIGN PRINT NO.
9. CROSS SECTION DWG MANUFACTURERS NO.
9A CROSS SECTION DWG. FOREIGN PRINT NO.
10 MFR'S. SERIAL NO. ON FINAL DATA SHEET

BECHTEL
HOUSTON

REV
DATE
DATE

* REQUIRED FOR PHASE O

JOB NO.
DWG NO K
REV 2

FORM H-280 8/66

TANK MIXER DATA SHEET

TANK MIXERS FOR ______ PLANT ______ MANUFACTURER ______

______ PROJECT ______ LOCATION ______ SPECIFICATION NO ______ REQ. NO ______

MIXER NUMBER 2	*					
MIXER INSTALLED IN TANK NUMBER 2	*					
NUMBER OF MIXERS IN TANK 2	*					
MIXER CHARACTERISTICS						
Continuous Mixing Withdrawal Rate of Mix Components GPM	*					
Batch Mixing Time Required for Uniform Blend HR	*					
Size of Batch BBL	*					
Number of Components to be Mixed						
Mix Description (Solution, Blend, Emulsion)						
Mixing Temperature °F	*					
Sp Gr at Mixing Temperature						
Viscosity at Mixing Temperature CENTISTOKES						
MIX COMPONENTS						
FIRST COMPONENT MATERIAL (In Sequence of Adding if Batch) 2	*					
Liquid Solid	*					
Sp Gr at Mix Temperature Density LB/CU. FT.	/	/	/	/	/	/
Viscosity at Mix Temperature CENTISTOKES						
Particle Size MICRON						
Volume Percent in Mix LB PER GALLON IN MIX						
Additional Characteristics (Describe as Necessary) Abrasive, Gummy, Crystalline, Fluffy, Miscibility, Solubility, Tendency to Foam, etc.)						
SECOND COMPONENT MATERIAL (In Sequence of Adding if Batch) 2	*					
Liquid Solid	*					
Sp Gr at Mix Temperature Density LB/CU FT	/	/	/	/	/	/
Viscosity at Mix Temperature CENTISTOKES						
Particle Size MICRON						
Volume Percent in Mix LB PER GALLON IN MIX						
Additional Characteristics (Describe as Necessary). Abrasive, Gummy, Crystalline, Fluffy, Miscibility, Solubility, Tendency to Foam, etc.)						
THIRD COMPONENT MATERIAL (In Sequence of Adding if Batch)						
Liquid Solid						
Sp Gr at Mix Temperature Density LB/CU FT	/	/	/	/	/	/
Viscosity at Mix Temperature CENTISTOKES						
Particle Size MICRON						
Volume Percent in Mix LB PER GALLON IN MIX						
Additional Characteristics (Describe as Necessary): Abrasive, Gummy, Crystalline, Fluffy, Miscibility, Solubility, Tendency to Foam, etc.)						
TANK DATA						
Type of Tank	*					
Capacity of Tank BBL	*					
Pressure PSI (ABS)	*					
Diameter/Height of Vessel FT.	* /	/	/	/	/	/
Shape of Bottom (Flat) (Cone)						
Preferred Location of Mixer (Top, Side, Bottom)						
Mounting (Nozzle, Rim, Etc.)						
ID-Length of Opening Available for Inserting Mixer INCHES	/	/	/	/	/	/
Minimum ID/Length of Opening to Pass Propeller INCHES	/	/	/	/	/	/
Type of Support (Tank, Pedestal, Structure)						
Support Furnished By (Supplier) (Purchaser)						

MIXER NUMBER						
OPERATION						
Propeller Speed RPM						
Type of Speed Reducer (Gear, V Belt, Chain Drive)						
Manufacturer and Model of Speed Reducer						
AGMA Gear Class						
Is Speed Reducer Integral with Driver?						
Brake Horsepower Required 2						
Motor Horsepower *						
Motor Speed 2 RPM						
Motor to be Furnished by (Purchaser) (Mixer Supplier)						
Motor Data Sheet Number						
NEMA Frame Number of Motor						
CONSTRUCTION & MATERIALS						
Number of Propellers or Impellers						
Propeller or Impeller Diameter INCHES						
Mixer Mounting Flange ANSI SIZE AND RATING						
Steady Bearing (Permissible) (Req'd)						
Stuffing Box Required						
Flexible Coupling, Type	/	/	/	/	/	/
Coupling Guard or V Belt Guard By	Vendor					
Shaft Diameter						
Packing or Mechanical Seal						
Seal or Flushing Fluid Required						
Packing Furnished By	Vendor					
Mixer to be Packed while Tank Full	Yes					
Material – Propeller or Impeller *						
– Shaft						
– Stuffing Box						
– Hard Surface Shaft thru Stuffing Box						
– Packing Mfg. and Style Number						
– Number Packing Rings						
Weight or Spring Loaded Stuffing Box Lubricator						
General Type of Lubrication (Grease, Flood Oiled, etc.)						
Critical Speed RPM						
Number of Propeller Blades						
Propeller Blade Configuration						
Propeller Pitch						
Number of Baffles Req'd per Tank						
Distance from Bottom of Tank to Bottom of Propeller						
MISCELLANEOUS						
Inspection Required 2						
Shipping Weight (Incl. Driver if Factory Mounted) LB.						
Manufacturer's Model						
Manufacturer's Serial Number (On Final Data Sheet)						

REV 2 1 0

* REQUIRED FOR PHASE 0

DATA SHEET NO	REV
Y	2

FORM 101 (3/72)

R & C

Specification 14222-A-17

PROJECT COMMUNICATIONS

1.0 SCOPE

Project communications are defined as letters,transmittals and teletype messages between the contractural entities. The Breckinridge Project communication will be controlled as described in this specification.

2.0 COMMUNICATIONS LOG

2.1 All project communications to and from Bechtel must pass through the Document Control person or group assigned to the project task force.

2.2 Document Control will then mark the communications logs to show receipt or release, and obtain a preliminary file copy if approval is pending.

2.3 Subcontractors shall maintain a similar log.

3.0 IDENTIFICATION OF COMMUNICATIONS

3.1 Identification codes for communications consists of three parts:

- Bechtel Job Numbers: 14222.
- Alpha code for the sending and receiving companies as set forth on sheet 2 of this specification.
- A sequential number: Obtained from Project Document Control for Bechtel originated documents.

3.2 Examples of communication code numbers are as follow:

- A letter from Bechtel to ASFI-14222-BA-1.
- A teletype from ASFI to Bechtel-14222-XAB-1.
- A transmittal from Bechtel to UOP-14222-TBUB-1.

4.0 DOCUMENT TRANSMITTAL FORM

A sample of the Project Engineering Document Transmittal form is attached to this specification. This form shall be used to formally transmit specifications, data sheets, drawings, studies, reports, etc, to ASFI and Bechtel Subcontractors. Subcontractors may use similar forms.

FORM H-292 7-66

△					
△					
△	3/80	ISSUED FOR PHASE ZERO			
△	4/80	ISSUED FOR APPROVAL			

AFSI THE BRECKINRIDGE PROJECT
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R2071
PROJECT SPECIFICATION
PROJECT COMMUNICATIONS

JOB NO. 14222

SPECIFICATION	REV
14222-A-18	1

SHEET 1 OF 2

ALPHA CODE FOR COMMUNICATION

FROM	TO	LETTERS	TELEGRAMS AND TELETYPES	TRANSMITTALS
BECHTEL	ASFI	BA-1	XBA-1	TBA-1
ASFI	BECHTEL	AB-2	XAB-1	TAB-1
BECHTEL	UOP	BU-1	XBU-1	TBU-1
UOP	BECHTEL	UB-1	XUB-1	TUB-1
BECHTEL	AIRCO	BR-1	XBR-1	TBR-1
AIRCO	BECHTEL	RB-1	XRB-1	TRB-1
BECHTEL	TEXACO	BT-1	XBT-1	TBT-1
TEXACO	BECHTEL	TB-1	XTB-1	TTB-1
BECHTEL	DAVY-McKEE	BD-1	XBD-1	TBD-1
DAVY-McKEE	BECHTEL	DB-1	XDB-1	TDB-1
BECHTEL (S.F.)	BECHTEL (HOUSTON)	BSB-1	XBSB-1	TBSB-1

PROJECT NOTES/CONFERENCE NOTES

1.0 SCOPE

1.1 This specification defines the procedures for recording discussions and decisions made in meetings or conferences.

1.2 In addition to documenting actions and decisions, project notes/conference notes will be used to keep ASFI and Bechtel advised of project activities.

1.3 Any decision which impacts budgets or schedules are not to be implemented as a result of agreement on the conference notes. Engineering Change Order Procedure as defined in Specification 14222-A-8 is to be followed in this situation.

2.0 RESPONSIBILITY

2.1 Bechtel is responsible for development and issue of the Conference notes pertaining to all conferences in Bechtel offices.

2.2 In offices of companies other than Bechtel, the host of that company will be responsible for the development and issue of the conference note.

3.0 PROCEDURE

3.1 The sample form (HO-51092) attached shall be used by Bechtel for conference notes. Subcontractors may use their similar forms.

3.2 The headings on the conference note form are self-explanatory. The action by column is extremely important. The name of the individual responsible for action must be entered in this column as well as the name of the company.

3.3 The conference note number must be entered on all sheets. The conference note is identified in three parts:

- CN: Conference Note
- The alpha designation used for communications (see Specification No. 14222-A-18).

FORM H-292 7-66

△					
△					
1	8/80	ISSUED FOR PHASE ZERO	HS		
0	7/80	ISSUED FOR APPROVAL	HS		

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATION
PROJECT NOTES/CONFERENCE NOTES

JOB NO. 14222
SPECIFICATION 14222-A-19
REV 1

- Sequential number.

Example: The first conference note issued by Bechtel: CNB-1.

The writer of the conference notes shall obtain the number from Project Document Control.

3.4 The last page of the text shall bear the writer's and typist initials in the lower left corner with the date immediately below, signifying the end of the conference note.

4.0 REVISIONS

4.1 If revisions to any conference note is desired by ASFI, the original note shall be returned to Bechtel with the revisions written theron, or appended to the note.

4.2 Bechtel will revise the note and return to ASFI.

4.3 The Conference Note Log will reflect the receipt of comments, resubmittal, and final issue. The log will be maintained by Project Document Control.

5.0 DISTRIBUTION

5.1 Distribution will be made by Project Document Control.

BECHTEL
CONFERENCE NOTES

Page 1 of ____

Conference Notes No. ____

SC File No. ____

Correspondence Log No. ____

Confirmation No. ____

Meeting on ____ ☐

Telephone Conversation ____ ☐

Date of above ____

Place ____

Recorded by ____

Job No. ____

Subject ____

Date ____

MINUTE NO.	DESCRIPTION	ACTION BY
	Purpose of Meeting: Attendees: Summary and Conclusions: Action Items:	

Distribution:

HO-51092 (9/75)

DOCUMENT AND EQUIPMENT NUMBERING

1.0 SCOPE

△1 All project documents other than correspondence are to be numbered according to the system set forth below. (Correspondence numbering is defined in Specification 14222-A-18, Project Communications). Numbered project documents will include reports, schedules, and other official documents as shown in this Procedure.

△1 Bechtel shall be contacted by subcontractor if there is any impact on budgets or schedules caused by these procedures.

1.1 These official documents will be numbered:

Document Type	Document Identification Code
Drawings	(Dwg. Sheet Size)
Sketches	SK
Data Sheets	DS
Calculations	CA
Reports	RE
Studies	ST
* Specifications	SP
Material Inquiries	MI
Schedules	SC
* Specific Equipment and systems	

2.0 DOCUMENT NUMBERING SYSTEM

2.1 A typical document number will contain four parts:

a. Job Number

b. Plant Number

c. Drawing size/group letter designator (for drawings), or document identification code/group letter designator (for other than drawings).

d. Sequence Number

△1 2.2 Overall project specifications (such as 14222-A-20) and general. Design specification (such as 14222-C-1) will consist of Job Number, group letter designator and sequence number.

FORM H-292 7-66

△					
△	11/21/8	ISSUED TO REVISE SECTION 2.4	[illegible]	[illegible]	[illegible]
△	5/80	ISSUED FOR PHASE ZERO		[illegible]	[illegible]
△	8/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
PROJECT SPECIFICATION
DOCUMENT AND EQUIPMENT NUMBERING

JOB NO. 14222
SPECIFICATION REV
14222-A-20 2

SHEET 1 OF -

2.2 Guides to project document numbering follow:

a. The Breckinridge Job number is 14222. This number is to be used on all documents as the first part of the document number.

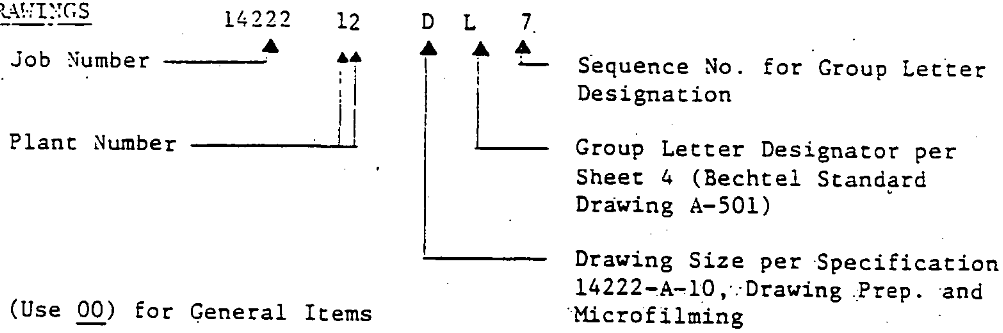
b. Whenever possible the plant number will be identified in the second part of the document number. See Specification 14222-A-6 for list of plant numbers. When particular documents cannot be identified with specific work area and/or work category, zeros will be inserted in the second part of the document number.

c. Drawing size or document identification code letters followed by group letter designator of the subject of the document for the third part of the document number. Sheet 4 of this specification (Bechtel Standard Drawing A-501) sets forth the group letter designators.

d. A sequentially assigned number for the group letter subject in the major work area and category subject of the document forms the fourth and final part of the document numbers.

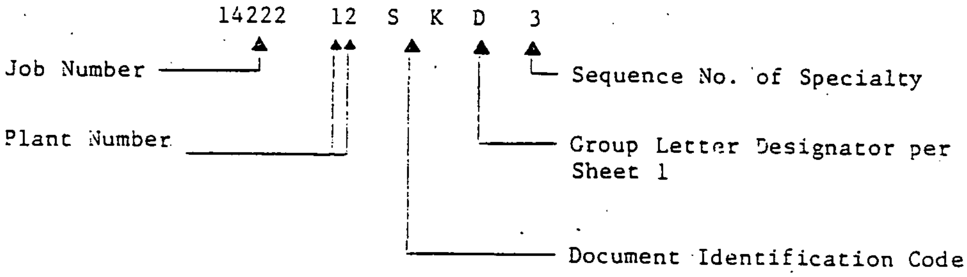
2.3 The following are illustrations of typical document numbers.

DRAWINGS



This sample identifies Gasification and Purification Plant "D" Size Pipe Drawing Number 7.

ALL OTHER DOCUMENTS



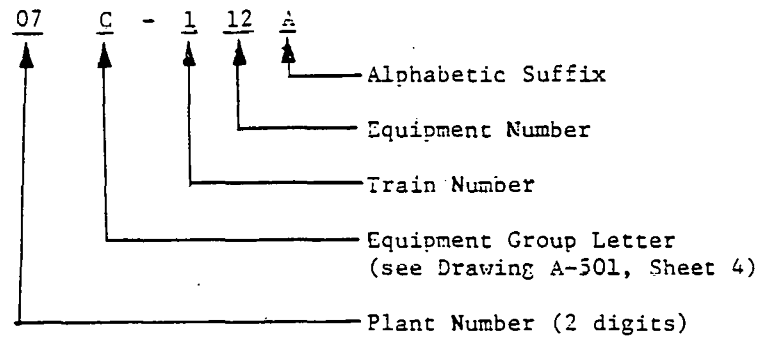
(Use 00 for General Items)

This sample identifies Gasification and Purification Plant Vessel Sketch Number 3.

NOTE: Only drawings have two letters in the third part (i.e, DL) of the document number. Non-drawings can be identified by three letters in the third part (i.e, SKD for vessel sketch).

2.4 EQUIPMENT NUMBERS

Equipment numbers for major equipment, used on drawings and in orders will conform to the Bechtel numbering system. Subcontractor's standard numbering should also appear on the documents.



Single train plant equipment numbers should begin with 100 series (i.e. for plant 07, 07C-101, 07C-102,etc.).

Multi train equipment numbers should begin with 100 series for the first train, 200 series for the second train, etc. (12C-101: 12C-201, are the same equipment in different trains).

Any equipment which is "common" to trains is to have numbers beginning with 001 series.(12C-001, 12C-002 etc).

Similar equipment in identical service, operating as a unit in series or parallel, or as a spare, shall have identical equipment numbers followed by an alphabetical suffix unique to each piece of equipment. (3 exchangers in Plant 02 operating in series should be identified as 02E-112A,02E-112B,02E-112C).

After drawings are started and equipment numbers assigned, the previously assigned equipment numbers will not be changed to accommodate added equipment. Use the next open number in the series under the appropriate group letter for the plant concerned.

If a piece of equipment has been deleted from the project or from a plant, the equipment number shall not be reused.

In the event that a piece of equipment is moved from one plant to another, delete the equipment from the original plant listing and add it as a new piece of equipment under the other plant listing, with appropriate cross-references. Do not change an equipment number within a plant after original assignment of equipment numbers.

2.5 INSTRUMENT NUMBERS

Instrument identification numbers and symbols used on drawings and orders will conform to Bechtel standard practice as shown on Drawings J-G-0101, -0103, and -0104. See Project Specification 14222-A-1, Basic Instruction for P&ID Development.

GROUP LETTER	GROUP	DESCRIPTION
A	GENERAL	Plot Plans, P&I Diagrams, Maps, Basic Engineering Design Data Sheets, Indexes.
B	PROCESS	Process Design, Flow Diagrams, Data Sheets, etc.
C	COLUMNS AND PRESSURE VESSELS	All pressure vessels of any pressure designed in accordance with the ASME code. This includes towers columns, reactors, regenerators, spheres, drums, etc., including trays, liners, lining, packing, internals and appurtenances.
D	TANKS	All storage vessels other than ASME code vessels. Includes API atmospheric or low pressure storage tanks, bins, spheroids, hoppers, silos, etc., including internals and appurtenances.
E	EXCHANGERS	Heat transfer equipment such as tubular exchangers, condensers, evaporators, reboilers, coolers, fin-fan coolers and cooling towers; excludes fired heaters.
F	FIRED HEATERS	Fired heaters, furnaces, ovens, boilers, fired kilns and driers, including superheaters, air preheaters, tubes, headers, settings, burners, stacks, flues, draft fans and drivers associated with heaters, includes flare stacks and framework, incinerators.
G	PUMPS AND DRIVERS	Includes all pumps and their drivers.
H	VACUUM EQUIPMENT	Vacuum pumps, ejectors and other vacuum producing apparatus. Includes drivers and integral auxiliary equipment.
J	INSTRUMENTS	All instruments and control equipment (except electric power switchboards, controls and meters), including safety (relief) valves, measuring devices, controllers, control valves, indicators, sight glasses, alarms, instrument panels, fittings, control signal pneumatic tubing, air piping and filters, and winterization of instrumentation.
K	COMPRESSORS & DRIVERS	Compressors, blowers, fans and their drivers.
L	PIPING	All process and utility piping(except the following covered elsewhere: sewer and drainage piping(S Group); building plumbing, heating, ventilating and air conditioning(R Group); instrument piping and tubing(J Group); column and vessel internals(C or D Group); and integral piping on pumps or compressors, etc., (G or K Group)
M	STRUCTURES	All steel, concrete, masonry, wood or other structures except buildings. Includes bridges, pipe stanchions, platforms, stairs, ladders, conduit racks.
N	INSULATION	Thermal insulation of piping, vessels, tanks and equipment, also fireproofing of vessel skirts, legs, supports and structures.
P	ELECTRICAL	All electrical equipment and material(except process instrumentation covered under J Group). Includes generators and drivers, motor controls, switchgear, transformers, converters, rectifiers, transmission and distribution, communication systems, lighting,grounding, all necessary wire and conduit, cathodic protection. For equipment numbering refer to Std. Dwg. P-A101.
Q	FOUNDATIONS	All foundations for buildings, structures or equipment. Includes piling, ground floor slabs, trenches, pits, basins and associated earthwork, soils surveys.
R	BUILDINGS	All permanent buildings above their foundations and floorslab. Includes all integral permanently installed equipment, elevators, plumbing, piping, heating, ventilating and air conditioning and painting.
S	SITE IMPROVEMENTS	Includes clearing, grubbing, grading, fencing, signs, railroads, roads, walks, paving, parking areas, landscaping, sewers and drainage systems, topographic surveys.
T	MATERIAL HANDLING EQUIPMENT	Bucket elevator, conveyors, cranes, hoists, chutes, feeders, weighing devices and hoppers, scales, packaging devices.
U	EXPENDABLES	Chemicals, catalysts, refrigerants, etc.
V	PACKAGE UNITS	Includes integral "package" units, such as air-driers, refrigeration systems, etc., where applicable.
W	WELDING & METAL PROCESSING	Welding, casting and other metal processing specifications.
X	PAINTING	All paint and thinner for plant with exception of buildings.
Y	PROCESSING	Crushers, pulverizers, blenders, screens, separators, cyclones, filters, centrifuges, mixers, grinders, dryers, extruders and similar machinery including drivers.
Z	WATER & WASTE TREATMENT	All equipment intended specifically for treatment of water for general supply, cooling water, boiler feed water, etc., or for treatment of waste water for pollution control. Includes clarifiers, reactors, ion exchange equipment, chemical feeders, mixers, agitators, storage hoppers, liquid filters, settlers, cycle timer and specialty controls.

Note: For a more detailed description, refer to the Refinery and Chemical Standard Code of Accounts.

Reference: Standard Drawing A-506 Numbering Drawings and Documents.

See Specification 14222-A-10, Drawing Prep. and Microfilming for title block for the Breckinridge Project.

No	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
4	1/74	ADDED OWNERSHIP CLAUSE TO DWG.	L.S.	G.F				
2	1/71	Addition: Z	WRG					

SCALE	DESIGNED	DRAWN	CHIEF ENGR

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

GROUP LETTERS FOR DRAWING INDEXES
AND MATERIAL REQUISITIONS

JOB No.	DRAWING No.	REV.
STANDARD	A-501	2

DESIGN CALCULATIONS PROCEDURE

1.0 SCOPE

1.1 This procedure defines the methods used for preparing, checking, reviewing, controlling, and retaining engineering calculations. This procedure shall be used by all disciplines in Engineering for calculations prepared for project use. Subcontractors must keep similar control but may use own forms.

1.2 Confidential and secret documents are to be prepared as shown in this procedure. However, distribution will conform with the subcontract and project specification 14222-A-16, Procedure for Confidential and Secret Documents.

2.0 PREPARING CALCULATIONS

2.1 Generally, each calculation shall list the basic criteria; these include design assumptions, applicable codes, standards, and references. Major equation sources shall also be listed. The source or derivation of all uncommon equations shall be shown when they are introduced into the calculations.

2.2 Design assumptions shall be clearly stated so that they may be understood by the checker and in the event it becomes necessary to revise calculations or to make them available to outside parties.

2.3 Established design criteria and previously developed and approved designs, methods, and solutions should be used as guidelines, and identified as to source. The applicability of existing solutions to new problems will be determined before such design methods or solutions are adopted.

2.4 Calculations shall be orderly and complete, with enough sketches and notes so that the work can be understood. Diagrams indicating data (such as loads, flows, voltages, and dimensions) shall be included along with adequate freehand sketches of all important details not considered standard.

2.5 A calculation cover sheet shall be prepared by the originating engineer before calculations are submitted for checking and review. Sheet 5 hereof is the form to be used as the cover sheet for major calculations. The cover sheet shall show the project title, job number, file number, discipline, calculation number, calculation title, subject, brief statement of the problem, sources of data, sources of formulas and references, intended use of calculation (final design, preliminary

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△	4/80	ISSUED FOR APPROVAL	HS		

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATION
DESIGN CALCULATIONS PROCEDURE

JOB NO. 14222
SPECIFICATION 14222-A-21
REV 1

design, etc.), revision number and date, originator's name, checker's name and date, and approval signature and date. The names of all engineers and checkers who have made and checked any part of the calculations shall also be listed.

2.6 Calculations, excepting computer calculations, shall be made on Bechtel standed calculation sheets of which sheet 6 here of is a sample. The heading of each sheet in the set of calculation shall be completely filled in with the date, designer's name, checker's name, calculation and sheet number, file number, project title, job number, and subject of calculation.

2.7 When calculations are based upon preliminary data for early implementation of the work, such calculations shall be subjected to the complete review procedure, and the responsible lead engineer shall assure a final calculation check is made as soon as final input data are available.

2.8 All calculations involving computer printouts shall have an accompanying calculation package containing the appropriate information as outlined above. In case of unmanageable volume, computer calculations shall be prepared as a separate document available for checking and review, as required.

2.9 Project originated computer programs shall have a flow diagram, sample calculation, and complete description of the program. In those cases where a sample calculation is not practical, other acceptable verification shall be used.

2.10 The calculation package for a standard computer program, or one from outside the project, shall consist of a completed cover sheet, and a complete outline of the problem, including sketches, if applicable. The user's manual is the prime source of information.

3.0 CHECKING

All engineering design calculations shall be checked by an engineer who has a level of design qualifications senior to that required to originate the calculation. The checker shall not be the originator of the calculations.

After verifying the basis of a calculation, the checker has the option of performing a mathematical check or verifying the calculation by an alternate means. Approximation methods may be adequate for checking.

3.1 Checker Responsibilities

The checker shall be responsible for the following activities:

3.1.1 Checking calculations against the design drawings to verify whether they conform with specified configurations, dimensions, and materials.

3.1.2 Checking calculations for assumptions, analytical methods, mathematical accuracy, completeness, compliance with design criteria, and the adequacy of design.

3.1.3 Initialing and dating each page of the original calculations after they are completely checked and all necessary corrections and additions have been made, or attach initialled alternate calculations, if used.

3.1.4 Sign-off cover sheet.

3.2 Computer Calculations Checking Responsibilities

The checker shall assure that the following actions are taken for checking computer calculations:

3.2.1 Check the calculation package accompanying the computer printout checked in accordance with these procedures.

3.2.2 For project originated computer programs, check the computer listing for assumptions, program theory, compliance with the flow diagram, and overall correctness.

3.2.3 For standard computer programs, check to assure applicability of the program and assumptions made.

3.2.4 Regardless of the computer programs used, check all input data for correctness, as well as the application of output data.

3.2.5 Provide checker sign-off on cover sheet.

4.0 REVIEW AND APPROVAL

Calculations that are the basis for establishing design criteria, dimensions, or other major parameters shall be checked and submitted to the Lead Discipline Engineer for review and approval in accordance with this procedure. Sheet 7 here of depicts the calculation flow chart.

The Lead Discipline Engineer shall review all design calculations prepared by his group for technical adequacy and conformance with design requirements. The Chief Engineer or his delegated staff personnel shall review calculations as requested by project, or when the Chief Engineer elects to review specific calculations. Such calculations shall be subject to approval by the Chief Engineer. Preliminary calculations shall be reviewed and initialed by the Lead Discipline Engineer and shall clearly be marked "PRELIMINARY".

5.0 REVISIONS

For revisions to calculations, including superseding calculations, the same checking procedure shall be used for the revised calculations as for the original calculations. All parts of the complete calculation which are dependent upon the revision, shall be checked and the complete original calculation shall be reviewed to determine which parts are dependent. It is not necessary to recheck parts which are independent of the revision. Results of calculations revisions shall be made known to others who may be affected.

6.0 RETENTION

An index shall be initiated and maintained by the Engineering Supervisor for each discipline. A sample is attached as Sheet 8.

The originals of the design calculations for each discipline shall be kept in calculation binders in each discipline's files which serve as the master project calculation file for reference and for audit. Calculations shall be separated into groups: Preliminary, Final, and Superseded.

A copy of appropriate calculations shall be filed in the project area files.

Pertinent consultant and supplier calculations, designs, data, and all checks performed, shall be kept in the appropriate area technical file.

Computer printouts should be cross-referenced to their corresponding calculation package, and printouts shall be labeled and filed in the same manner as the hand calculations.

Calculations and computer printouts shall not be removed from their binder except when they are revised or reproduced. When calculation binders are removed from files, an "OUT" card shall be inserted in their place indicating what calculations were removed, when, and by whom.

BECHTEL INCORPORATED

CALCULATION COVER SHEET

CALC. NO. ________________

NO. OF SHEETS ________ DISCIPLINE ____________

JOB NO. ________________

REVISION NO. ________________

DATE ________________

TITLE:

SUBJECT:

STATEMENT OF PROBLEMS:

SOURCES OF DATA:

SOURCES OF FORMULA & REFERENCES:

INTENDED USE: ________________________________

PRELIMINARY CALC. ☐ FINAL CALC. ☐ SUPERSEDES CALC. NO. ________________

REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

PL 1157

CALCULATION SHEET

P. O. BOX 2166
HOUSTON, TEXAS 77001

CALC. NO. ______

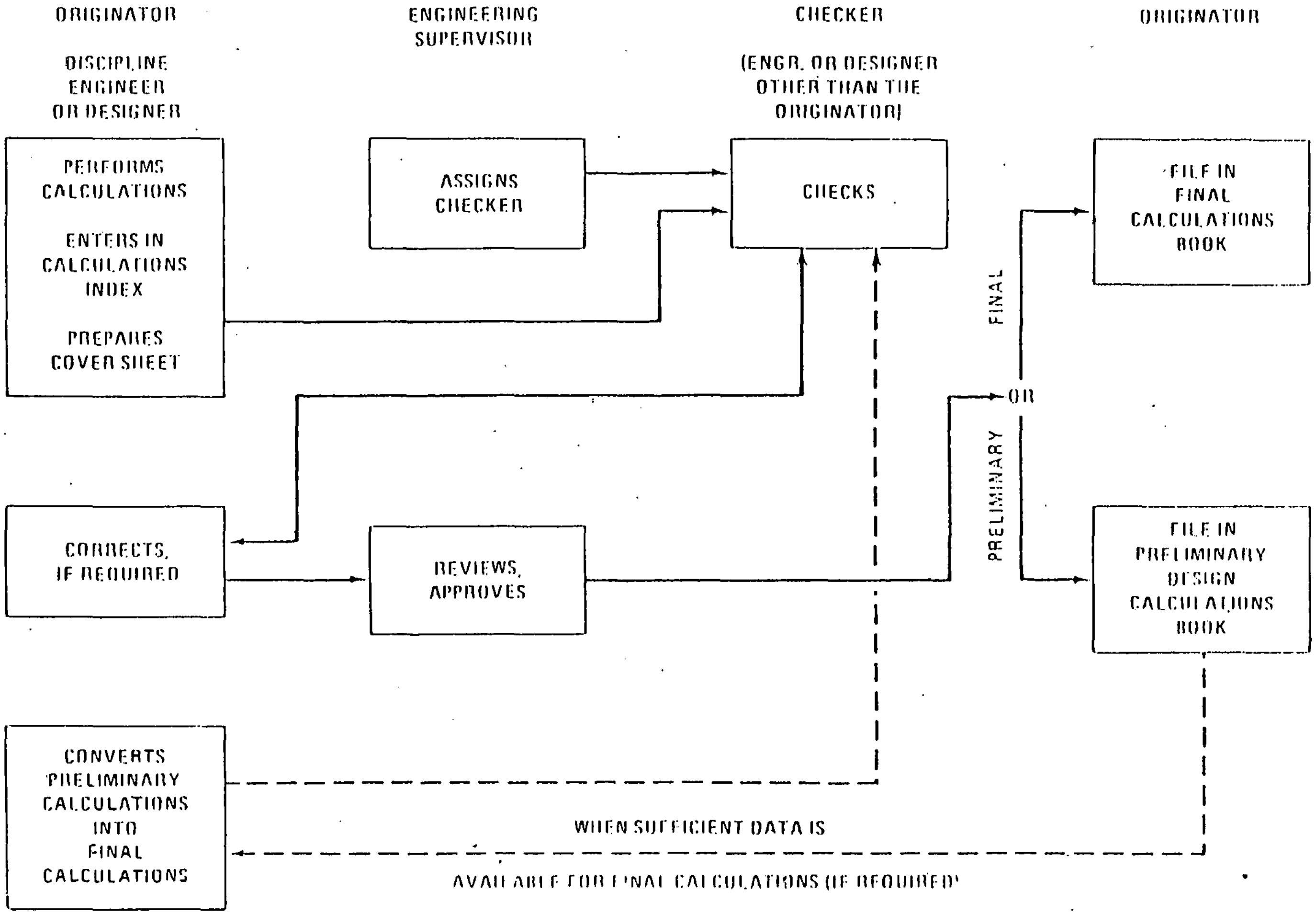
SIGNATURE ______ DATE ______ CHECKED ______ DATE ______

PROJECT ______ JOB NO. ______

SUBJECT ______ SHEET ______ OF ______ SHEETS

HO-90101 (9/74)

ON-PROJECT CALCULATION
FLOW CHART
PREPARATION AND CHECKING



CALCULATION INDEX

Bechtel

JOB NO

DISCIPLINE

JOB TITLE

CALC. NO.	REV/DATE		DESCRIPTION	REMARKS

CLIENT REVIEW & APPROVAL OF

PHASE ZERO DELIVERABLES

1.0 SCOPE

1.1 This specification establishes the procedure for processing Phase Zero Deliverables which are listed in Agreement No. BC-01 between ASFI and Bechtel as well as those items indicated on the Distribution of Documents Matrix which require ASFI approval.

2.0 PROCEDURE

2.1 Two types of submissions shall be made for drawings and specifications:

- Issue for Review and Approval
- Issue for Phase Zero

2.1.1 The drawing or specification shall be delivered to Bechtel Document Control (DC). DC shall enter it into the log and deliver prints to the Client Project Director (CPD). Prints shall be marked "ISSUE FOR REVIEW & APPROVAL".

2.1.2 CPD returns one signed, approved print marked with comments, if any, to the Bechtel Project Manager (BPM) within ten (10) working days. BPM forwards print to DC who enters it into the log.

2.1.3 DC shall refer the comments to the designated Project Engineer who shall resolve them.

2.1.4 After resolution of comments and drawing or specification updating, it shall be delivered to DC. DC shall obtain the initials of the following as applicable on the original.

- Bechtel Discipline or Project Engineer
- Bechtel Project Engineering Manager
- Bechtel Project Manager

and one of the following:

- Client Project Director
- Client Project Manager
- Client Project Engineering Manager
- Client Process Engineering Manager

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATION
CLIENT REVIEW & APPROVAL OF PHASE ZERO DELIVERABLES

JOB NO. 14222

SPECIFICATION	REV
14222-A-22	1

SHEET - OF -

Full distribution shall then be made in accordance with the Distribution of Documents Matrix and the prints shall be marked "ISSUE FOR PHASE ZERO".

2.2 One submission shall be made for documents other than drawings and specifications:

- Issue for Phase Zero

2.2.1 The document shall be delivered to DC who shall enter it into the log and deliver prints to CPD. Prints shall be marked "ISSUE FOR PHASE ZERO" and full internal distribution shall be made in accordance with the Distribution of Documents Matrix.

2.2.2 Should CPD have any comments, one signed print marked with such comments will be returned to BPM within ten (10) working days. Otherwise, the documents will stand as issued. BPM forwards received prints to DC who enters them into the log.

2.2.3 DC shall refer any prints received with comments to the designated Project Engineer who shall resolve them.

2.2.4 After the elapse of ten (10) working days following document issue and/or after resolution of comments and document updating and return to DC; DC shall obtain the the initials of the following as applicable on the original.

- Bechtel Discipline or Project Engineer
- Bechtel Project Engineering Manager
- Bechtel Project Manager

and one of the following:

- Client Project Director
- Client Project Manager
- Client Project Engineering Manager
- Client Process Engineering Manager

No further distribution shall be made internally pending assembly of the Deliverable Report Drafts. Full distribution shall be made for ASFI in accordance with the Distribution of Documents Matrix.

FORM 293

Pressure
Vessels—C

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1	7/22/80	ISSUED FOR PHASE ZERO	[illegible]	HS	[illegible]
0	3/80	ISSUED FOR APPROVAL	OR	HS	

ASFI THE BRECKINRIDGE PROJECT AECI

U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717

GENERAL DESIGN SPECIFICATION

C. STEEL AND LOW-ALLOY VESSELS, UNDER 2" THICK

JOB NO. 14222

SPECIFICATION 14222-C-1 REV 2

SHEET 1 OF 3

1. GENERAL

1.1 This specification covers the minimum requirements for the design, fabrication, inspection and certification of carbon and low-alloy steel pressure vessels with shell thicknesses less than 2".

△2 1.2 For field-fabricated and/or high-alloy clad pressure vessels, the requirements of Specificiations 14222-C-5 and 14222-C-6, respectively, shall supplement the requirements of this specification.

2. CODES, REGULATIONS AND STANDARDS

2.1 All design and construction shall be in accordance with the ASME Code Section VIII, Division 1, and with all local regulatory requirements.

2.2 The applicable ASME Code Section VIII, Division 1, shall be that current at the date of purchase and shall include all Addenda current at that date. In this specification, Division 1 means ASME Code Section VIII, Division 1.

2.3 Unless otherwise specified or approved by the Buyer, ASME Code stamped vessels are required.

2.4 The standard drawings as listed and attached to Standard Drawing Index C-500 shall be complied with as applicable and as specified on the Buyer's vessel drawings.

3. SELLER'S RESPONSIBILITY

3.1 Seller shall assume complete responsibility for the design and construction of the vessels and their integral components, and shall consider thicknesses shown on the Buyer's vessel drawings as minimum design requirements.

3.2 Seller shall apply for and obtain all necessary approval of his design and construction from the local Regulatory Authorities, as appropriate.

3.3 Should conflict occur between Buyer's specifications and drawings or attachments, it shall be the responsibility of the Seller to call Buyer's attention to the conflict and request a ruling or interpretation from the Buyer. The Seller is not at liberty to assume which instruction would govern.

3.4 Buyer's review of Seller's drawings, or release of vessel for shipment by the Buyer's inspector, shall in no way relieve the Seller of the responsibility for complying with all the requirements of the purchase document.

4. BUYER'S RESPONSIBILITY

4.1 Buyer will provide basic configuration, service data and design requirements for each vessel.

4.2 The revision block on the drawings prepared by the Buyer will show the extent of release for Seller's work, e.g. quotations, materials commitment, construction, etc.

5. DESIGN

5.1 All vessels shall be designed for the pressure and temperature specified, and for dead loads, lateral loads and all other applicable loads.

5.2 For vertical vessels and vessel supports, the Seller shall make a design check for the condition of vessels shut-down and empty combined with the specified wind load.

5.3 All vessels and vessel supports shall be designed for the condition of vessels full of water combined with 25% wind load.

5.4 For large, thin-wall vessels, the Seller shall make a design check and, if necessary, provide additional stiffening to prevent shell distortion during fabrication, heat treatment, hydrotesting or shipment.

△2 5.5 All vessels subject to steam out will be designed for at least 50 psig or full vacuum, whichever is more severe.

6. SELLER'S DRAWINGS AND DATA

6.1 Seller shall comply with the requirements of Specification C-8, and furnish all applicable drawings, welding procedure specifications with procedure qualification records, all other documents called for, and by such date as to enable the Buyer to review and comment on the Seller's proposals, and resolve conflicts, without delaying the Seller's schedule.

6.2 Mill and shop material test reports (showing compliance with the requirements of paras. 7.4, 7.6, and 7.72 as appropriate), shall be presented to the Buyer's inspector for review.

7. MATERIALS OF CONSTRUCTION

7.1 Written approval for use of any materials other than specified on the Buyer's vessel drawings must be obtained from the Buyer prior to any detailing or fabrication, and preferably at the time of Seller's proposal.

7.2 The requirements of paragraph UG-85 of Division I shall be adhered to in all Division I constructions. Except for the exemptions allowed by para. UCS-85 of Div. 1, all test specimens shall be taken from sample coupons which shall be given Buyer approved simulated heat treatment equivalent to the maximum heat treatments which the vessel or its components can receive, including such heat treatments applied at the material manufacturer's mill and any applied by the vessel manufacturer during fabrication. Heat treatment in this context shall be considered as any heating operation which results in the material being tempered or in residual stresses being relieved, i.e., the material properties are changed.

7.3 All material substitutions shall meet the standards of quality required by this specification and Division 1, and shall have properties adequate for the design conditions of the vessels.

7.3.1 Substitute materials with other than ASME designations shall require complete chemical and mechanical properties of the material to be furnished at the time of proposal.

7.4 Impact Tests (Cv) On Base Materials

Unless otherwise specified by the Buyer's drawings or documents, impact test requirements for all carbon and low-alloy steel materials shall be in accordance with the requirements of Division 1, and the following:

7.4.1 Impact tests shall be done at a temperature no higher than the minimum design temperature for the vessel.

7.4.2 Lateral expansion values shall not be less than 15 mils for all materials.

7.4.3 All impact test results shall be reported in the material suppliers' certified test reports. Percent shear shall be reported for information only.

7.5 Welds shall have an actual ultimate tensile strength at room temperature and in the final condition, including any specified heat treatment, within the specification range of the weaker of the base materials joined.

7.6 The actual maximum room temperature strength of all high-strength materials (i.e., when specification tensile strength may exceed 100,000 psi) and welds in their final condition shall not exceed the following:

Yield Strength = 90,000 psi
Ultimate tensile strength = 125,000 psi

7.7 Materials of Construction for Vessels in Severe Service (Hydrogen (H_2), Hydrogen Sulfide (H_2S), Cyanide (CN), Hydrofluoric Acid (HF) or as otherwise specified on the Buyer's vessel drawings).

7.7.1 All welding procedure details shall be selected to minimize areas and points of hardness in deposited welds and heat-affected zones in their final condition.

7.7.2 The actual maximum room temperature strength of all specified or proposed base materials and welds, in their final condition, shall not exceed.

Yield Strength = 70,000 psi
Ultimate tensile strength = 95,000 psi

7.8 Casting materials shall not be used without Buyer's approval.

7.9 For external attachments (non-pressure-retaining parts), any Division I approved carbon steel may be used for any low-alloy steel vessels provided that the weld metal joining the parts to such vessels is of the same chemical composition as the vessel base material.

7.10 Unless otherwise specified, material for external bolts shall be SA-193 Grade B7 for design temperatures from - 50°F to 850°F, and Grade B16 above 850°F. Material for nuts shall be SA-194 Grade 2H.

8. FABRICATION REQUIREMENTS

8.1 Welding

8.1.1 All welding shall be in accordance with Division 1, Specification 14222-W-1, and these requirements; for post-weld heat-treated vessels, welding shall be completed before applying the final heat treatment.

8.1.2 All welding procedure details shall be selected to minimize areas and points of hardness in deposited welds and heat-affected zones in their final condition. Brinell hardness of completed welds shall satisfy requirements of Spec. 14222-W-1.

8.1.3 Seller's welding procedure specifications, including qualification records, shall be submitted for approval per Specification 14222-C-8.

8.1.4 Whenever possible, all weld seams shall be located so as to permit adequate and proper inspection and repair. Weld seams that will be partially or wholly covered shall be 100% radiographed for the length of the weld to be covered, plus 3" at each end, prior to covering the weld. This radiograph requirement does not apply to plate brackets, etc., 1" and less in thickness installed on edge transverse to a weld seam.

8.2 Weld Procedure Qualification (WPQ)

8.2.1 Impact Testing of Welds and Heat - Affected Zones (HAZ's)

8.2.1.1 When impact testing of base materials is specified, all WPQ and production test plates shall have weld metal and HAZ's impact tested. Impact tests of the base materials used in the WPQ's are not required. However, base materials used in WPQ's shall comply with the same material specifications as required for the actual construction, including supplementary requirements of the specifications and drawings, but they need not be taken from the material heats to be used in the construction.

8.2.1.2 Basic test requirements, including any required heat treatment of impact specimen coupons, impact temperature, required minimum impact data to be reported, shall be as specified for base materials (See para. 7.4).

8.2.2 All-Weld-Metal Tensile Tests

For vessels in severe service or utilizing high-strength materials (see para. 7.6 and 7.7), WPQ's shall include room temperature all-weld-metal tensile tests.

8.2.3 WPQ Records

WPQ Records shall show compliance with the mechanical, and impact properties called for in paras. 7.7, 8.21, and 8.22 as appropriate, for weld metal and HAZ's. Records shall also show all heat-treating times and temperatures, full details of welding, including voltage, amperage, and travel speed.

8.3 Heat Treatment

8.3.1 Unless a higher temperature is specified, postweld heat treatment (PWHT) shall be in accordance with Division 1 and Specification 14222-W-1.

8.3.2 When PWHT is required by Code, or is specified on the Buyer's vessel drawings, it is the Buyer's intention that the complete vessel shall be postweld heat treated in one piece in a furnace. Any exceptions shall be clearly stated in the Seller's bid and be subject to Buyer's prior review and approval.

8.3.3 Cold formed one-piece heads and toriconical transition sections shall be heat-treated in accordance with para. UW-40 of Division 1 when the plate used to form such section exceeds ½ inch thickness.

8.3.4 All finished machined and threaded surfaces shall be protected against oxidation during heat treatment.

8.4 Repairs

Any repairs required after final PWHT or after the hydrostatic test shall be described in detail and submitted, together with the Seller's proposal for subsequent examination, PWHT and testing, for Buyer's approval before proceeding with such repairs. All repairs shall comply with Division 1 requirements and shall be examined in accordance with the requirements of this specification.

8.5 Tolerances

Fabrication tolerances shall be such as to permit proper installation and function of the internals. Minimum tolerance requirements shall be in accordance with Division 1, the Buyer's vessel drawings, Standard Drawing C-515, and Buyer's specifications.

8.6 Nameplates

In addition to the data required by Division 1, all nameplates shall include Buyer's vessel identification number. Nameplates shall be 18-8 stainless steel and permanently attached to a suitable bracket with adequate projection to prevent nameplate being covered by insulation.

9. INSPECTION, EXAMINATION, AND TESTING

9.1 General Inspection

9.1.1 In addition to Division 1 inspection, Seller's work and all sub-vendors' work shall be subject to inspection by the Buyer and the user. Personnel representing either of these parties shall be granted access to all areas of the Seller's and his sub-vendors' plant(s) concerned with the production, inspection examination, and testing of the vessels and related components. Seller shall be responsible for imposing all pertinent requirements of the purchase document on all of his sub-vendors including written notice on his purchase order to sub-vendors indicating that their work is subject to Buyer and user inspection.

9.1.2 When specified, Buyer's inspector will request the Seller to make hardness readings in accordance with Specification 14222-W-1 at various locations on applicable constructions to verify compliance with the requirements. These readings must be witnessed and approved by the Buyer's Inspector for acceptance of the vessel.

9.1.3 An ASME Manufacturer's Data Report will be required for each vessel unless specifically waived in the purchase document.

9.2 Radiographic Examination (RT)

Radiography shall be in accordance with Specification 14222-W-1, and for acceptance shall be made at a late stage of fabrication but prior to any final PWHT.

9.3 Magnetic Particle Examination (MT)

When specified, magnetic particle examination shall be in accordance with Specification 14222-W-1.

9.4 Liquid Penetrant Examination (PT)

Liquid penetrant examination of high-alloy overlay welding shall be in accordance with the requirements of Specification 14222-C-6.

9.5 Weld Sampling

When the vessel base material is other than a P-1 material or when high-alloy clad base material is specified, samples of deposited weld metal shall be taken in accordance with Specification 14222-C-2.

9.6 Hydrostatic Test

9.6.1 Testing shall conform to para. UG-99 (c) Division 1. Test pressure shall be as specified and the pressure on any section shall not exceed 1.75 times the maximum allowable pressure new, at test temperature, except for field-fabricated vessels, see Specification 14222-C-5.

9.6.2 The minimum metal temperature throughout the hydrotest shall be established by the Seller to ensure the safety of the vessel, but shall not be less than the higher of:

a) The minimum design temperature specified on the vessel drawing.

b) The impact test temperature, where the base material and welds of the vessel are required to be impact tested.

c) 60°F.

d) Code requirement.

9.6.3 Hydrostatic test water shall be potable, except that vessels containing high-alloy cladding or internal attachments shall be tested with water complying with the requirements of Specification 14222-C-6.

10. CLEANING AND PAINTING

10.1 All vessel surfaces shall be cleaned to remove loose scale, rust, grease, dirt, weld spatter, hydrotest water and other foreign matter.

10.2 Surface preparation and painting shall be in accordance with Specification 14222-X-1, unless otherwise specified. Vessels undergoing ocean shipment shall be provided with VPI corrosion inhibitors, rubber gaskets under all nozzle shipping covers and, when external painting is not otherwise required, one coat of red lead paint on external surfaces.

10.3 All exposed machined and threaded surfaces shall be thoroughly coated with a suitable rust preventative compound and suitably protected for shipment. The Seller shall show details on his drawings.

10.4 All loose parts shall be adequately crated and given clear markings relating the parts to the vessel identification number.

10.5 After application of the paint required by paragraph 10.2, each vessel receiving PWHT shall have the following stenciled along both sides of the vessel in large white letters, in English, and if applicable, in the native language of the country producing and receiving the vessel.

"Do not weld or strike arcs--stress relieved vessel".

Reference Drawings and Specifications

Specification 14222-C-2
14222-C-8
14222-C-5
14222-C-6
14222-W-1
14222-X-1

Standard Drawing Index C-500 } To be attached during Phase 1.
Standard Drawing C-515

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL DESIGN SPECIFICATION
PRESSURE VESSEL WELD DEPOSIT SAMPLING

JOB NO. 14222

SPECIFICATION	REV
14222-C-2	1

SHEET 1 OF 4

1. GENERAL

1.1 This specification covers weld deposit sampling for analysis to determine the significant constituent elements in the low-alloy and 300 series high-alloy weld deposit chemistry, and the ferrite content determination of 300 series high-alloy weld metal.

1.2 Samples shall consist of drillings or chips removed in such a manner as to avoid contamination of the samples. A minimum of 10 grams (1/3 oz) of material is required for each sample.

1.3 Samples shall be placed in individual packages and each package clearly marked with the vessel identification number and location from which the sample was taken.

1.4 A stub end of each coil of filler wire used in automatic and electro-slag welding shall be taken as a sample and tagged to identify it with the work in which it was used. The samples shall be retained for future analysis if required.

2. SELLER'S RESPONSIBILITY

2.1 For vessels requiring weld deposit sampling, Seller shall take actual samples in accordance with the requirements of this specification, and as soon as the designated welds are completed.

2.2 Seller shall select a qualified laboratory, subject to Buyer's approval, to perform the chemical analyses of the samples, and submit the report of the laboratory to the Buyer for his review and acceptance.

2.3 Seller shall pay for the sample taking, the associated rewelding and the services of the laboratory.

2.4 In the event the analysis of an initial sample shows the chemistry to be outside the specified limits, Seller may take two additional samples from the same weld as the sample showing non-conformance to the specifications, and have an analysis done by the same laboratory or a Buyer approved substitute. Cost of additional sampling and analysis shall be borne by the Seller.

2.5 If one of the additional samples fails to meet requirements, the entire weld shall be removed and replaced in accordance with Buyer approved procedures.

2.6 All repaired welds shall be resampled as outlined above.

3. BUYER'S RESPONSIBILITY

3.1 Buyer's inspector will designate the locations from which all weld deposit samples shall be taken.

3.2 Buyer's inspector will approve Seller's selection of testing laboratory, and will review the results of all sample analyses.

4. LOW ALLOY WELDING

4.1 Where hydrogen-resistant construction is required according to API publication No. 941, or when specified for other services, samples of deposited weld metal shall be taken, as a minimum, from each longitudinal weld, each circumferential weld, each manway weld, one nozzle weld and each repair weld for each piece of equipment. At each location, the sample shall be taken on or below the inside surface.

4.2 The chromium and molybdenum contents of the weld samples shall be within the range specified for the base material.

5. WELD OVERLAY

Except when 300 series high-alloy weld overlay is part of a weld deposit in 400 series construction, the following requirements shall apply:

5.1 The specified 300 series high-alloy weld overlay chemistry shall be guaranteed. Samples of as deposited weld metal shall be taken to check the conformance of deposit chemistry with specifications for each component. The sample shall be taken from the surface at the nominal depth of the specified corrosion allowance ± 1/16 inch and from the following locations:

5.1.1 One sample shall be required for each approved welding process (submerged arc, shielded metal arc, etc.) used.

5.1.2 One sample from each flange overlay weld.

5.1.3 One sample from each repair weld made from the clad side in clad components where the repaired area extends into the base metal.

5.1.4 One sample from each longitudinal and circumferential weld joint in equipment constructed from clad plate where the cladding was stripped back and subsequently overlayed.

5.1.5 Two samples taken 180 degrees apart and 6 inches from the edge of each course in equipment that is weld overlayed. In addition, weld overlayed equipment shall have two samples taken from each head, one 6 inches from the edge and the other from an area designated by the Buyer's inspector.

5.2 Where type 347 austenitic stainless steel weld overlay is specifiec the composition of the weld overlay samples shall be as follows:

Max. C	Min Cr.	Min. Ni	Cb
0.08	17.5	8.0	8 x C (Min.), 1% (Max.)

5.3 The ferrite number of as-deposited 300 series high-alloy weld metal shall meet the requirements of paragraph 5.7 of Specification 14222-W-1.

Reference Specification

Specification 14222-W-1.

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL DESIGN SPECIFICATION
. PROCESS COLUMN TRAYS

JOB NO. 14222

SPECIFICATION	REV
14222-C-3	1

1. GENERAL

1.1 This specification covers the minimum requirements for the design, performance, materials of construction and details of trays and related components installed in process columns.

1.2 Trays are classified by responsibility for their process design, as follows:

	Responsibility for process design
Class I	Seller
Class II	Buyer

2. DESIGN

2.1 Design shall be adequate for all conditions of operation and shall permit normal installation, erection and maintenance procedures.

2.2 The following shall be considered minimum basic criteria:

2.2.1 Loads

Live Loads	Class I	Class II
Decks	Seller's standard	12 psf*
Seal Areas	Seller's standard	64 psf*

* or weight of water or process fluid at weir height and seal level, whichever is greater.

Maintenance Load - 300 lb. concentrated at any point

Uplift

When noted on the Buyer's tray data sheets, trays shall be designed to resist the specified uplift pressure. When none is specified, the standard uplift pressure shall be 1 psi.

2.2.2 Deflections

Unless otherwise specified, the maximum deflection of any loaded tray component, at operating temperature and in the corroded condition, shall conform to the following:

Class I	Class II
Seller's standard	1/8" (For process columns less than 8 feet diameter) Column dia. (inches) ÷ 750 (For process columns 8 feet or greater diameter)

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When critical, the maximum acceptable deflection for tray decks under operating conditions will be specified on the Buyer's tray data sheet. It shall be the Seller's responsibility to provide adequate design so that the deflection will not exceed the specified maximum based on tray components being in the fully corroded condition.

Thicknesses

Unless otherwise specified, the minimum thickness (including corrosion allowance) and minimum total corrosion allowance shall conform to the following:

Type of Section & Description	Minimum Thickness (Gauge)*		Minimum Total Corrosion Allowance (on two sides)	
	Carbon Steel	Alloy	Carbon Steel	Alloy
Removable Sections Decks & Downcomers	10	12△	0.03"	None
Integral Beams & Separate Minor Beams	10	12△	0.03"	None
Major Beams & Trusses	7	10	1.0 x Vessel C.A.	None
Contacting Devices (Caps & Valves)	14**	16**	None	None
Welded-in Sections*** Support Rings, Bolting Bars, Beam Seats, etc.	3/8△	¼△	1.5 x Vessel C.A.	0.06" or Vessel CA (if Alloy)

* Carbon Steel: United States Standard
Alloy: United States Standard - Stainless Steel

** Seller's standard may be proposed for Buyer's approval.

*** Unless approved otherwise by the Buyer all trays including the attachment to their supports shall be of bolted or clamped construction.

△ 2.2.4 Fractionation trays, caps, downcomers, baffles and other internals for fractionating towers shall be made from type 410 stainless steel sheet unless otherwise specified.

2.2.5 Tightness
Trays shall be designed and fabricated to comply with the tightness requirements of Specification 14222-C-7.

3. DESIGN RESPONSIBILITY

3.1 For Class 1 trays, Seller shall assume complete responsibility for the design of the trays including all details necessary to meet his performance guarantee and the requirements of this specification.

3.2 For Class 11 trays, Seller shall provide mechanical design conforming to the requirements of the Buyer's tray data sheets, vessel drawings and this specification.

4. PERFORMANCE GUARANTEES

4.1 For Class 1 trays, Seller shall incorporate a written guarantee into his quotation stating that:

a) His tray design will pass the specified liquid and vapor traffic without flooding or excessive entrainment.

b) His trays will not exceed any specified pressure drop.

4.2 For Class II trays, Seller is not required to guarantee process performance.

4.3 For both Class 1 & 11 trays, Seller shall guarantee that the leakage rates specified in Specification 14222-C-7, or as otherwise called for, will not be exceeded with trays properly installed in the column. Seller shall furnish adequate and suitable tray installation instructions for the tray installer's use.

5. MATERIALS OF CONSTRUCTION

5.1 Materials of construction shall be as specified on the Buyer's tray data sheets and vessel drawings, and as follows:

5.11 Carbon steel material shall be weldable commercial quality.

5.12 Alloy material shall be weldable commercial or economy quality, number 1 finish.

5.13 Unless prohibited by the service conditions, bolting shall be SA-307 for carbon steel decks, beams, etc., and 12 Cr for tray manways and alloy parts.

5.14 For austenitic stainless steel tray parts, bolts shall be Type 304 stainless steel with Type 304 nuts.

5.2 Alloy valves may be used in carbon steel decks except when service conditions prohibit the particular alloy (e.g. 12 Cr shall not be used in HF service).

5.3 Gaskets

Unless otherwise specified on the Buyer's tray data sheets or vessel drawings, gaskets for tray components where used shall be 1/16-inch asbestos of the following grade or quality:

400°F. and below..................	Commercial quality (75% to 80% asbestos)
Between 400°F & 750°F...........	AAA Grade (95% to 98% asbestos)
Between 750°F & 900°F...........	AAAA Grade (95% to 100% asbestos)
Above 900°F......................	Pure asbestos fiber reinforced with stainless steel wire
Acid or caustic services below 600°F......................	Teflon impregnated asbestos

6. CONSTRUCTION DETAILS

6.1 Any components to be welded directly to the vessel shell shall normally be furnished and installed by the vessel manufacturer in accordance with design and details to be supplied by the tray Seller.

6.2 All removable sections shall be sized to pass through the nearest column manway as indicated on the Buyer's vessel drawing.

6.3 Internal access to all sections of the contacting deck area shall be provided.

6.3.1 A minimum 13"x16" clear opening shall be provided for all tray manways and 14" clearance between members shall be provided for access.

6.3.2 Tray manways shall be vertically aligned when possible.

6.3.3 Unless otherwise specified, tray manways shall be removable from both top and bottom sides.

6.4 Valve Trays

Valve tray designs shall incorporate the following features:

6.4.1 All valve caps, other than those requiring flush seating, shall be provided with small protuberances at the periphery to prevent sticking of the valve to the tray deck or valve seat.

6.4.2 Flush seating valve caps shall be provided for total draw trays and for trays serving once-through reboilers.

6.4.3 Flush seating valve caps shall be 12 Cr material unless otherwise specified.

6.4.4 Trays with flush seating valve caps shall have adequate provision for automatic drainage as required to avoid overloading the trays when hydrostatic test water is drained from the vessel.

6.4.5 Valve caps shall be of non-spinning design.

6.4.6 Valve units shall be of the two piece design in which the valvue cap is separated from its fixed retainer.

6.5 Fabrication Tolerances

6.5.1 Vessel shell and attachments shall be fabricated in conformance with the tolerances shown on Standard Drawing C-515.

6.5.2 The Sellar of Class 1 trays shall establish such tolerances and shall build the trays to these tolerances so that the performance guarantees are met allowing for the vessel tolerances called for on Standard Drawing C-515.

6.5.3 Class II trays shall be fabricated to allow assembly within 1/8" of the specified dimensions.

6.6 Miscellaneous:

6.6.1 Leakage rates shall generally be controlled by the tray design and the use of gaskets. Seal welding of joints by the tray installer shall not be called for or allowed unless specifically approved by the Buyer at the time of tray quotation evaluation.

6.6.2 Welded-in tray supports or sections shall conform to the minimum welding requirements of Standard Drawing C-526.

6.6.3 Bolting shall be 3/8" minimum diameter. UNC threads with a number 2 fit are required unless otherwise noted on the vessel drawings. All bolts and tapped holes shall be free and clean of all burrs and threading compounds.

6.6.4 Weir adjustment features, etc., are not required unless specifically noted on the vessel drawings by the Seller for his performance guarantee.

6.6.5 Unless otherwise specified, weep holes shall be provided in all sections that may trap liquid during shutdown. In inlet areas with weirs, they shall be located at the base of the inlet weir to drain onto the tray.

7. QUOTATIONS

7.1 Seller's quotation shall include the following:

7.1.1 For Class I trays

7.1.1.1 Buyer's tray data sheet, with all required information provided, or adequate equivalent data for Buyer's evaluation of the quotation.

7.1.1.2 Approximate location and configuration of downcomers. (For Buyer's use in vessel model building and vessel nozzle orientation).

7.1.1.3 Method of attaching downcomers to support members. (Through-bolted or clamped).

7.1.1.4 Width of support rings and bars if greater than shown on Standard Drawing C-526.

7.1.1.5 Approximate dimension for any required vertical off-set in deck support rings at inlet sumps, cascades, etc.

7.1.1.6 Recommended details, location, configuration, etc., of distributors. Seller may quote a separate price for supplying these items.

7.1.1.7 A statement verifying compliance with the performance guarantees of paras. 4.1 and 4.3.

7.12 For Class II Trays

A statement verifying compliance with the requirements of paras. 3.2 and 4.3.

7.2 Seller is encouraged to submit supplementary alternative proposals when any of the following conditions apply:

7.2.1 When the process information supplied by The Buyer for Class II trays is detailed enough for the Seller to propose competitive Class I trays.

7.2.2 When alternative materials of construction are significantly more economical and will provide adequate service life for the operating conditions specified.

7.2.3 When the sizes of manway inside diameters specified by the Buyer limit the Seller's standard construction and the alternative sizes are larger than those specified.

8. SELLER'S DRAWINGS AND DATA

Upon receipt of the purchase document, the Seller shall comply with the requirements of Buyer's Form 15A, and furnish all applicable drawings and documents called for, and by as early a date as possible to enable the Buyer to review and comment on the Seller's proposals, and resolve any conflicts, with minimum delay so that vessel details can be completed without changing or delaying the vessel manufacturer's work.

9. INSPECTION, TESTING & CLEANING

9.1 Trays and related components will be subject to Buyer's inspection and testing in accordance with the requirements of Specification 14222-C-7

9.2 All surfaces of trays and related components shall be cleaned to remove all loose scale, rust, grease, weld spatter and other foreign matter. (Oil coating inherent in the fabrication process need not be removed.)

Reference Specifications and Standard Drawings

Standard Drawing C-515 }
Standard Drawing C-526 } To be provided during Phase 1.

Specification 14222-C-7

Form 15A

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05- 80OR20717
GENERAL DESIGN SPECIFICATION
C. STEEL AND LOW ALLOY VESSELS, OVER 2" THICK

JOB NO. 14222
SPECIFICATION 14222-C-4
REV 1

1. GENERAL

1.1 This specification covers the minimum requirements for the design, fabrication, inspection and certification of carbon and low-alloy steel pressure vessels with shells of 2" or greater thickness.

1.2 For field fabricated, and/or high-alloy clad pressure vessels, the requirements of Specifications 14222-C-5 and C-6, respectively, shall supplement the requirements of this specification.

2. CODES, REGULATIONS, AND STANDARDS

2.1 All design and construction shall be in accordance with the ASME Code Section VIII, Division 1 or 2, and when approved by the Buyer may be of the Seller's proprietary construction provided all applicable specifications and local regulatory requirements are complied with.

2.2 The applicable ASME Code, Section VIII, shall be that current at the date of purchase and shall include all Addenda current at that date. In this specification, Division 1 and Division 2 mean ASME Code Section VIII, Division 1 and Division 2, respectively.

2.3 Unless otherwise specified or approved by the Buyer, ASME Code stamped vessels are required.

2.4 The standard drawings as listed and attached to Buyer's Drawing Index C-500 shall be complied with as applicable and as specified on the Buyer's vessel drawings.

3. SELLER'S RESPONSIBILITY

3.1 Seller shall assume complete responsibility for the design and construction of the vessels and their integral components, and shall consider thicknesses shown on the Buyer's vessel drawings as minimum design requirements.

3.2 Seller shall apply for and obtain all necessary approvals of his design and construction from the local Regulatory Authorities, as appropriate.

3.3 Should conflict occur between Buyer's specifications and drawings or attachments, it shall be the responsibility of the Seller to call Buyer's attention to the conflict and request a ruling or interpretation from the Buyer. The Seller is not at liberty to assume which instruction would govern.

3.4 Buyer's review of Seller's drawings, or release of vessel for shipment by the Buyer's inspector shall in no way relieve the Seller of the responsibility for complying with all the requirements of the purchase document.

4. BUYER'S RESPONSIBILITY

4.1 Buyer will provide basic configuration, service data and design requirements for each vessel.

4.2 The revision block on the drawing prepared by the Buyer will show the extent of release for Seller's work, e.g., quotations, materials commitment, construction, etc.

5. DESIGN

5.1 All vessels shall be designed for the pressure and temperature specified, and for dead loads, lateral loads, and all other applicable loads.

5.2 For vertical vessels and vessel supports, the Seller shall make a design check for the condition of vessels shut down and empty combined with the specified wind load.

5.3 All vessels and vessel supports shall be designed for the condition of vessels full of water combined with 25% wind load.

5.4 The design shall be such that the hydrostatic test does not cause a primary stress in excess of 90 percent of the yield strength of the material at the test temperature.

5.5 For proprietary materials, or non-Code stress designs, allowable design stresses shall be determined from complete mechanical tests made at both room temperature and at design temperature. The allowable design stresses shall not exceed the <u>lowest</u> of i(a) to ii(f), below:

i. For designs when creep and stress to rupture do not govern:

(a) UTS r.t. ÷ Stress Factor
(b) UTS d.t. ÷ Stress Factor
(c) YP r.t. ÷ 1.5
(d) YP d.t. ÷ 1.5

ii. For designs when creep and stress to rupture govern:

(e) Stress for 0.1% creep in 10,000 hrs. at the design temp.
(f) Stress to rupture in 100,000 hrs. at the design temp.

UTS r.t. = Ultimate tensile strength at room temperature
UTS d.t. = Ultimate tensile strength at design temperature
YP r.t. = Yield point or yield strength (0.2% offset) at room temp.
YP d.t. = Yield point or yield strength (0.2% offset) at design temp.

NOTE: Creep and stress to rupture limits shall be based upon tests made in accordance with ASTM E-139 for determination of these properties.

Unless specifically approved by the Buyer, stress factor shall not be less than 3.0.

5.6 The following minimum stress analyses shall be provided as applicable (and in addition to basic Code calculation requirements):

a) Complete detailed calculations shall be provided for lug or ring-type vessel supports, when used. These shall include the effects on the vessel shell local to the attachment.

b) For Division 2 vessels supported by skirts, an analysis shall be provided of the skirt to head junction area where significant temperature gradients will exist.

c) Complete design calculations shall be provided for special, large diameter closures and seals, when used.

d) An analysis, including discontinuity stresses, shall be provided for all portions of non-Code vessels, designed with a stress factor of less than 3.5. Combinations of stress components and allowable limits of stress intensities shall be in accordance with Division 2 requirements.

5.7 In the case of proprietary type construction, the Seller shall submit for approval, with his design calculations, the formulas and their method of application, as well as definition of terms involved, assumptions, actual stresses and efficiencies used, etc.

5.8 Seller shall submit all design calculations, details, etc., for Buyer's review and approval. Comments by the Buyer on the Seller's design must be completely investigated and justified to the satisfaction of the Buyer or modifications to the design made that will be mutually acceptable.

6. SELLER'S DRAWINGS AND DATA

6.1 Seller shall comply with the requirements of Buyer's Specification 14222-C-8, and furnish all applicable drawings, welding procedure specifications with procedure qualification records, all other documents called for, and by such date as to enable the Buyer to review and comment on the Seller's proposals, and resolve conflicts without delaying the Seller's schedule.

6.2 Mill and shop material test reports (showing compliance with the requirements of paras. 7.02, 7.03, 7.05, 7.08, and 7.092, as appropriate), shall be furnished for Buyer's review and record.

7. MATERIALS OF CONSTRUCTION

7.1 All proposed materials shall be subject to approval by the Buyer.

7.2 Seller shall furnish mill test certificates with complete chemical analysis and room temperature mechanical properties for all Code design materials used.

The requirements of Code para. UG-85 or Article T-1 as applicable shall be adhered to in all constructions. Except for the exemptions allowed by Code Para. UCS-85 or AT-114 as applicable, all test specimens shall be taken from sample coupons which shall be given Buyer approved simulated heat treatment equivalent to the maximum heat treatments which the vessel or its components can receive including such heat treatments applied at the material manufacturer's mill and any applied by the vessel manufacturer during fabrication. Heat treatment in this context shall be considered as any heating operation which results in the material being tempered or in the residual stresses being relieved, i.e., the material properties are changed.

7.3 For proprietary and non ASME or ASTM listed materials, in addition to showing compliance with chemical analysis requirements, material properties shall be proven by tests at both room and design temperatures, for acceptance, for all materials. All test coupons shall be taken from locations complying with code requirements and shall be given Buyer approved maximum and minimum simulated heat treatments, equivalent to the heat treatments which the vessel or its components can receive.

7.4 Ultrasonic Examination of Plates and Forgings (UT)

7.4.1 All plate materials 4" and over in thickness shall be ultrasonically examined and meet all requirements of SA-435.

7.4.2 All finished forgings materials 4" and over in thickness, shall be ultrasonically examined in accordance with Division 2 requirements. Flat forgings shall be examined by the longitudinal wave technique. Rings and other hollow forgings shall be examined by the shear wave technique.

7.4.3 For the longitudinal wave technique the reference specimens shall be of the same nominal thickness and composition as the items to be tested. The calibration standard hole shall be a 1/2" diameter flat-bottomed hole, 1/4-inch deep.

7.4.4 For the shear wave technique the calibration notch shall be a 60° V-notch, 1-inch long with a depth equal to 3% of the nominal forging thickness.

7.4.5 Defects which produce a loss of back reflection in excess of that produced by the standard hole or exceed the height of the standard notch render the forging unacceptable. Also, those indications requiring recording per SA-388 shall be considered unacceptable. Defects may be removed, the material repaired and the repair area re-examined.

7.5 Impact Test (Cv) on Base Materials

Unless otherwise specified by the Buyer's drawings or documents, impact test requirements for all carbon and low-alloy steel materials in Division 1 or Division 2 construction shall be in accordance with the requirements of the Code, (and para. AM-218 of Division 2, in the case of Division 1 construction), and the following:

7.5.1 Impact tests shall be done at a temperature not higher than the minimum design temperature for the vessel.

7.5.2 Lateral expansion values shall not be less than 15 mils for all materials.

7.5.3 For multiple-layer construction, all materials in excess of 5/16" thickness shall be impact tested.

7.5.4 All impact test results shall be reported in the material suppliers' certified test reports. Percent shear shall be reported for information only.

7.6 All finished surfaces of forgings over 4" thick shall be magnetic particle examined in accordance with para. 9.3.

7.7 Welds shall have an actual ultimate tensile strength at room temperature and in the final condition, including any specified heat treatment, within the specification range (modified per para. 7.08, if applicable) of the weaker of the base materials joined.

7.8 The actual maximum room temperature strength of all high-strength materials (i.e., when specification tensile strength may exceed 100,000 psi) and welds in their final condition shall not exceed the following:

Yield strength = 90,000 psi
Ultimate tensile strength = 125,000 psi

7.9 Materials of Construction for Vessels in Severe Service (Hydrogen (H_2), Hydrogen Sulfide (H_2S), Cyanide (CN), Hydrofluoric Acid (HF), or as otherwise specified on the Buyer's vessel drawings.)

7.9.1 All welding procedure details shall be selected to minimize areas and points of hardness in deposited welds and heat-affected zones in their final condition.

7.9.2 The actual maximum room temperature strength of all specified or proposed base materials and welds, in their final condition, shall not exceed:

Yield strength = 70,000 psi
Ultimate tensile strength = 95,000 psi

7.10 Casting materials shall not be used without Buyer's approval.

7.11 For external attachments (non-pressure-retaining parts), any Code approved carbon steel may be used for any low-alloy steel vessels provided that the weld metal joining the parts to such vessels is of the same chemical composition as the vessel base material.

7.12 Unless otherwise specified, material for external bolts shall be SA-193 Grade B7 for design temperatures from - 50°F to 850°F, and Grade B16 above 850°F. Material for nuts shall be SA-194 Grade 2H. Bolts to SA-193 Grade B7 or B16 may be used above a design temperature of 700°F for Division 2 construction providing the requirements of Code Case 1490 are met.

7.13 All plates, forgings and weld metal shall have a maximum carbon content not exceeding 0.30%. Both ladle and check analyses shall meet this requirement.

Copper content of base materials and weld metal shall not exceed 0.20% and shall be confirmed by chemical analysis.

8. FABRICATION REQUIREMENTS

8.1 Welding

8.1.1 All welding shall be in accordance with the Code, Specification 14222-W-1 and these requirements.

8.1.2 All welding procedure details shall be selected to minimize areas and points of hardness in deposited welds and heat-affected zones in their final condition. Brinell hardness of completed welds shall satisfy the requirements of Specification 14222-W-1.

8.1.3 Seller's welding procedure specifications, including qualification records, shall be submitted for approval per Specification 14222-W-1.

8.1.4 Welding shall not be performed on any part of the vessel after final postweld heat treatment except to buffer-welds or pads designed and approved by the Buyer for such later welding.

8.1.5 The preparation of edges for welding shall be done by machining or by flame cutting. When flame cutting is used, the piece shall be preheated as required for welding and shall be followed by finish grinding to remove ridges and valleys.

8.1.6 All butt-welded joints, including longitudinal and circumferential seams of skirts, shall be double welded with full penetration and fusion.

For Division 2 vessels supported by skirts where significant temperature gradients will exist in the skirt to head junction area, the skirt to head joint shall utilize a weld build-up on the head or a forging, similar to that shown in Fig. AD-912.1 (k) of Division 2, such that the joint is fully radiographable. (See para. 9.21).

8.1.7 All permanent attachment welds shall be full penetration and reinforcing fillet welds shall be concave and merged smoothly with adjoining surfaces.

8.1.8 The preheat and interpass temperature requirements of Specification 14222-W-1 shall be maintained throughout all welding operations.

8.1.8.1 For all pressure retaining welds extending through the full shell or head thickness in other than P-1 materials, the requirements shall be maintained after welding is completed and until the welded joint has received its intermediate or final postweld heat treatment.

8.1.8.2 If the Seller considers his shop techniques and practices are of such a nature that the preheat maintenance after welding followed by postweld heat treatment requirements of para. 8.181 are not required for his work:

a) Longitudinal and circumferential shell, including shell to head, seam welds may be allowed to cool to ambient temperature without a subsequent postweld heat treatment, provided that such seam welds are ultrasonically examined in accordance wtih the Code as soon as practical after completion of the weld and before final postweld heat treatment.

b) All other pressure retaining welds extending through the full shell or head thickness (head seam welds and penetration seam welds, e. g. nozzles, through the shell or head thickness) shall be subject to the requirements of para. 8.181. No exceptions will be allowed. If Seller intends to implement the technique outlined in para. 8.182(a) above, this intent shall be clearly stated in the Seller's bid proposal.

8.1.9 In the actual construction, the welding heat input (joules per inch) shall not exceed that used in the WPQ tests. Other details used in the tests shall also be strictly followed.

8.2 Weld Procedure Qualification(WPQ)

8.2.1 Impact Testing of Welds and Heat-Affected Zones (HAZ's)

8.2.1.1 When impact testing of base materials is specified, all WPQ and production test plates shall have weld metal and HAZ's impact tested. Impact tests of the base materials used in the WPQ's are not required. However, base materials used in the WPQ's shall comply with the same material specifications as required for the actual construction, including supplementary requirements of the specifications and drawings, but they need not be taken from the material heats to be used in the construction. Care shall be taken to ensure that the impact test specimens for HAZ's are properly oriented so that the reduced section under the notch contains the HAZ's. Etching may be required to locate the HAZ. A separate test plate for HAZ impact specimens may be necessary or the bevel angle modified on the oringinal WPQ in order to meet this requirement.

8.2.1.2 Basic test requirements, including heat treatment of impact specimen coupons, impact temperature, required minimum impact data to be reported, shall be as specified for base materials (see para. 7.05).

8.2.2 All Weld-Metal Tensile Tests

For vessels in severe service, or utilizing high strength materials (see paras. 7.08 and 7.09), WPQ's shall include room temperature all-weld-metal tensile tests.

8.2.3 WPQ Records

WPQ records shall show compliance with the mechanical, and impact properties called for in paras. 7.09, 8.21, and 8.22, as appropriate, for weld metal and HAZ's. Records shall also show complete details of all heat treatment sequences, full details of welding, including voltage, amperage, speed of travel, and heat input (joules per inch), etc.

8.3 Nozzles

8.3.1 For Division 1 construction with shells of 3" or greater thickness and for all Division 2 construction, all nozzles larger than 2 inches and all manway necks shall be integrally self-reinforced and attached by welding completely through the total thickness of the shell or head. Such welds shall be fully radiographed per para. 9.2. Configuration of these connections shall be of styles similar to details a, b, c, c-1 or d of Fig. AD-613-1 in Division 2.

8.3.2 Studded connections shall conform to Code and be approved by the Buyer.

8.3.3 Nozzles 2 inches and smaller shall comply with Code requirements. They may be "set-on" type, provided the attachment is a full penetration weld with the root drilled out, and prior to welding the adjacent shell is ultrasonically examined, and found free of cracks and laminations.

8.3.4 Nozzles and attachment welds shall be ground smooth and flush with the inside of the vessel shell. The internal periphery of these openings shall be rounded to form a smooth curvature complying with Code requirements but with a radius of not less than 1/2 inch.

8.4 Heat Treatment

8.4.1 Unless a higher temperature is specified, postweld heat treatment (PWHT) shall be in accordance with the Code, and Specification 14222-W-1.

8.4.2 The highest PWHT temperature for quenched and tempered materials shall be at least 100°F below the tempering temperature, unless the tempering is done as the final PWHT.

8.4.3 Unless otherwise specified, it is the Buyer's intention that the complete vessel shall receive a PWHT in one piece in a furnace. Any exceptions shall be clearly stated in the Seller's bid proposal and be subject to Buyer's prior review and approval.

8.4.4 Details of all furnace controls, thermocouple layout and attachment and calibration certificates as well as proposed PWHT temperature ranges and anticipated holding times shall be submitted to the Buyer for approval. Buyer requires positively attached thermocouples on all components for all tempering and PWHT. For bidding purposes a minimum of eight thermocouples shall be allowed, six outside and two inside. Furnace calibration is not acceptable.

8.4.5 All finished machined and threaded surfaces shall be protected against oxidation during heat treatment.

8.5 Repairs

Any repairs required after final PWHT, or after the hydrostatic test shall be described in detail and submitted, together with the Seller's proposal for subsequent examination, PWHT and testing, for Buyer's approval before proceeding with such repairs. All repairs shall comply with Code requirements and shall be examined in accordance with the requirements of this specification.

8.6 Tolerances

Fabrication tolerances shall be such as to permit proper installation and function of the internals. Minimum tolerance requirements shall be in accordance with the Code, the Buyer's vessel drawings, Standard Drawing C-515, and Buyer's specifications.

8.7 Nameplates

In addition to the data required by the Code, all nameplates shall include Buyer's vessel identification number. Nameplates shall be 18-8 stainless steel and permanently attached to a suitable bracket with adequate projection to prevent nameplate being covered by insulation.

9. INSPECTION, EXAMINATION AND TESTING

9.1 General Inspection

9.1.1 In addition to Code inspection, Seller's work and all sub-vendors' work shall be subject to inspection by the Buyer and the user. Personnel representing either of these parties shall be granted access to all areas of the Seller's and his sub-vendor's plant(s) concerned with the production, inspection, examination, and testing of the vessels and related components. Seller shall be responsible for imposing all pertinent requirements of the purchase document on all of his sub-vendors including written notice on his purchase order to sub-vendors indicating that their work is subject to Buyer and user inspection.

9.1.2 Buyer and user may provide full time inspection, including at the plate mill and forging shops. Buyer's inspector will review, for approval and acceptance, plate and forging manufacture, including heat treatment and all proposed repairs.

9.1.3 When specified, Buyer's inspector will request the Seller to make hardness readings in accordance with Specification W-1, at various locations on all applicable constructions to verify compliance with the requirements. These readings must be witnessed and approved by the Buyer's inspector for acceptance of the vessel.

9.1.4 An ASME Manufacturer's Data Report will be required for each vessel unless specifically waived in the purchase document.

9.2 Radiographic Examination (RT)

9.2.1 Radiography shall be in accordance with Specification W-1 and for acceptance shall be made at a late stage of fabrication, but prior to any final PWHT.

The following welds shall be 100% radiographed:

a) Shell and head Seams

b) Attachment welds of manways and nozzles greater than 2" nominal size in Division 1 construction with shells 3" or greater in thickness and in all Division 2 or proprietary construction (see para. 8.3).

c) Built-up weld deposits in Division 2 or proprietary construction.

d) The attachment weld between the vessel and its support skirt in Division 2 construction when significant temperature gradients will exist in the skirt to head junction area (see para. 8.16).

e) For Division 2 construction, all seams in support skirts (or portions of skirts) made of other than P-1 materials, including the seam joining a non P-1 material skirt section to a P-1 material section.

f) For Division 1 and proprietary construction and those portions of Division 2 construction not covered by (e) above, skirt welds shall be spot radiographed for 10% of their length, except standards for acceptance shall be in accordance with 100% radiography.

g) Repair welds made to any of the above welds.

9.2.2 For multiple-layer construction, films of all radiographed seams, in and to the multiple-layer section, shall be submitted for Buyer's review and approval. Any differences in interpretation shall be resolved to mutual satisfaction. Radiographs will be returned to the Seller for record purposes after review. All transmittals of radiographs shall be made by insured mail at a replacement valuation determined by the Seller. Buyer's review of these radiographs shall in no way relieve the Seller of his responsibility for the work.

9.3 Magnetic Particle Examination (MT)

9.3.1 All magnetic particle examination shall be in accordance with Specification 14222-W-1.

9.3.2 Magnetic particle examination shall be made at the following locations.

a) Plate edges of 2" and greater thickness, prior to welding, for laminations or cracks.

b) All back chipped or gouged surfaces prepared for second side welding.

c) For Division 1 construction, the surfaces of all welds joining heavily loaded attachments to the vessel internal or external surface, e.g., vessel support rings, lugs or saddles; brackets and rings supporting internal catalyst bed gratings. All other internal or external attachment welds shall have a minimum of 10% of their surfaces examined at locations selected by the Buyer's inspector.

d) For Division 2 or proprietary construction, the surfaces of all permanent attachment welds, such as occur at internally or externally attached lugs, rings, brackets, supports or clips.

e) The inside and outside surfaces of all seams and nozzle attachment welds.

f) All machined faces and openings in forgings shall be examined in the Seller's shops.

g) Built-up weld deposits in Division 2 or proprietary construction shall have the first weld layer and the completed weld build-up surface, together with all adjacent base metal surfaces within six inches of the build-up examined.

h) The inside and outside surface of the attachment weld between the vessel and its support skirt in Division 2 construction where significant temperature gradients will exist in the skirt to head junction area (see para. 8.16).

i) The outside surface of the attachment weld between the vessel and its support skirt in Division 1, proprietary or Division 2 construction not covered by 9.32 (h) above.

j) The inside, where accessible, and outside surfaces of all seams in support skirts (or portions of skirts) made of other than P-1 materials, including the seam joining a non P-1 material skirt section to a P-1 material section.

k) The surface of repair welds caused by any of the above examinations.

9.3.3 The examinations required by para. 9.32 (c), (d), (e), (g) except the first weld layer, (h), (i), (j) and (k), as applicable, shall be made after final PWHT, for acceptance. In high-alloy clad construction the inside surface of base material welds shall be examined prior to clad restoration. Other welds that will not be accessible after final PWHT shall have an earlier examination agreed upon with the Buyer.

9.3.4 When 5% or 9% nickel steels are specified, all of the above examinations shall be made by the liquid penetrant examination technique in accordance with Specification 14222-W-1.

9.3.5 Plate edge laminations shall not exceed ½" in length. No cracks will be permitted.

9.3.6 All repairs shall be made by a Buyer approved procedure.

9.4 Ultrasonic Examination (UT)

9.4.1. All materials 4" and over in thickness shall be ultrasonically examined in accordance with the requirements of para. 7.04.

9.4.2 All welds 4" and over in thickness including shell to head welds where the shell is 4" or over in thickness before any tapering but the head is not, shall be ultrasonically examined in accordance with Specification 14222-W-1. For acceptance, such examination shall be made after final PWHT. This requirement shall not apply to welds in multiple-layer construction.

9.5 Liquid Penetrant Examination (PT)

Liquid penetrant examination of high-alloy overlay welding shall be in accordance with the requirements of Specification 14222-C-2.

9.6 Weld Sampling

When the vessel base material is other than a P-1 material or when high-alloy clad base material is specified, samples of deposited weld metal shall be taken in accordance with Specification 14222-C-2.

9.7 Hydrostatic Test

9.7.1 Testing shall conform to Code para. UG-99 (c) or Article T-3 as applicable except that the minimum metal temperature throughout the hydrotest shall be established by the Seller to ensure the safety of the vessel, but shall not be less than the higher of:

a) The minimum design temperature specified on the vessel drawing

b) The impact test temperature, where the base material and welds of the vessel are required to be impact tested

c) 60°F

d) Code requirement

9.7.2 All hydrostatic tests shall be made in the presence of the

Buyer's inspector. No preliminary tests, regardless of pressure, shall be made prior to any required PWHT.

9.7.3 Hydrostatic test water shall be potable, except that vessels containing high-alloy cladding or internal attachments shall be tested with water complying with the requirements of Specification 14222-C-6.

9.7.4 There shall be no leakage of test water from nozzle blinds or seals during any hydrotest. Bolt-up shall be calculated for the test condition and achieved by torque wrench or other suitable device.

10. CLEANING AND PAINTING

10.1 All vessel surfaces shall be cleaned to remove loose scale, rust, grease, dirt, weld spatter, hydrotest water and other foreign matter.

10.2 Surface preparation and painting shall be in accordance with Specification 14222-X-1, unless otherwise specified. Vessels undergoing ocean shipment shall be provided with VPI corrosion inhibitors, rubber gaskets under all nozzle shipping covers and, when external painting is not otherwise required, one coat of red lead paint on external surfaces.

10.3 All exposed machined and threaded surfaces shall be thoroughly coated with a suitable rust preventative compound and suitably protected for shipment. Seller shall show details on his drawings.

10.4 All loose parts shall be adequately crated and given clear markings relating the parts to the vessel identification number.

10.5 After application of the paint required by paragraph 10.2, each vessel receiving PWHT shall have the following stenciled along both sides of the vessel in large white letters in the English, and if applicable, in the native language of the country producing and receiving the vessel.

"Do not weld or strike arcs--stress relieved vessel."

Reference Drawings and Specifications

Specification 14222-C-2
14222-C-7
14222-C-8
14222-C-5
14222-C-6
14222-W-1
14222-X-1

Standard Drawing Index C-500 }
Standard Drawing C-515 } To be provided during Phase 1.

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ASFI THE BRECKINRIDGE PROJECT AECI	JOB NO. 14222	
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717	SPECIFICATION	REV
GENERAL DESIGN SPECIFICATION FIELD FABRICATION OF PRESSURE VESSELS	14222-G-5	1

SHEET 1 OF 5

1. GENERAL

1.1 This specification covers the requirements for field fabrication of pressure vessels, and supplements the requirements of Specifications 14222-C-1 or C-4, as applicable.

2. SELLER'S RESPONSIBILITY

2.1 Furnish all necessary material, labor and equipment to complete the work.

2.2 Transfer all dimensions, levels and orientations from those provided by the Buyer at the foundation.

2.3 Submit plot layout of hoisting equipment, when used, including details of any guys and deadmen for the Buyer's review and approval.

2.4 Furnish and install all temporary insulation and furnish all fuel and equipment necessary for postweld heat treatment of the vessels when required.

2.5 Hydrostatically test the vessel per para. 5.3.

3. BUYER'S RESPONSIBILITY

3.1 Buyer will furnish:

- 3.11 Vessel foundation complete with centerlines and base elevation.
- 3.12 Utilities, storage area, etc. per Exhibit B of subcontracts document.

3.2 All construction activities shall be coordinated with the Buyer's field superintendent.

4. FABRICATION AND REQUIREMENTS

4.1 Postweld Heat Treatment (PWHT)

Seller shall submit full details of any proposed field PWHT of pressure vessels for Buyer's review and approval. Seller shall include overall arrangement details of all heater controls, thermo-couple layout and attachment and calibration certificates, etc.

5. INSPECTION, EXAMINATION AND TESTING

5.1 Radiographic Examination (RT)

When specified, spot radiography shall be a minimum of 12" in length and shall be performed as follows:

5.11 All junctions of longitudinal vessel seams and circumferential seams shall be radiographed with the greater length of the film on the longitudinal seam.

5.12 Additional radiographs are required when any seams exceed 20 feet in length between junctions described in para. 5.11. The examinations shall be performed at approximately the mid-points between junctions.

5.2 Magnetic Particle Examination (MT)

This paragraph applies to pressure vessels governed by Specification C-1 and details additional requirements for MT.

5.2.1 Examination shall be made at the following locations:

5.2.1.1 For P-1 materials:

a. All back-chipped or gouged surfaces of field welds, prepared for second side welding. This requirement shall not apply to field welds receiving full radiography.

b. Plate edges over 1½" thick shall be examined for laminations or cracks in the Seller's shop. Plates 1½" or less in thickness shall have all edges visually examined.

c. The inside and outside surfaces of all seams and nozzle attachment welds made in the field.

d. The surfaces of all welds made in the field joining heavily loaded attachments to the vessel internal or external surface, e.g. vessel support skirts, rings, lugs or saddles; brackets and rings supporting internal catalyst bed gratings. All other internal or external attachment welds made in the field shall have a minimum of 10% of their surfaces examined at locations selected by the Buyer's inspector.

e. The surface of repair welds required by any of the above examinations.

5.2.1.2 For other than P-1 materials:

a) All back-chipped or gouged surfaces of field welds prepared for second side welding.

b) The edges of components which will be field-welded shall be examined for laminations or cracks in the Seller's shop.

c) The inside and outside surfaces of all seams and nozzle attachment welds made in the field.

d) The surfaces of all welds made in the field joining heavily loaded attachments to the vessel internal or external surface, e.g. vessel support skirts, rings, lugs or saddles; brackets and rings supporting internal catalyst gratings. All other internal or external welds made in the field shall have a minimum of 10% of their surfaces examined at locations selected by the Buyer's inspector.

e) The inside, where accessible, and outside surfaces of all seams in support skirts (or portions of skirts) made of other than P-1 materials, including the seam joining a non P-1 material skirt section to a P-1 material section.

f) The surface of repair welds required by any of the above examinations.

5.2.2 The examinations required by para. 5.211(c), (d), (e) and 5.212 (c), (d), (e) and (f), as applicable, shall be made after any final PWHT for acceptance. In high alloy clad construction, the inside surface of base material welds shall be examined prior to clad restoration. Other welds that will not be accessible after any final PWHT shall have an earlier examination agreed upon with the Buyer.

5.2.3 Plate edge laminations shall not exceed ½" in length. No cracks will be permitted.

5.2.4 All repairs shall be made by a Buyer approved procedure.

5.3 Field Hydrostatic Test

5.3.1 For vessels designed in accordance with Division 1, Seller shall conduct a test in accordance with the requirements of paragraph UG-99(c), (test pressure shall not exceed 1.5 x the maximum allowable pressure new, at test temperature for any section of a field fabricated pressure vessel). The Seller shall provide the following items:

5.3.1.1 A test procedure for Buyer's review, approval and record.

5.3.1.2 The necessary test instruments and vacuum breaking equipment.

5.3.1.3 Pressure pump.

5.3.1.4 Water supply pump, piping, fittings, valves and hoses, as required.

5.3.1.5 Labor to fill and drain vessel.

5.3.1.6 Water heating equipment when necessary.

5.3.2 The required metal temperature throughout the hydrotest shall be established by the Seller to comply with the Code and to ensure the safety of the vessel, but shall not be less than the lower of:

(a) The minimum design temperature specified on the vessel drawing plus 30°F.

(b) The impact test temperature plus 30°F, where the base material and welds of the vessel are required to be impact tested.

(c) 80°F.

6. QUOTATIONS

6.1 It is the Buyer's intent to obtain the most economical vessel installation, considering shop fabrication in large section with field assembly and erection, and complete field fabrication in place, consistent with the overall project construction activities and schedule. Alternative detailed proposals to accomplish this objective are solicited.

6.2 Proposals shall be complete in definition and include:

6.2.1 Predicted field work schedules.

6.2.2 Estimated power requirements.

6.2.3 Brief description and size of hoisting equipment to be used including number and approximate spread of guys, if proposed.

6.2.4 Proposed metal temperature of vessel during hydrotest (see para. 5.3.2).

6.3 Bidders must be familiar with conditions at the jobsite and pre-bid visits to the site are encouraged.

6.4 Bidders shall itemize costs, as additives to the base bid of each vessel, for the following as applicable:

6.4.1 Installation of equipment or materials supplied by the Buyer.

6.4.2 Field intermediate and/or final postweld heat treatment.

6.4.3 Cost to heat test water to meet para. 5.32 requirements. This cost shall be given for 10°F increments of temperature above the actual temperature of water provided. Final cost to be determined at time of test.

Reference Specifications

Specification 14222-C-1
14222-C-4
14222-C-6
14222-W-1

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AFSI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL DESIGN SPECIFICATION
HIGH ALLOY CLAD PRESSURE VESSELS

JOB NO 14222
SPECIFICATION 14222-C-6
REV 1

1 GENERAL

1.1 This specification covers the minimum fabrication requirements for carbon or low-alloy steel pressure vessels with corrosion-resistant high-alloy cladding and lined components.

1.2 This specification supplements the requirements of Specification 14222-C-1 or C-4 as applicable, and the Buyer's standard drawings.

1.3 Specific requirements shall be in accordance with the Buyer's vessel drawings.

2. DEFINITIONS

2.1 Base Material is the carbon or low-alloy steel selected as the pressure retaining material for the shell, heads and nozzles.

2.2 Cladding is the high-alloy material fully bonded to the inside surface of the base material by roll cladding, explosion bonded cladding or overlay welding.

2.3 Lining is the high-alloy nozzle sleeve material which is not fully bonded to the inside surface of the base material.

2.4 Corrosion Allowance is equal to the nominal cladding or lining thickness. No other allowance for corrosion is required for the base material, unless specifically stated otherwise.

3. CLADDING

3.1 Roll clad, and explosion bonded clad plate shall meet the requirements of the applicable ASME Specifications SA-263, SA-264, or SA-265, and this specification. The shear test is required and one test shall be made for each plate or component.

3.2 Joints in or to roll clad and explosion bonded clad plate sections shall have edge preparation and welding details complying with the requirements of Appendix B.

3.3 High-alloy welding electrodes shall comply with Appendix A.

3.4 Surfaces to be overlayed shall be prepared by grinding or sand or grit blasting to uniform grey metal without millscale or rust.

3.5 Weld overlay on carbon steel seams using GMAW or SAW processes shall be done with stringer beads using sufficient overlap to prevent excessive penetration and dilution.

4. NOZZLE LINING

4.1 Lining may only be used for sleeve lining nozzles less than 6" diameter, and shall meet the requirements of the applicable ASME Material Specification and this specification.

4.2 Linings in nozzles attached to postweld heat treated vessels shall be vented during any heat treatment.

5. NOZZLE AND MANWAY CONSTRUCTION

5.1 Permissible methods of cladding or lining nozzle necks are shown in Appendix B.

5.2 Construction details shall conform to Standard Drawing C-525, as applicable, except as modified by this specification.

5.3 Minimum base material neck thickness, excluding corrosion allowance, shall not be less than that required by the Code.

5.4 Thickness of nozzle neck cladding and lining shall be as follows:

5.41 All neck cladding shall have a thickness at least equal to that specified for the vessel cladding.

5.42 Sleeve lining thickness shall be the greater of:

a). That specified for the vessel cladding.

b). 0.125"

c). That required to withstand all possible loads on the sleeves.

5.5 Flanges and blind flanges shall be weld overlayed and shall comply with the requirements of Appendices A & B. Facings shall be machined to MSS SP-6 standards, with cladding thickness at the bottom of any groove facing, at least equal to that specified for the vessel.

6. INTERNALS

6.1 Unless otherwise specified on the Buyer's vessel drawings, internal support lugs, rings, and clips, etc., welded directly to the vessel base material or cladding shall be of the same material as the cladding.

6.2 Unless otherwise specified on the Buyer's vessel drawings, welds attaching internals to the vessel shall be high-alloy welds and comply with Appendix A.

7. PROHIBITED CONSTRUCTIONS

7.1 The following constructions are not acceptable:

a) Strip lining.

b) Solid alloy pressure retaining parts.

7.2 See Standard Drawing C-525 for conditions where forged slip-on and fabricated plate flanges are prohibited.

8. EXAMINATIONS

8.1 Liquid Penetrant Examination (PT)

Unless otherwise specified, liquid penetrant examination is required for the finished surface of all overlay including overlay welds at clad plate joints, flange facings and in nozzle bores. The examination shall be in accordance with Specification 14222-W-1.

8.2 Ultrasonic Examination (UT)

For pressure vessels with clad shells of 1 1/2" or greater total thickness, roll clad and explosion bonded clad plate shall be ultrasonically examined in accordance with the procedures of ASTM A578 including supplementary paragraph S6 except that areas within 4 inches of heavily loaded internal attachments, prior to attachment welding, shall be 100 percent ultrasonically examined to establish the integrity of the bond between the cladding and the base material. Unbonded cladding may be repaired in accordance with Buyer approved welding procedures only if the unbonded area does not exceed three per cent of the surface covered. Unbonded areas larger than this shall be cause for component rejection.

8.3 Weld Sampling

Unless otherwise specified, samples of 300 series high-alloy corrosion-resistant overlay weld metal shall be taken in accordance with Specification 14222-C-2.

8.4 Macro Hardness Tests

When weld overlay on carbon steel seams is done by GMAW or SAW processes using type 309 or 309L weld metal, macro hardness tests shall be taken on the surface for every 10 feet of overlay. Location of the tests shall be determined by the Buyer's inspector. Hardnesses shall not exceed 200 BHN.

If a test reveals hardness exceeding the specified limit by not more than 5%, two more tests at locations 6" on either side of the original test may be taken. If both of these two tests indicate that hardness is below the specified value, then the weld is considered acceptable. If welds are required to be postweld heat treated, then hardness tests shall be conducted after the postweld heat treatment. Hardnesses exceeding the specified value by 5% or more, or subsequent adjacent tests showing higher than specified hardness are not acceptable and the welds showing the excessive hardness shall be repaired in accordance with a procedure approved by the Buyer.

9. TESTING

9.1 Vessel hydrotest closures for stub nozzles shall be designed by the Seller and shall comply with Appendix B.

9.2 Testing of sleeve linings shall be as follows:

a) A ¼" maximum NPT tapped hole shall be provided through the base material for air pressure testing.

b) A 25 psig compressed air and soap test shall be applied to all sleeve welds.

c) Holes shall not be plugged after testing.

9.3 Vessels containing high-alloy cladding or internal attachments shall be hydrostatically tested with water having a chloride ion concentration not exceeding 100 ppm. All test water shall be completely drained out.

Reference Drawings and Specifications

Specification 14222-C-1
14222-C-2
14222-C-4
14222-C-5
14222-W-1
Standard Drawing C-525 (To be provided during Phase 1)

FORM 203

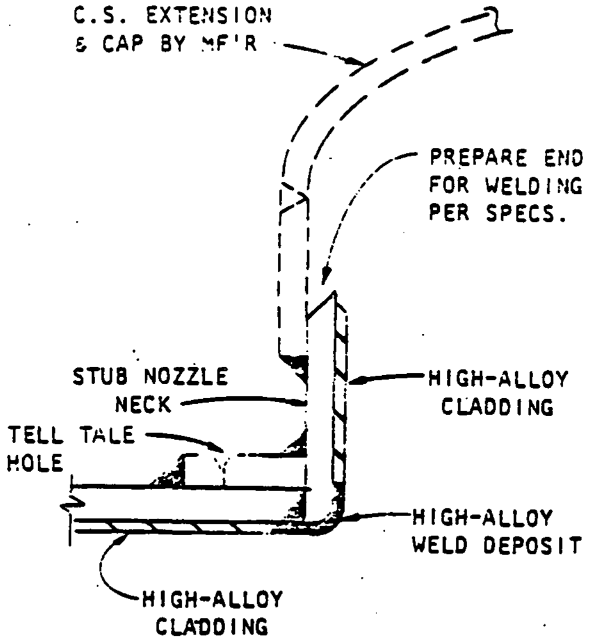
HIGH-ALLOY WELDING REQUIREMENTS, BASED ON SPECIFIED CLADDING MATERIAL ALL MATERIALS SHALL CONFORM TO LATEST ASME SPECIFICATIONS

CLADDING MATERIAL	ELECTRODE FOR ALLOY WELDING ②	
TYPE	FIRST LAYER	SUBSEQUENT LAYERS
405 ① 410S ①	309 OR INCONEL ③	309 OR INCONEL ③
304	E309	308
316		316
321		347
347		347
304L	E309L	308L
316L		316L
SB-127 MONEL	MONEL 190	MONEL 190

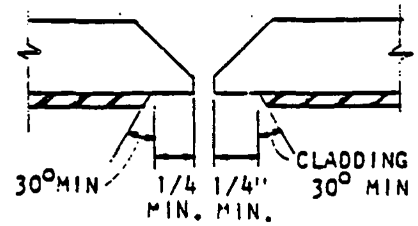
① Type 405 and 410S material is subject to embrittlement at temperatures exceeding 750°F, and shall only be used when approved by the Buyer.

② In lieu of multiple layers using different electrodes, single layer series-arc or similar processes may be used, subject to prior Buyer's approval.

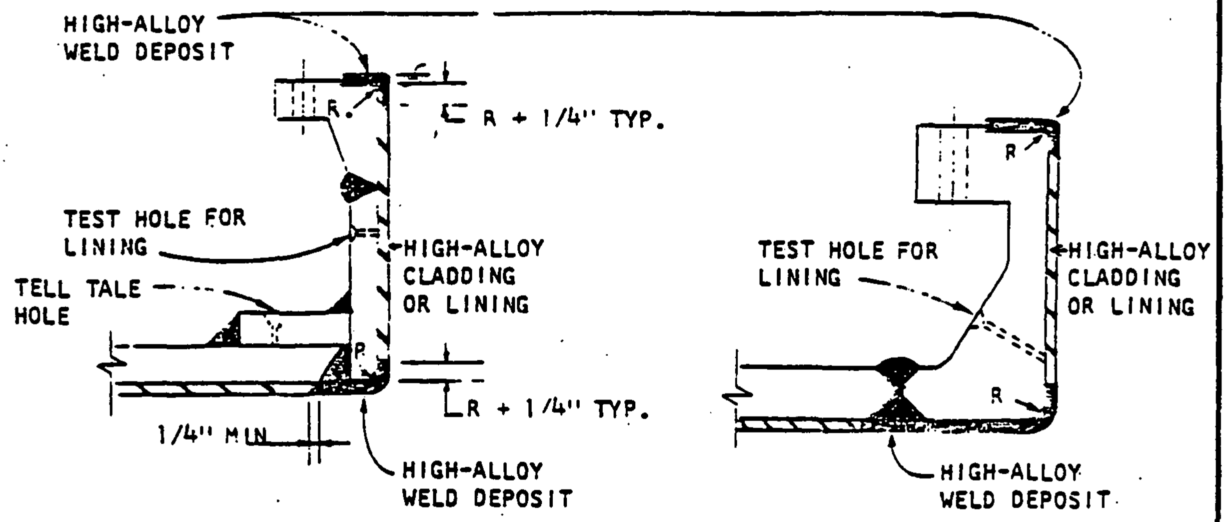
③ Use Inco A, 82, 92 or 182 electrodes only, in temperature cycling service (e.g. Coke Drums).



STUB NOZZLE
& TEST CLOSURE



TYPICAL JOINT
PREPARATION



* REFER TO PARAGRAPH 9.2

TYPICAL NOZZLE DETAILS

APPENDIX "B"

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL DISIGN SPECIFICATION
VESSEL ENGINEERING INSTRUCTIONS

JOB NO. 14222
SPECIFICATION 14222-C-7
REV 1

SHEET 1 OF 4

1.0 GENERAL

1.1 This specification covers the minimum requirements for pressure vessel design criteria to be shown on the individual data sheets.

1.2 This specification supplements specifications:

14222-C-1 C. Steel and Low-Alloy Vessels, under 2" thick.
14222-C-4 C. Steel and Low-Alloy Vessels, over 2" thick.

2.0 DESIGN DATA

2.1 Vessels will be designed and stamped for maximum temperature allowable without increasing the required flange rating.

2.2 A minimum corrosion allowance of 1/8" shall be used in the design of all carbon steel vessels. Alloy vessels will be designed with a corrosion allowance as indicated in the process design.

2.3 No pressure vessel shall be designed for less than 50#/Sq. in. gage unless specifically approved by Purchaser. A design pressure of 25 pounds more than the maximum anticipated operating pressure shall be used for all vessels up to an anticipated operating pressure of 250 pounds gage, and all vessels over this range shall have 10% added to the maximum anticipated operating pressure.

2.4 Design pressure is always at the top and the normal liquid level must be added to calculate the bottom head and shell thickness. The liquid will be assumed to have a specific gravity of 1.0 unless otherwise specified.

2.5 Unless otherwise specified, vertical vessels should be designed for full hydrostatic test in a vertical position. Foundations must also be designed for vessels liquid full. On very large low pressure designs, consideration will be given to a combination air-water test to avoid needless excessive shell thickness at the bottom.

3.0 DESIGN DETAILS

3.1 Where diameter permits, all vessels will be provided with at least one manway. New fractionating towers will have manways at top, bottom, and feed deck. Manways shall be not less than 18" I.D. size, 20" nominal size is preferred, and all covers equipped with davits. Manway flanges and covers shall conform to ASA flange dimensions. The centerline of the manway shall be 3'-0" above the platform decks.

3.2 Steam drums, coils, and shells of fired steam generators shall meet Section I of ASME code. Unfired steam generators and air receivers shall be designed in accordance with Section VIII, division I of ASME code.

3.3 The preferable mounting for all major towers is the open table top construction with support from a short skirt or lugs on the tower. Where long skirts are used, two openings of not less than 18" clear with adequate reinforcing shall be used for access beneath the vessel.

3.4 Only seamless pipe or long welding neck forgings shall be used for nozzles. The pipe shall be A106 Grade B for carbon steel vessels and of a suitable alloy for alloy vessels. Pipe nozzles shall not be lighter than Sch. 80 for 2" or below and standard weight pipe plus corrosion allowance for 3" or above except manway nozzles.

3.5 Vessel shells and heads from carbon steel shall normally be of ASTM A516 Gr. 70.

3.6 The use of cast iron, wrought iron, malleable iron, or semi-steel is prohibited for any pressure part.

3.7 All nozzles and manways shall conform to standards for USAS B 16.5-1968, where applicable, and pipe specifications herein. Vendor is expected to furnish blinds, metal gaskets, and studs for manways, and inspection openings and adequate protection for other nozzles during shipment. An anti-seizing compound shall be used on all bolts where service is about 500°F.

3.8 Vessels designed for 400°F or higher shall have all nozzles designed with flanged connections unless otherwise specified. Couplings where allowed shall be 6000# F.S. No pressure vessel shall have nozzle connections smaller than 1". Flange connections of size 3" and smaller shall not have ratings lower than ASA 300#.

3.9 Tolerance for out of roundness in tower will be ± ½% of the nominal diameter, with a maximum of ½".

3.10 The contractor assumes final responsibility to provide sufficient skirt height to insure reboiler circulation. In the case of Thermosyphon reboiler, the following design criteria are applicable:

  3.10.1 Pressure drop between lower draw nozzle and reboiler inlet flange not to exceed 0.5 psi (draw nozzle loss included).

  3.10.2 Pressure drop across reboiler (from inlet to outlet flange) not to exceed 0.5. psi.

  3.10.3 Pressure drop between reboiler outlet flange and tower return nozzle not to exceed 0.5 psi (return nozzle loss included).

  3.10.4 Assume 200 equivalent feet from tower to reboiler and 200 equivalent feet from reboiler back to tower.

  3.10.5 Check reboiler return line for slug flow. Slug flow must be avoided even if rule 3.9.3 is violated.

  3.10.6 Distance between normal liquid level and bottom of reboiler return nozzle to be a minimum of three feet.

  3.10.7 Driving force available must be equivalent to a system pressure drop of 1.5 psi minimum. Assume liquid level at tangent line of the tower.

In the case of kettle reboiler, the following design criteria shall be used:

3.10.8 Pressure drop between lower draw nozzle and reboiler inlet flange not to exceed 0.5 psi (draw nozzle loss included).

3.10.9 Pressure drop across reboiler (from inlet to oulet flange) not to exceed 0.5. psi.

3.10.10 Pressure drop between reboiler outlet flange and tower return nozzle not to exceed 0.5 psi (return nozzle loss included).

3.10.11 Assume 200 equivalent feet from tower to reboiler and 200 equivalent feet from reboiler back to tower.

3.11 The Contractor must provide sufficient residence time and disengaging space in the bottom of the tower. Unless otherwise specified, there will be 5 minutes residence time (based on net product) from bottom tangent line to normal liquid level. The height between the normal liquid level and the bottom of the reboiler return line will be 3 feet. The height between the top of the reboiler return line and the seal pan from the bottom tray will be 6 inches. Length of the downcomer from the bottom tray will be 6 inches greater than the nominal tray spacing to allow for reboiler surge.

4.0 SPECIAL APPLICATIONS

4.1 Where free hydrogen is present at elevated temperatures and pressures, special provisions shall be made to prevent leakage and decarburization.

Carbon steel as previously specified may be used up to temperatures of 400°F and pressures up to 1,000#/Sq. in. hydrogen partial pressure.

For conditions exceeding 400°F and 1,000#/Sq. in., alloys will be selected consistent with the Nelson curves.

5.0 REFERENCES

Specifications: 14222-C-1
14222-C-4

Tanks—D

1.0 SCOPE

This specification covers the design, fabrication, erection, and testing of Field Erected Welded Steel Storage Tanks operating at internal pressures approximating atmospheric pressure. For Low-Pressure Storage Tanks and operating at pressure above atmospheric and up to 15 psig, refer to Standard Specification 14222-D-3.

2.0 DEFINITIONS

2.1 Buyer means Bechtel.

2.2 Seller means the Tank Subcontractor.

2.3 API means the American Petroleum Institute.

2.4 ASTM means the American Society for Testing and Materials.

3.0 DESIGN AND CONSTRUCTION

3.1 General

3.1.1 Seller shall design the tanks. He shall furnish all materials, labor, transportation, staging, tools, and equipment for the fabrication, erection, and testing of the tanks.

3.1.2 Storage tanks shall be designed, fabricated, erected, and tested in accordance with API Standard 650 (latest edition), Welded Steel Tanks for Oil Storage.

3.1.3 All material shall be new and of first quality.

3.1.4 All tanks 12' and smaller in diameter shall have foundation designed with overturning investigated.

3.1.5 Tanks requiring ringwall foundations will be designed on the basis of hoop stress as well as vertical and lateral load. Foundations designed by API 650 appendix B <u>will not</u> be acceptable.

3.1.6 Tanks shall be designed for a product specific gravity of 1.0 unless a higher specific gravity is given in the invitation to bid.

3.1.7 All tanks having a shell thickness over ½" shall be designed in accordance with appendix D or appendix G.

FORM H-292 7-66

△					
△		REVISED PAR. 3.2.5 REF. TO 3.1.8			
△	6/30	ISSUED FOR PHASE ZERO		HS	
△	3/80	ISSUED FOR APPROVAL		HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
GENERAL DESIGN SPECIFICATION
FIELD-ERECTED WELDED STEEL ATM.PRESSURE STORAGE TANKS

JOB NO.

SPECIFICATION	REV
14222-D-1	2

SHEET 1 OF 3

3.1.8 All tanks shall have cone roofs except tanks with a capacity of over 40,000 gal in the following services: gasoline, crude oil, benzene, and any other products having a vapor pressure over 1.5 psia. Tanks in these services holding over 40,000 gal shall have either an Appendix H covered floating roof or a Hammond Flote II internal floating cover as manufactured by the Pittsburgh-Des Moines Steel Company or the Ultraflote internal cover as manufactured by the Ultrafloat Corp.

3.2 Appurtenances

3.2.1 Buyer will furnish a tank appurtenance list for each tank. This list shall clearly indicate Buyer and Seller individual responsibilities.

3.2.2 Buyer will furnish a sketch or drawing for each tank showing the required orientation of appurtenances.

3.2.3 Tanks over 30 feet high shall be provided with a circumferential stairway, tanks to be insulated shall have a double stringer stairway with a minimum of 6" clearence between the tank and the stairway. Tanks under 30 feet high shall be provided with a vertical ladder with a cage. Where ladders are called for inside a tank over 30' high a safety track as manufactured by air space devices shall be provided.

3.2.4 Where vents are specified, design, fabrication, and testing shall be in accordance with applicable portions of API Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks.

3.2.5 Flame arresting venting nozzles shall be used on cone roof tanks in flammable product service with products having a vapor pressure higher than 1.5 psia.

3.2.6 Double walled steam jacketed vents shall be used in naphthalene and sulfur service.

3.2.7 Explosion hatches shall be installed on any tank maintained at a temperature of 220°F or higher.

3.2.8 Water draw sumps shall be provided.

3.2.9 Tank to ground connections are not required in all tanks containing interanl floaters. A static ground shall be provided by two or more retractable cable reels as manufactured by Tank Services Inc. Wrap around shunts are not permited.

3.3 Welding

3.3.1 All welding shall be in accordance with API Standard 650.

3.3.2 Welding shall meet the requirements for workmanship and quality set forth in Specification 14222-W-1, General Welding Requirements.

4.0 INSPECTION AND TESTS

4.1 Inspection and tests shall be in accordance with API Standard 650.

4.2 Weld inspection shall be by the radiograph method in accordance with API Standard 650.

4.3 Shop inspection of fabrications or materials shall not constitute final acceptance.

4.4 Final acceptance will be made only upon satisfactory completion of field inspection and testing.

4.5 Testing of floating roof seals shall be Seller's standard subject to written approval by the Buyer.

4.6 Hydrostatic test schedule shall suit the limitations of the foundation subsoil and shall be arrived at by mutual agreement of Buyer and Seller.

5.0 TANK MEASUREMENT AND CALIBRATION (STRAPPING)

If so stipulated in the subcontract, the Seller shall measure and calibrate each tank in accordance with API Standard 2550 (ASTM Designation D-1220) latest edition: Measurement and Calibration of Upright Cylindrical Tanks. Seller shall furnish six (6) copies of the tank calibration tables for each tank.

6.0 PAINTING AND INSULATION

Painting and insulation are not included within the scope of this specification.

7.0 CORROSION ALLOWANCE

Unless otherwise specified, 1/" corrosion allowance shall be added to shell thickness, as calculated in Section 3.3.3 of the API Code 650, for all tanks in which will be stored gasoline or any light end with a vapor pressure higher than 1.5 psia at normal temperatures. All other services will have a corrosion allowance of 1/16". No corrosion allowance is required for floor and roof plates.

REFERENCES

Form 79, Manufacturer's Welding Procedure, Specification and Qualification Record (to be attached during Phase 1).

Specification No. 14222-W-1, General Welding Requirements.

1.0 SCOPE

This specification covers the design, fabrication, complete assembly, inspection and testing of shop-assembled, welded steel storage tanks.

2.0 DEFINITIONS

2.1 Buyer means Bechtel.

2.2 Seller means the Tank Subcontractor.

2.3 API means the American Petroleum Institute.

2.4 ASTM means the American Society for Testing and Materials.

3.0 GENERAL

3.1 Design, fabrication, complete assembly, inspection and testing of the tanks shall be in accordance with Appendix J of American Petroleum Institute (API) Standard 650, latest edition: Shop Assembled Storage Tanks.

3.2 All material shall be new and of first quality.

3.3 The Seller shall not prime or paint the tanks. The Buyer will prime and paint the tanks at the jobsite.

3.4 Tank roofs shall be self-supporting cone type unless otherwise specified in the purchase order.

3.5 Seller shall not measure and calibrate the tanks unless called for in the purchase order.

4.0 APPURTENANCES

4.1 Buyer will furnish an appurtenance list for each tank clearly indicating the individual responsibilities of the Buyer and Seller.

4.2 Buyer will furnish a sketch or drawing of each tank showing the orientation of appurtenances.

4.3 Vents, when specified on the appurtenance list, shall be in accordance with API Standard 2000, (latest edition), Venting Atmospheric and Low-Pressure Storage Tanks.

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△					
△	7/80	ISSUED FOR PHASE ZERO			
△	3/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
GENERAL DESIGN SPECIFICATION
SHOP-ASSEMBLED WELDED STEEL STORAGE TANKS

JOB NO. 14222
SPECIFICATION 14222-D-2
REV 1

SHEET 1 OF 2

5.0 INSPECTION

5.1 Inspection of welds shall be by the radiograph method in accordance with API Standard 650.

5.2 Shop inspection shall not constitute final acceptance. Final acceptance will be made upon satisfactory completion of field inspection and testing at the jobsite.

REFERENCES

Form 79, Manufacturer's Welding Procedure, Specification and Qualification Record (to be attached during Phase 1).

Specification No. 14222-W-1, General Welding Requirements.

FORM H-293 7/66

1.0 SCOPE

This specification covers the design, fabrication, erection, and testing of field erected, welded, low-pressure storage tanks operating at internal pressure above atmospheric pressure and up to 15 psig.

2.0 DEFINITIONS

2.1 Buyer means Bechtel.

2.2 Seller means the Tank Subcontractor.

2.3 API means the American Petroleum Institute.

2.4 ASTM means the American Society for Testing and Materials.

3.0 DESIGN AND CONSTRUCTION

3.1 General

3.1.1 Seller shall furnish all materials, labor, transporation, staging, tools, and equipment for the complete design, fabrication, erection, and testing of the tanks.

3.1.2 Storage tanks shall be designed, fabricated, erected, and tested in accordance with API Standed 620 (latest edition): Design and Construction of Large, Welded, Low-Pressure Storage Tanks, except as follows:

a. Tanks for the storage of liquefied natural gas (LNG) to minus (-) 270°F shall be designed in accordance with Appendix Q of API Standard 620 and "List of Appurtenances and Tank Data."

b. Tanks for the storage of refrigerated products to minus (-) 60°F shall be designed in accordance with Appendix R of API Standard 620 and "List of Appurtenances and Tank Data."

3.1.3 All tanks 12' and smaller in diameter shall have foundation designed with overturning investigated.

3.1.4 Tanks requiring ringwall foundations will be designed on the basis of hoop stress as well as vertical and lateral load. Foundations designed by API 650 Appendix B will not be acceptable.

FORM H-292 7-66

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△	[illegible]	REVISED PAR. 3.2.5 REF. 3.1.7			
△	6/80	ISSUED FOR PHASE ZERO		HS	
△	3/80	ISSUED FOR APPROVAL		HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
GENERAL DESIGN SPECIFICATION
FIELD-ERECTED WELDED LOW-PRESSURE STORAGE TANKS

JOB NO.
SPECIFICATION 14222-D-3
REV 2

3.1.5 Tanks shall be designed for a product specific gravity of 1.0 unless a higher specific gavity is given in the invitation to bid.

3.1.6 All tanks having a shell thickness over ½" shall be designed in accordance with Appendix D or Appendix G.

3.1.7 All tanks shall have cone roofs except tanks with a capacity of over 40,000 gal in the following services: gasoline, crude oil, benzene, and any other products having a vapor pressure higher than 1.5 psia. Tanks in these services holding over 40,000 gal shall have either an Appendix H covered floating roof or a Hammond Flote II internal floating cover as manufactured by the Pittsburgh-Des Moines Steel Company or the Ultraflote internal cover as manufactured by the Ultraflote Corp.

3.2 Appurtenances

3.2.1 Buyer will furnish a tank appurtenance list for each tank. This list will clearly indicate Buyer's and Seller's individual responsibilities.

3.2.2 Buyer will furnish a sketch or drawing of each tank showing the required orientation or appurtenances.

3.2.3 Tanks over 30 feet high shall be provided with a circumferential stairway. Tanks to be insulated shall have a double stringer stairway with a minumum of 6" clearence between the tank and the stairway. Tanks under 30 feet high shall be provided with a vertical ladder with a cage. Where ladders are called for inside a tank over 30' high a safety track as manufactured by air space devices shall be provided.

3.2.4 Where vents are specified, design, fabrication, and testing shall be in accordance with API Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks.

3.2.5 Flame arresting venting nozzles shall be used on cone roof tanks in flammable product service with products having a vapor pressure higher than 1.5 psia.

3.2.6 Double wlled steam jacketed vents shall be used in naphthalene and sulfur service.

3.2.7 Explosion hatches shall be installed on any tank maintained at a temperature of 220°F or higher.

3.2.8 Water draw sumps shall be provided.

3.2.9 Tank to ground connections are not reqired in all tanks containing internal floaters static ground shall be provided by two or more retractable cable reels as manufactured by Tank Services Inc. Wrap around shunts are not permitted.

3.3 Welding

Welding shall meet the requirements for workmanship and quality set forth in Standard Specification 14222-W-1, General Welding Requirements.

4.0 INSPECTION AND TESTS

4.1 Weld inspection shall be by the radiograph method.

4.2 Shop inspection of fabrication or materials shall not constitute final acceptance.

4.3 Final acceptance will be made only upon satisfactory completion of field inspection and testing.

4.4 Hydrostatic test schedule shall suit the limitations of the foundation subsoil and shall be arrived at by mutual agreement of the Buyer and the Seller.

5.0 TANK MEASUREMENT AND CALIBRATION

If so stipulated in the subcontract, the Seller shall measure and calibrate each tank in accordance with one of the following API Standards, as appropriate:

a. 2550 (ASTM D-1220), Measurement and Calibration of Upright Cylindrical Tanks.

b. 2552 (ASTM D-1408), Measurement and Calibration of Spheres and Spheroids.

c. 2555 (ASTM D-1406), Liquid Calibration of Tanks.

The Seller shall funish (6) copies of the tank calibration tables for each tank.

6.0 PAINTING AND INSULATION

Painting and insulation are not included within the scope of this specification.

7.0 CORROSION ALLOWANCE

Unless otherwise specified, a 1/8" corrosion allowance shall be added to shell thickness, as calculated in Section 3.3.3 of the API Code 650, for all tanks in which gasoline, or any light ends with a vapor pressure higher than 1.5 psia at normal temperatures, will be stored. All other services will have a corrosion allowance of 1/16". No corrosion allowance is required for floor and roof plates.

REFERENCES

Form 79, Manufacturer's Welding Procedure, Specification and Qualification Record (to be attached during Phase 1).

Specification 14222-W-1, General Welding Requirements.

Exchangers—E

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△	1/23/80	ISSUE FOR PHASE ZERO	TLC	HS	
△	3/80	ISSUED FOR APPROVAL	TLC	HS	

ASFI THE BRECKINRIDGE PROJECT AECI

U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717

STANDARD SPECIFICATION

AIR COOLED HEAT EXCHANGERS

JOB NO. 14222

SPECIFICATION 14222-E-1

REV 1

1. SCOPE

1.1 General

1.1.1 The purpose of this specification is to supplement API Standard 661 for the design, fabrication, testing and preparation for shipment of air-cooled heat exchangers.

1.1.2 Exchanger data sheets, which will include material specifications, fluid characteristics and design conditions, will be supplied by the Buyer for each unit.

1.1.3 In case of conflict between the documents included in a material requisition, the order of precedence is:

a) Individual data sheets

b) Notes in material requisition

c) Addendum to specifications

d) This specification

1.2 Quotations

1.2.1 In order to receive due consideration, the Seller shall quote in strict accordance with this and other applicable specifications, and shall so state in his proposal. Alternates on different methods of fabrication may be submitted at the option of the Seller, providing such alternates are clearly indicated and quoted as additions or deductions to the basic bid.

1.2.2 Quoted price shall include the cost of ASME Code inspection and stamping.

1.2.3 Seller shall calculate the heat transfer rate for each unit and base his quotation on the minimum surface, air flow and fan brake horsepower necessary for the duty and fouling factors specified. Actual fouling factor available should be indicated on the heat exchanger quotation sheet.

1.2.4 Seller shall submit with his quotation the cost for the following spare parts for each exchanger:

a) Plug Type Header - 5% of one complete set of gaskets

b) Bolted Cover Header - One complete set of gaskets

c) Plugs - 2% of one complete set

1.2.5 Seller shall advise the cost for header walkways as described in Paragraph 4.5.3.

2. CODES AND STANDARDS REQUIREMENTS

2.1 Design, construction, testing and inspection of air-cooled exchanger pressure parts shall be in accordance with the latest Edition (with latest Addenda) of the ASME Code for Unfired Pressure Vessels, Section VIII, Division 1, and all referenced local requirements and codes.

2.2 Air-cooled heat exchangers and related auxiliary equipment shall conform to API Standard 661, except as modified herein.

3. DESIGN

3.1 Weighted mean temperature difference (MTD) shall be used when heat release curves are provided.

3.2 Tube inserts shall not be used for turbulence promotion in process units. Turbulence promoters may be used with lube oil coolers with Buyer approval.

3.3 Exchangers with laminar flow, the calculated tube wall temperature shall be a minimum of 25°F (14°C) above the fluid pour point temperature indicated on the data sheet. This shall apply to all design cases including reduced flow rates; see Paragraph 3.4 coincident with minimum ambient air temperature.

3.4 Air-cooled heat exchanger design shall permit continuous stable operation at reduced flow. When the reduced flow rate is not specified on the data sheet, it shall be taken as 50 percent of the design flow rate.

3.5 Services requiring multiple bays shall be designed with an even number of bundles to facilitate even flow distribution from the inlet header to each bundle. Units with incoming two-phase fluids shall have a symmetrical piping arrangement consisting of multiple cascading headers to equalize the flow to each bundle.

3.6 Induced draft design shall be used when a process outlet temperature control of ± 5°F (± 3°C) or less is required; or when the swing of the process outlet temperature during operation is to be limited to 20°F (11°C) or less. For all other cases forced draft design is acceptable. Forced draft shall be used when the maximum process inlet temperature exceeds 400°F (205°C).

3.7 Total condensing services having operating pressures below 15 psi (103 kpa) (gage) shall be designed either as a singlepass unit or a two pass unit with the bottom row of tubes as the second pass. First pass shall be sloped.

3.8 Fluid outlet temperature shall be designed for not less than a 30°F approach to the dry bulb air temperature.

4. MODIFICATIONS TO API STANDARD 661

The remainder of this specification consists of amendments to API Standard 661 (1978). The section and paragraph numbers refer to those in the API Standard 661.

4.1 Section 1 - General

4.1.1 Paragraph 1.2 - General

(a) Paragraph 1.2.4 (New Paragraph)

Preferably, units shall be completely shop assembled. When complete shop assembly is impractical, units shall be partially shop assembled into the largest practical subunits to minimize field assembly work.

Structural members and assemblies shall be marked to correspond with erection drawings.

When the air-cooled exchanger is divided into several bays, each bay and its tube bundle shall be identical for each structure.

4.2 Section 2 - Proposals

4.2.1 Paragraph 2.2 - Vendor's Responsibilities

(a) Paragraph 2.2.8 (Modification)

For each unit, Seller's proposal shall include a completed noise data sheet.

(b) Paragraph 2.2.12 (Addition)

Seller's proposal shall include fan performance curves, and any applicable instructions for proper use of the curves.

4.3 Section 3 - Documentation

4.3.1 Paragraph 3.1 - Approval Information

(a) Paragraph 3.1.3 (Addition)

Shop detail drawings of all tube bundles, including all standard drawings pertaining thereto, shall be submitted to Buyer for review prior to the start of fabrication. Drawings must show full fabrication details of all headers.

(b) Paragraph 3.1.4 (Modification - Purchaser's Choice)

Proposed welding procedures and qualifications shall be submitted for review prior to start of fabrication.

4.3.2 Paragraph 3.2 - Final Records

(a) Paragraph 3.2.1 (Addition)

Number of copies shall be specified in the material requisition.

(b) Paragraph 3.2.1.5 (Modification - Purchaser's Choice)

Schematic control diagram for automatically controlled fan pitch or louver adjustment shall be provided if controller is furnished by Seller.

(c) Paragraph 3.2.1.6 (Addition)

Air-cooled exchangers with gear drives - Seller shall provide information concerning the expected gear lubrication oil temperature, grade of oil initially provided, and other lubrication recommendations.

(d) Paragraph 3.2.1.8 (Addition - Purchaser's Choice)

Noise data sheet shall be furnished.

(e) Paragraph 3.2.1.9 - Fan Performance Curve (Addition - Purchaser's Choice)

A fan performance curve shall be furnished. The curves, or applicable correction factors, shall relate all performance to the actual physical arrangement and design of the plenum and fan ring.

4.4 Section 4 - Guarantee

4.4.1 Paragraph 4.1 General (Complete Substitution)

(a) Paragraph 4.1.1

Seller shall guarantee the exchanger against defective workmanship or materials, improper design and failure to perform as specified at design conditions. The guarantee period shall be as stated in the material requisition. In the event exchanger does not perform satisfactorily or material or workmanship defects occur during this period, the Seller shall make necessary repairs, alterations, or replacements at no cost to Buyer.

(b) Paragraph 4.1.2

Seller shall guarantee that the exchanger will withstand, without damage, exposure to design or reduced flow rates at design temperature with or without fans in operation at specified process inlet and maximum ambient air conditions.

4.5 Section 5 - Design

4.5.1 Paragraph 5.1 - Tube Bundle Design

(a) Paragraph 5.1.1 - General Requirements

(b) Paragraph 5.1.1.2 (Complete Substitution)

Steam coils provided for freeze-up protection shall be a separate bundle with side frames. The steam coil shall be single pass, with tubes on a maximum pitch of twice the pitch of the process tube bundle.

(c) Paragraph 5.1.2 - Tube Bundle Design Temperature

(d) Paragraph 5.1.2.3 (Addition - Purchaser's Choice)

For fin-type selection, when the maximum operating temperature is not specified, it shall be taken as the specified process fluid inlet temperature plus 25°F (14°C). For definition of fin types, see Paragraph 5.1.12.7.

Fin Type

1. Embedded - Limit this type finned tube to 750°F (400°C) maximum operating temperature.

2. Integral (Extruded) - Limit this type finned tube to 500°F (260°C) maximum operating temperature.

3. Overlapping Footed - Limit this type finned tube to 300°F (149°C) maximum operating temperature.

4. Footed - This type finned tube may be used for tempered water systems only.

5. Galvanized, Brazed or Welded - These fabrication procedures shall be approved by Buyer before submission of Seller's proposal, or they may be quoted as an alternate.

(e) Paragraph 5.1.4 - Corrosion Allowance

(f) Paragraph 5.1.4.1 (Modification)

Corrosion allowance shall be as specified on the data sheet for all surfaces exposed to the process fluid. Gasket contact surfaces for coverplate header design shall be given allow protection when the corrosion allowance exceeds 0.125" (3.2 mm).

(g) Paragraph 5.1.5 - General Requirements for Headers

(h) Paragraph 5.1.5.4 (Addition)

Two-phase velocities shall be based on weighted volume fractions of the liquid and vapor components.

(i) Paragraph 5.1.5.5 (Modification)

The minimum tubesheet thickness minus corrosion allowance shall be 1" (25 mm).

(j) Paragraph 5.1.5.6 (Addition)

Pass partitions used as stiffeners for the tube sheet and plugsheet shall be made of one integral plate. In calculating the thickness of the stiffener plate, a welding efficiency of 0.6 shall be used for full penetration single butt-weld attachment.

(k) Paragraph 5.1.5.7 (New Paragraph)

Header design shall meet the following additional requirements.

1. Headers shall be of the removable-cover-plate design when the specified fouling resistance exceeds 0.005°F-Ft^2-Hr/Btu (0.00088°C M^2/W).

2. For design pressure higher than 2000 psi (13 790 kPa) (gage), cylindrical manifold headers with welded U-tube construction shall be quoted.

3. Horizontal partition plates shall be provided with a ¼" (6.4 mm) hole for drainage and venting.

4. The lateral flow area at any point in the header shall be at least equal to the tube cross-sectional flow area downstream of that point.

(l) Paragraph 5.1.6 - Headers - Removable-Cover-Plate Type.

(m) Paragraph 5.1.6.7 (Addition - Purchaser's Choice) Through bolting is required.

(n) Paragraph 5.1.9 - Gaskets

(o) Paragraph 5.1.9.1 (Addition)

Plug gaskets shall be flat and burr-free. Plug gaskets shall be solid metal of sufficient thickness to cover one thread pitch.

(p) Paragraph 5.1.10 - Nozzles and Other Connections.

(q) Paragraph 5.1.10.4 (Addition)

Flanged connections 2" (51 mm) NPS and smaller shall be integrally forged flanged-type (long welding neck). Built-up nozzles with a minimum wall thickness of Schedule 160 for nozzle neck pipes may be used in special cases subject to Buyer's approval.

(r) Paragraph 5.1.10.8 (Addition - Purchaser's Choice)

One thermowell connection shall be furnished on one inlet nozzle and one outlet nozzle of each bundle. Thermowell connections shall be horizontal and shall be made with 1" (25.4 mm) 6000 lb (41 370 kPa) forged steel coupling.

(s) Paragraph 5.1.10.9 (Addition - Purchaser's Choice)

One pressure gage connection shall be furnished on one inlet nozzle and one outlet nozzle of each bundle. Pressure gage connections shall be horizontal and shall be made with 3/4" (19 mm) 6000 lb (41 370 kPa) forged steel coupling.

(t) Paragraph 5.1.10.15 (Modification)

Vent and drain connections shall be furnished on each header. Vent and drain connections shall be 6000 lb (41 370 kPa) forged steel couplings. Provisions shall be made to insure that all header box compartments can be completely vented and drained.

(u) Paragraph 5.1.12 - Tubes

(v) Paragraph 5.1.12.4 (Addition)

Nominal wall thickness is acceptable in place of minimum wall thickness for copper-base tube materials only.

(w) Unless otherwise stated, fins shall start at least 2" (51 mm) from the header box.

The unfinned tube ends shall be coated with Pittsburgh Plate Glass Coal Tar Epoxy, Type UC-40075 or equal approved by Buyer.

(x) Paragraph 5.1.12.9 (New Paragraph)

The number of fins shall not exceed 11 per inch (433 per meter).

4.5.2 Paragraph 5.2 - Air-side Design

(a) Paragraph 5.2.1 General Requirements

(b) Paragraph 5.2.1.5 (Addition - Purchaser's Choice)

Design temperature for mechanical (nonpressure) parts located below the bundle, shall be the design ambient temperature.

(c) Paragraph 5.2.1.6 (New Paragraph)

All fans, drive trains and drivers shall be interchangeable within each exchanger unit.

(d) Paragraph 5.2.1.7 (New Paragraph)

When an outlet process temperature control of +5°F (+3°C) or less is indicated on the data sheet, fan rings of induced draft design exchangers shall be provided with a drain device to prevent rainwater from entering the bundle.

(e) Paragraph 5.2.2 - Noise Control

(f) Paragraph 5.2.2.1 (Addition - Purchaser's Choice)

Noise requirements shall be in accordance with the Noise Data Sheet.

(g) Paragraph 5.2.3 - Fans and Fan Hubs

(h) Paragraph 5.2.3.2 (Addition)

The fans shall be of high efficiency, multi-blade propeller type. Blades are to be adjustable for pitch angle and individually fastened to a common hub. There shall be a minimum of four blades per fan.

(i) Paragraph 5.2.3.5 (Modification)

For belt- and gear-driven fans the tip speed shall not exceed 12,000 feet per minute (60.96 m/sec).

(j) Paragraph 5.2.3.7 (Substitution)

Fan blades shall be of air foil design. All fans shall be balanced as assemblies.

(k) Paragraph 5.2.3.11 (Addition - Purchaser's Choice)

Upon loss of control air pressure, fan blades shall automatically adjust to maximum pitch.

(l) Paragraph 5.2.4 - Fan Shafts and Bearings

(m) Paragraph 5.2.4.6 (New Paragraph)

Induced draft fans shall have mounting and bearing arrangement designed to allow fan and hub removal and reinstallation without disturbing bundle.

(n) Paragraph 5.2.4.7 (New Paragraph)

Fan shafts shall be solid with a minimum size of 2-15/16" (75 mm) O.D. for drivers up to and including 30 hp (22.4 KW), and with a maximum of 10 feet center-to-center of bearings. For forced draft design, Seller may quote his standard shaft design as an alternate. Fan shafts shall have rounded key corners.

Fan guard mesh shall be galvanized expanded metal not less than 0.1" (2.5 mm) thick, with square or diamond shaped openings arranged on a maximum pitch of 2" (51 mm). Minimum distance between guard and fan blade at operating pitch maximum angle shall be 6 in. (153 mm).

(o) Paragraph 5.2.7.1 (Substitution)

Seller shall furnish all drive equipment.

Drivers shall be rated to operate at minimum air temperature conditions with the blade angle set for operation at the ambient air design temperature specified.

Fans and driving equipment shall be arranged and mounted so as to provide ready and complete accessibility for service.

Drive equipment shall not be located on top of the bundle.

(p) Paragraph 5.2.8 - Electrical Motor Drivers.

(q) Paragraph 5.2.8.2 (Addition)

Motors shall conform to the requirements of the Induction Motor Specification.

(r) Paragraph 5.2.10 - Couplings and Power Transmissions.

(s) Paragraph 5.2.10.3 (Complete substitution)

Fan shaft and gear shaft coupling shall be of the nonlubricated flexible type, Thomas Type SN, SF or equivalent.

(t) Paragraph 5.2.11 - Belt Drives

(u) Paragraph 5.2.11.1 (Addition)

V-belts shall be of the banded type.

(v) Paragraph 5.2.11.9 (Modification)

V-belts shall have a minimum service factor of 1.75, based on driver rated horsepower (kilowatts).

(w) Paragraph 5.2.12 - Gear Drives.

(x) Paragraph 5.2.12.5 (Addition).

Design shall permit addition of oil while unit is running.

(y) Paragraph 5.2.14 - Vibration Cutout Switches

(z) Paragraph 5.2.14.1 (Addition - Purchaser's Choice)

Vibration switches are required. Switches shall be enclosed in explosion-proof housing, suitable for Class I, Group D, Division 2 location, Robertshaw or Buyer approved equal.

(aa) Paragraph 5.2.15 - Louvers.

(bb) Paragraph 5.2.15.15 (Addition - Purchaser's Choice)

Upon loss of control air pressure automatically controlled louvers shall fail in full open position.

(cc) Paragraph 5.2.15.16 (Addition)

Remote operation of louvers shall be by manually activated pneumatic control.

(dd) Paragraph 5.2.15.19 (New Paragraph)

Louvers shall be the opposed-acting type.

(ee) Paragraph 5.12.15.20 (New Paragraph)

Louvers shall be located over the process bundles. Louvers positioned under the bundles are not permitted. Louvers on top of the induced draft fan ring are not permitted.

4.5.3 Paragraph 5.3 - Structural Design

(a) Paragraph 5.3.1 - General Requirements.

(b) Paragraph 5.3.1.5 (Addition - Purchaser's Choice)

For completely shop assembled items, the Seller shall verify during the shop run-in test that vibration of a bay of the assembly is within the specified limits at normal operating speed.

(c) Paragraph 5.3.1.6 (Addition)

Individual bays shall be designed, shop fabricated and shipped with the minimum number of loose structural pieces for bolted field assembly. Bolted assemblies of the complete unit shall be protected against loosening by vibration through the use of lock washers or elastic stop nuts for all bolts. Transit and erection clips or fastenings shall be clearly identified.

(d) Paragraph 5.3.1.7 (Addition - Purchaser's Choice)

Tube bundles shall be removable without removing header and drive maintenance platforms.

(e) Paragraph 5.3.2.6 (Modification - Purchaser's Choice)

Windload design shall be in accordance with the basic design data sheet.

(f) Paragraph 5.3.3 - Plenums.

(g) Paragraph 5.3.4 - Access Facilities

(h) Paragraph 5.3.4.1 (Addition - Purchaser's Choice)

Seller shall provide full width header platforms with interconnecting cross-walk along one side of the exchanger, or every 100 feet (30.48 m) for piperack mounted exchangers. Seller shall provide service platforms for access and maintenance of all drivers, speed reducers and fans, and for access to plenum doors, when supplied. For induced draft designs with a transition plenum or flat upper fan deck, a top-mounted center platform 2'-6" (762 mm) shall be provided. However, the flat upper deck space between fan rings may serve as the center platform if structurally adequate. Railings shall be provided for all platforms and for top decks which may be used as platforms. On induced draft units a grid shall be provided under each fan capable of supporting personnel for maintenance of the fan and speed reducer.

Unless otherwise indicated in the data sheet. Seller shall furnish the necessary support columns to provide:

1. A minimum vertical distance of 6' -6" (1981 mm) between the bottom of induced draft bundles or the fan guard of forced draft bundles to grade or access and service platforms.

2. A minimum vertical clearance of 2' -6" (762 mm) below the underside of the maintenance platform structural supports.

   All platforms shall be supported from the exchanger structure but not the tube bundle side frames.

(h) Paragraph 5.3.4.2 (Modification)

Maintenance platforms under each drive shall be designed to permit personnel to perform motor maintenance and belt adjustment safely.

(i) Paragraph 5.3.4.4 (Addition - Purchaser's Choice)

Provide a ladder between header platforms and crosswalk. Provide one ladder at one end of header platforms under 25'-0" (7620 mm) long and one at each end of header platforms over 25'-0" (7620 mm) long.

(j.) Paragraph 5.3.5 - Lifting Devices

(k) Paragraph 5.3.5.4 (Addition)

Two lifting eyes shall be provided on the drive assembly beams to facilitate motor removal.

(l.) Paragraph 5.3.5.5 (Addition)

Lifting lugs shall be solid forgings or plate type with an opening of at least 1-1/2" (38 mm) diameter.

4.6 Section 6 - Materials

4.6.1 Paragraph 6.1 - General Requirements

(a) Paragraph 6.1.3 (Complete Substitution)

Plates for pressure parts shall be pressure vessel quality. Welded nonpressure parts may be ASTM A-283 (Grades A, B, or C), A-36, or any steel permitted for pressure parts.

ASME SA-515 (Grades 65 and 70) may be used for welded components when exempted from impact testing as established by Figure AM-218.1 of ASME Section VIII, Division 2, for the minimum anticipated operating temperature. When stainless steel header boxes are specified low carbon grade shall be used.

(b) Paragraph 6.1.7 (Complete Substitution)

Welded header partitions and stiffeners shall be of the same material as the header plate.

(c) Paragraph 6.1.8 (Complete Substitution)

Fan blades shall be of reinforced plastic (phenolic or epoxy resin) or aluminum alloy. Plastic blades shall not be used when the design temperature for mechanical parts established by Paragraph 5.2.1.5 exceeds 400°F (205°C) with fans off, or when the outlet air temperature of induced draft units exceeds 225°F (107°C) with fans running.

(d) Paragraph 6.1.11 (Addition)

Linkages and torque tubes shall be galvanized steel.

(e) Paragraph 6.1.16 (Addition)

Tie bar and linkage pivot pins shall be Type 430 or Type 300 Series stainless steel.

(f) Paragraph 6.1.23 (Addition)

Plugs shall be ASME Code approved forged material.

4.7 Section 7 - Fabrication

4.7.1 Paragraph 7.1 - Welding

(a) Paragraph 7.1.1 - General

(b) Paragraph 7.1.1.1 (Addition)

All welding and heat treatment shall be in accordance with General Specification for Welding.

(c) Paragraph 7.1.1.3 (Addition)

With Buyer approval, backing strips may be used for design pressures up to 2000 psi (13 790 kPa) (gage). Filler passes shall be applied using a multilayer technique.

(d) Paragraph 7.1.1.5 (New Paragraph)

1. Start and run-off pads shall be used.
2. For design pressures of 2000 psi (13 790 kPa) (gage) or greater the following requirements shall apply:
   a. Blind corner root welds are not permitted. Header corner design shall provide for complete interpretation of root weld by radiography. Seller shall include with his proposal a drawing showing full details of the proposed corner design.
   b. Tubes shall be seal welded to tubesheets in addition to being roller expanded.

(e) Paragraph 7.1.3 - Removable Cover Plate and Removable Bonnet-Type Headers

(f) Paragraph 7.1.3.1 (Addition)

Partial penetration welds shall not be used.

4.7.2 Paragraph 7.3 - Tube-to-Tubesheet Joints

(a) Paragraph 7.3.1 - Tube Hole Diameters and Tolerances.

(b) Paragraph 7.3.1.2 (Addition - Purchaser's Choice)

When stainless steel tubes are specified, the tube holes in the tubesheet shall be machined in accordance with special close fit tolerances as set out in Table 2 - Column (b).

(c) Paragraph 7.3.2.1 (Substitution)

All tube holes shall be double grooved, each groove being 1/8"(3.2 mm)wide and 1/64" (0.4 mm) deep.

(d) Paragraph 7.3.4 - Welded Tube-to-Tubesheet Joints.

(e) Paragraph 7.3.4.3 (Complete Substitution)

When welded tube joints are specified they shall be in accordance with the tube-to-tubesheet welding specification.

4.7.3 Paragraph 7.4 - Gasket Contact Surfaces

(a) Paragraph 7.4.2 - (Addition - Purchaser's Choice)

All cover plate gasket faces shall have a flatness tolerance of ± 0.0315" (± 0.8 mm) over the entire length.

(b) Paragraph 7.5.1 (Complete Substitution)

All plug and bolt threads shall be coated with a high temperature copper powder base anti-seizing lubricant, Fel-Pro C5A or equivalent. In services where copper is prohibited, plug threads shall be coated with a molybenum disulfide base lubricant.

4.7.4 Paragraph 7.6 - Alignment and Tolerances

(a) Paragraph 7.6.4 (New Paragraph)

For completely field or module yard assembled units, Seller shall demonstrate proper fit-up and match tolerance of the complete structure, including all components such as columns, fan ring and plenum, for each size and design encompassed by an order or multiple orders for the same project. The prototype unit shall be assembled using the same drilling template or punch guides used for all other units of the same size and design. If the unit is shipped partially assembled, proper fit-up of all components that require field assembly shall be demonstrated by shop assembly of prototype prefabricated components.

4.8 Section 8 - Inspection, Examination and Test

4.8.1 Paragraph 8.2 - Quality Control

(a) Paragraph 8.2.3 (Addition - Purchaser's Choice)

All butt welds in carbon-moly and chrome-moly materials shall be completely radiographed, after postweld heat treatment.

(b) Paragraph 8.2.7 (Addition)

The same procedure shall be followed for P1 number when 100% radiography is required.

(c) Paragraph 8.2.13.4 (Complete Substitution)

Hardness of welds and related heat-affected zones shall not exceed the requirement of the welding specification.

(d) Paragraph 8.2.13.5 (Addition)

Where double butt welding has been used, weld hardness shall be checked inside and outside.

(e) Paragraph 8.2.15 (Complete Substitution)

Intermediate circumferential tube welds are not acceptable.

(f) Tube seal welds, applied weld metal lining and cladding restoration on main seams and nozzles shall be inspected for surface cracks by a dye penetrant fluid or magnetic particle test examination. Where weld overlays are machined, such inspection shall be performed after machining. Tube seal welds shall be examined after final rolling.

(g) Paragraph 8.2.18 (New Paragraph)

The following additional inspection requirements shall apply, unless indicated otherwise in the material requisition:

1. Ultrasonic examination of material is required for plates or platelike forgings over 2 1/2" (63.5 mm) thick or other forgings over 4" (101.6 mm) thick.

2. Ultrasonic examination of welds is required for plate or forgings over 2-1/2 in. (63.5 mm) thick, and for all nozzle attachment welds made in this thickness material.

3. For design pressures 2000 psi (13 790 kPa) (gage) and greater:

    a. All header corner joints, header longitudinal welds and nozzle attachment welds shall be 100 percent radiographed, and the root and final weld pass shall be magnetic particle inspected. For nozzles not readily radiographable, the magnetic particle examination is sufficient.

    b. Prior to welding, a magnetic particle examination shall be made of all edges and plate openings prepared for welding. Defects found shall be cleaned to sound metal and then backwelded.

    c. A magnetic particle examination shall be made of all attachment welds, including supports.

    d. A magnetic particle examination shall be made of areas where temporary lugs have been removed. These areas shall be prepared for examination by grinding.

4.8.2 Paragraph 8.3 - Pressure Test

(a) Paragraph 8.3.1 (Complete Substitution)

Air cooled exchanger bundles shall be given a hydrostatic test with water in accordance with Paragraph UA-60 (e) of ASME Code Section VIII, Division 1. Hydrostatic testing with oils is not acceptable.

The hydrostatic test pressure shall be maintained for a minimum of one hour to permit a thorough inspection and to detect small seepage-type leaks. When hydrostatic tests are performed, two indicating gages or one indicating and one recording gage shall be attached to the exchanger. Unit shall not be subject to external condensation or "seating" while under test.

(b) Paragraph 8.3.3 (Addition)

The minimum permissible metal temperature for welded components during hydrostatic testing shall be in accordance with Paragraph AD-155 and Figure AM-218.1 of Section VIII, Div. 2 of the ASME Code.

(c) Paragraph 8.3.4 (Complete Substitution)

The hydrostatic test water for solid or clad austenitic stainless steel components shall not exceed a chloride content of 100 ppm.

(d) Paragraph 8.3.6 (Addition - Purchaser's Choice)

In addition to the hydrostatic test, a shop air test at 50 psi (345 kPa) (gage) shall be applied to all units in hydrogen-rich service when hydrogen partial pressure is 100 psi (689 kPa) (gage), or when such service is indicated on the data sheet. All bolted joints, tube joints and screwed plugs shall be checked for leaks with a soap solution.

For exchangers with design pressures 2000 psi (13,790 kPa) (gage) and greater, the entire tube bundle shall be given a Halogen test, Freon is not acceptable, in addition to the hydrostatic test. All joints shall be checked for leaks.

Tube seal welds shall be Halogen tested prior to final rolling.

(e) Paragraph 8.3.7 (New Paragraph)

Reinforcing pad welds shall be tested with air before stress relieving. Air test shall be at 50 psi (345 kPa) (gage) minimum. Test holes in pads shall be left open.

(f) Paragraph 8.3.8 (New Paragraph)

Joints which are broken after hydrostatic test shall be reassembled with new gaskets and retested.

(g) Paragraph 8.3.9 (New Paragraph)

Gasket coatings other than graphite in combination with oil or grease are prohibited and shall not be used under any circumstances.

4.8.3 Paragraph 8.4 - Shop Run-In

(a) Paragraph 8.4 (Addition - Purchaser's Choice)

Units which are shipped completely shop-assembled shall be given a shop run-in test for the driver, drive assembly and fan.

4.8.4 Section 9 - Preparation for Shipment

(a) Paragraph 9.1.2 (Complete Substitution)

Painting shall be in accordance with the General Painting Specification.

(b) Paragraph 9.1.3 (Complete Substitution)

Protective coating shall be in accordance with the Shop Preparation of Equipment Specification.

4.8.5 Section 10 - Supplemental Requirements

Paragraph 10.1 - General

Unless specified on data sheet the supplemental requirements shall be incorporated when the tubesheet thickness exceeds 2" (50.8 mm), and when the design pressure exceeds 2000 psi (13,790 kPa)(gauge).

5. SPECIFICATION CHECKLIST

Listed below are possible related specifications to be included with the material requisition:

- Shop Preparation of Equipment
- Structural Steel
- Induction Motor
- Steam Turbine
- Painting
- Welding
- Noise

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△					
△					
△	9/23/80	ISSUE FOR PHASE ZERO	TMS	HS	
△	3/80	ISSUED FOR APPROVAL	TMS	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
STANDARD SPECIFICATION
SURFACE CONDENSERS

JOB NO. 14222

SPECIFICATION	REV
14222-E-3	1

SHEET 1 OF 6

1. SCOPE

1.1 General

1.1.1 The purpose of this specification is to cover in general the requirements for the design, fabrication and testing of steam surface condensers.

1.1.2 Condenser data sheets which will define capacity, operating and design conditions, will be supplied by the Buyer.

1.1.3 In case of conflict between the documents included in a material requisition, the order of precedence is:

a) Data sheet

b) Notes and referenced specifications in material requisition

c) Addendum to specification

d) This specification

1.1.4 The Buyer will furnish the following items:

a) Foundations

b) Condensate pumps

c) Instrumentation

d) Cooling water piping and valves to and from main condenser

d) Steam piping to ejectors

1.1.5 The Seller shall furnish the following items:

a) Main condenser

b) Air injectors

c) Inter-condenser

d) After-condenser

e) Atmospheric relief valve

f) Inter/After-condenser relief valves

g) Inter/After-condenser drain traps

h) Ejector isolating valves

i) Strainers

j) Interconnecting piping to include air piping from condensers to ejectors, and condensate piping from inter- and after-condenser to hotwell

k) Distance piece from turbine nozzle to surface condenser to include stainless steel expansion joint. Additional information will be furnished in material requisition, see Paragraph 3.5

l) Silencers

m) Instrument connections

n) Hogging ejector shall be quoted as an extra for rapid evacuation of the condenser for start-up. Advise the time required to lower condenser pressure to 4" (102 mm) of mercury absolute with and without hogging ejector.

1.2 Quotation

1.2.1 In order to receive due consideration, the Seller shall quote in strict accordance with this and other applicable specifications, and shall so state in his proposal.

1.2.2 The Seller shall furnish the following information with his proposal:

a) Completed condenser data sheets

b) Ejector operating data and motive steam requirements

c) Method of shell to tube expansion relief

d) Dimensional drawing of complete unit.

d) Itemized description of complete unit and auxiliaries including material of construction

f) Location and description of silencers

2. CODES AND STANDARDS

Design, construction and testing of surface condenser shall be in accordance with the latest Edition (with latest Addenda) of the ASME Code for Boilers and Pressure Vessels Section VIII, Division I, and the Heat Exchanger Institute Standards for Steam Surface Condensers. Piping, valve and fitting design and construction shall be in accordance with the latest Edition (with latest Addenda) of the ANSI Code for Power Piping B31.1.

3. DESIGN - PROCESS

3.1 Cleanliness factor to be used in the design of the condensers shall be:

Titanium Tube	-	90 Percent
Inhibited Admiralty	-	85 Percent

3.2 The minimum water velocity in the tubes shall be:

	Minimum	Maximum
Titanium	8 ft/s (2.44 m/s)	30 ft/s (9.144 m/s)
Inhibited Admiralty	4 ft/s (1.22 m/s)	7 ft/s (2.134 m/s)

3.3 The hotwell shall be designed to provide 3 minutes storage from normal water operating level when the condenser is operating at maximum steam load.

3.4 The primary air ejector shall be two-stage twin element with each ejector capable of handling 50 percent load. The ejectors shall be complete with air isolation valves so that either ejector may be removed from service while the other ejector is in operation.

3.5 The distance piece flange shall match the turbine exhaust flange. Dimension, orientation and nozzle loadings of turbine exhaust shall be provided by the Buyer. If the dimensions are not available at the time of quotation, the Seller shall size the distance peice on the basis of a steam velocity of 350 ft/s (107 m/s). The approximate length will be specified by the Buyer. Seller shall quote a cost per foot (meter) for increasing or decreasing the length.

4. DESIGN - MECHANICAL

4.1 The main condenser, inter/after-condensers, and auxiliary equipment shall be designed for an outdoor installation.

4.2 Corrosion allowance for carbon steel pressure parts shall be 1/8" (3.2 mm).

4.3 All piping and instrument connections shall be flanged. The minimum size connection shall be 1" (25.4 mm).

4.4 Vents and drains shall be provided at high and low points, respectively, in both the shell and tube side systems.

4.5 Materials

4.5.1

ITEM	SERVICE	
	SEAWATER-BRACKISH WATER	FRESH COOLING TOWER WATER
Mainshell	Carbon Steel	Carbon Steel
Water Box	ASTM B-127 Monel 400 or Carbon Steel Clad with Monel 400 Minimum clad thickness to be 0.1" (2.54 mm)	90-10 CuNi or Monel 400 or Carbon Steel Clad with Monel 400 or 90-10 CuNi. Minimum clad thickness to be 0.1" (2.54 mm)
Tubes	Titanium ASTM B-338 Gr 2 welded, 20 gauge minimum wall	Admiralty ASTM B111 alloy C443, C444 or C445 16 gauge minimum wall.
Tube Sheets	Carbon Steel Clad with Titanium, A-516 with B265 Gr2. Minimum clad thickness to be 0.187" (4.8 mm)	Carbon Steel Overlay/clad with Admiralty or Bronze

4.5.2 When construction features require weld overlay, the minimum weld overlay thickness shall be 0.125" (3.2 mm).

4.5.3 Ejectors

a) Nozzles - 18-8 stainless steel

b) Diffusers - Steel

c) Air Chambers - Steel

d) Steam Chest - Steel

4.3 All piping and instruments connections shall be flanged. The minimum size connection shall be 1" (25.4 mm).

4.4 Vents and drains shall be provided at high and low points, respectively, in both the shell and tube side systems.

5. VIBRATION

The Seller shall submit for the Buyer's review calculations per HEI Paragraph 6.2.4.5 confirming that the condenser tube bundles have been investigated for flow-induced tube vibrations.

6. INSPECTION AND TESTING

6.1 The condenser shall be tested in accordance with the requirements of the Pressure Vessel Code and Heat Exchanger Institute Standards as applicable.

7. SPECIFICATION CHECKLIST

Listed below are possible related specifications to be included with the material requisition:

Shop Preparation of Equipment
Painting
Welding
Noise
Data Sheet Form 908

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[illegible]	[illegible]	REVISED PARS. 3.1.19 & 3.2.2	[illegible]		[illegible]
[illegible]	10/17 8[illegible]	REVISED AS NOTED ON PAGE 8	TMC	HS	[illegible]
[illegible]	10/1[illegible].8[illegible]	ISSUED FOR PHASE ZERO	TMC	HS	
[illegible]	10/1/80	ISSUED FOR APPROVAL	TMC	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO.DE-FC05-80OR20717
PROJECT SPECIFICATIONS
TUBULAR HEAT EXCHANGERS

JOB NO. 14222
SPECIFICATION 14222-E-4
REV 3

SHEET 1 OF 24

1. SCOPE

1.1 General

1.1.1 The purpose of this specification is to cover in general the design, fabrication, testing and preparation for shipment of shell and tube type heat exchangers.

1.1.2 Exchanger data sheets, which will include material specifications, fluid characteristics, design conditions, tube size, length and pitch, etc., will be supplied by the buyer for each unit.

1.2 Quotations

1.2.1 In order to receive due consideration, the Seller shall quote in strict accordance with this and other applicable specifications, and shall so state in his proposal.

1.2.2 The Seller shall guarantee the thermal and mechanical design of the exchanger. When a thermal design is furnished by the Buyer, the Seller shall verify the thermal design, and state in his proposal that he will supply a thermal and mechanical guarantee.

1.2.3 One complete set of spare gaskets shall be included in the quoted price.

1.2.4 Floating head test rings and/or channel test rings shall be quoted as an extra.

2. CODE AND STANDARDS REQUIREMENTS

Design, construction, testing and inspection of all shell and tube heat exchanger equipment shall be in accordance with the latest Edition (with latest Addenda) of the ASME Code for Unfired Pressure Vessels, Section VIII, Division 1, or in the case of steam generators ASME Code for Power Boilers, Section 1, and with the TEMA Standards Class "R".

A test pressure shall be calculated for each component of the exchanger. The highest value shall be used for the actual test pressure. Each component thickness shall be such that the component is stressed at least 1.5 times but not greater than 1.75 times the maximum allowable stress at the test temperature when subjected to the actual test pressure.

3. DESIGN

3.1 General

3.1.1 Shell and tube TEMA type shall be as specified on the exchanger data sheet.

3.1.2 Minimum design pressures will be specified on the data sheet. The Seller shall compute the maximum allowable working pressure (MAWP). When nozzle flange ratings limit MAWP, any excess material shall be converted to corrosion allowance. The MAWP shall be stamped on the nameplate. The nozzle-to-shell attachment, tubesheet, or other secondary attachment shall not limit the MAWP.

a) Differential pressure design shall be considered only when specified on the data sheet.

b) The allowable external pressure (excluding tubesheets) shall be calculated and shown on the outline drawing.

3.1.3 Nominal design temperatures will be specified on the data sheets. External bolting stress values shall be based on the design temperature. Designing with temperature gradients is not acceptable. Temperature gradient design procedures require Buyer approval.

a) The Seller shall establish maximum and minimum design temperatures and stamp these temperatures on the nameplate as allowed by the Code or this specification without:

   (1) Incurring reduced allowable stress.

   (2) Being forced into a higher flange rating.

   (3) Changing testing requirements.

3.1.4 When alloy construction is involved, either solid or clad, full information shall be furnished by the Seller with regard to finished thickness and the proposed method of fabrication including welding, heat treating, and nondestructive testing for approval by the Buyer. Approval must be obtained prior to the start of fabrication.

3.1.5 The Seller shall submit all mechanical calculations for Buyer review.

3.1.6 When stacked exchangers are used in a service having a large temperature range, the Seller should investigate potential thermal expansion problems of the intermediate connecting nozzles and supports.

3.1.7 Unless specified on the data sheet, stacking of exchangers shall be limited to three (3) high or a maximum height of 12 feet from underside of bottom exchanger height saddle to the centerline of the top shell.

3.1.8 Lifting lugs shall be provided for handling the channel, channel cover, and shell cover. Minimum lug thickness is 3/4 in.

3.1.9 All pressure parts shall be full penetration welded.

3.1.10 No corrosion allowance is required on nonpressure internal parts, 3.1.11 Double shell pass exchangers may be quoted with the following limitations:

(a) 7 psi maximum pressure drop.

(b) 400°F maximum temperature differential.

(c) Sealing shall be accomplished by multiple leaf, lamiflex type.

3.1.12 Finned tube type of heat exchanger equipment may be quoted as an alternate when economical, when shell side service is non-fouling.

3.1.13 Velocity of fluids through exchangers shall conform to the following unless otherwise specified:

Minimum of 5 fps for water through tubes.

Minimum of 5 fps for hot oil through U-tubes.

Minimum of 3 fps for other fluids through tubes.

Minimum of 1 fps for fluids through shell.

Minimum of 4.5 and maximum of 8 fps for slurry oil through tubes.

If the above minimum velocities are not compatible with the allowable pressure drops, the pressure drops shall be governing. Calculated velocities through shell and tube shall be indicated on the manufacturer's data sheet.

3.1.14 Allowable pressure drops specified shall include entrance and exit losses through nozzles and loss due to fluid acceleration. The allowable pressure drop shall be taken to mean 20% in excess of the calculated clean pressure drop. The pressure drop (20% in excess of clean) shall be indicated on the manufacturer's data sheet.

3.1.15 Adequate impingement protection shall be provided at shell inlet nozzles when vapor or mixed phase fluids are entering. The tube protection can be afforded by use of dummy tubes, or double perforated-staggered plates on the bundle, or, preferably locating the inlet behind the U of a U-tube exchanger. Adequate space must be provided between the tube bundle and the shell to accommodate these impingement devices.

3.1.16 Kettle type reboilers shall have the tube bundle located in the lower portion of the shell. A weir shall be located beyond the tube bundle to maintain level above the tubes. Weir height shall be established 2" or more above the top of the tubes and at least 1/3 shell diameter below the top of the shell. One or more weep holes, as recommended by the manufacturer, shall be provided at the bottom of the weir for drainage. Liquid outlet shall be located beyond the weir. Minimum shell length beyond the weir shall be 3/4 shell diameter. Two 1-1/2" side connections for a gauge glass and two 1-1/2" side connections for a liquid level controller shall be provided. The ratio of the tube bundle length to the tube bundle diameter shall not be more than 6:1.

3.1.17 Unless otherwise specified, minimum fouling factors shall not be less than those recommended in TEMA Standards.

3.1.18 A triangular tube pitch shall be used only when the shell side fluid is low-fouling, i.e., .002 or less.

3.1.19 Exchangers shall be designed for a minimum of 75 psig. For operating pressures above 125 psi to 270 psi; minimum design pressure shall be 300 psi. For operating pressure above 270 psi, exchangers should have a minimum design pressure 10% above the maximum operating pressure.

3.1.20 Corrosion allowance shall be added as specified and as recommended in the TEMA Standards, except that it shall also be added to low alloy steel parts and to nozzle and manway necks. Corrosion allowance shall not be added to stainless steel parts unless otherwise specified.

3.1.21 For heat exchangers in slurry service, wear sleeves or ferrules shall be provided at the inlet to each tube. They shall be about 8 inches long and 18 BWG thick. The inner end shall be feathered, and if there is clearance between tube and ferrule, shall be flared to fit the ID of the tube and provided for a smooth flow of oil. The other end shall be rolled flush with the tubesheet. Material shall have the same coefficient of expansion as the tubes.

3.1.22 When fixed tubesheet of floating head single pass tubeside is specified, calculations for metal temperatures fo each component for all combinations of fouled and unfouled heat transfer surface with no flow and flow of each fluid shall be submitted for Buyer's review.

3.1.23 Baffle spacing shall be a maximum of 36" and a minimum of 2" or 20% of shell diameter, which ever is larger, unless otherwise specified. Number and spacing of baffles shall be specified on data sheet.

3.2 <u>Tubes</u>

3.2.1 Unless otherwise specified C.S. tubes shall be 14 BWG and alloy tubes 16 BWG. The wall thickness will mean minimum △2 wall thickness. Tubes shall be 3/4" O.D., tubes of 1¼" O.D. may be considered for highfouling stocks. If U-tube construction is indicated, the Seller shall follow the requirements in Paragraph R-2.3 of TEMA.

△3 3.2.2 Preferred straight tube length shall be 20'-0".

3.2.3 Seller shall guarantee that the yield strength of the tube material does not critically exceed the yield strength of the tubesheet material in order to insure a quality rolling, expanding and sealing of tubes to tubesheet is attainable.

3.2.4 All austenitic stainless steel U-bends shall be stress relieved beyond the tangent line. Seller shall submit the stress relieving procedure for approval. In addition, tube shall meet the following requirements:

(a) All tubes shall be in the fully annealed condition as received from the mill.

(b) Tubes shall be bent cold.

(c) Permissible ovality (out-of-roundness) of the tube cross section at the U-bend, shall be ± 6% of the tube O.D.

(d) Minimum radius of bend shall be two times the nominal O.D. of the tube.

3.2.5 All tubes shall be domestic unless otherwise approved by the Buyer.

3.3 Tubesheet

3.3.1 Four tapped holes shall be provided in the face of all nonbolt through, removable bundle tubesheets. These holes are for pulling studs necessary in removing the bundle. Plugs of the same material as the tubesheet shall be provided for plugging the holes. Gasketed shoulder plugs of the same material as the cladding shall be provided for plugging holes in clad tubesheets.

3.3.2 Jackscrews and tapped hole shall be provided on all removable bundles larger than 12 in. O.D. The threaded length of the tap shall not exceed the diameter of the jackscrew. Lugs welded to the tubesheet O.D. to accommodate the jackscrews may be used on nonbolt-through tubesheets.

3.3.3 Where nonferrous tubesheets are called for, the clad type may be considered unless otherwise specified. When the clad type is used, it shall meet the following specifications:

(a) The cladding shall not be counted for the strength which it adds to the tubesheet. The base metal thickness shall be calculated as though there were no cladding. The base metal shall be a silicon killed steel, ASTM A-516 Gr. 70.

(b) When clad tubesheets are considered, the cladding shall be one of the continuous bond types such as: (1) Lukens Clad, (2) silver solder type, or (3) deposited weld machined type. However, the silver solder type shall not be used when it is specified that tubes will be seal welded to the tubesheet, since the continuous bond would be impaired by the welding. The following clad types are not acceptable: (1) the spot welded type, (2) the plug welded type, or (3) the bolted-on type.

(c) When the silver solder type of cladding is used, it shall be at least 3/16" thick after machining, including thickness in pass partition grooves. Lukens type must be thick enough to give approximately 3/16" at all points, including thickness in pass partition grooves.

(d) If cladding is proposed for the shell side of a tubesheet, it shall be at least ½" thick with one tube groove in the cladding.

3.4 Tube Bundle

3.4.1 The maximum removable bundle OTL (outer tube linit) shall be 48 inches. Larger bundle size requires Buyer approval.

3.4.2 U-bends shall be investigated for vibration and shall be suitably supported.

3.4.3 When tube to tubesheet welds are required, they shall conform to the referenced specification.

3.4.4 Transverse baffles shall be vertically cut, single, double, or triple segmental cross-flow type.

a) Baffle cuts, when the tube pattern is triangular, shall be specially cut to prevent excess metal from cutting tubes.

b) Provide ½" high vee notch on bottom canterline of all vertical cut baffles.

3.4.5 Seal strips are required when the radial clearance between the OTL (outer tube limit) and shell is greater than one tube diameter, or when a large mumber of tubes are dropped for impingememt plates. The seal strips shall be placed 1 in. to 3 in. from the baffle cut, and approximately every eight rows of tubes; and shall extend to within the ligament distance of the tubes. Dummy tubes or solid bars shall be placed in the void areas caused by pass ribs. Only those areas parallel to cross-flow need be considered.

3.4.6 Skid bars are required on removable bundles 30 in. in diameter and larger to facilitate bundle removal. Slide rails shall be provided in kettle-type shells. Design of such skid bars and slide rails is subject to Buyer approval.

3.4.7 Bundles shall be withdrawn after insertion, a distance equal to the lesser of two central baffle spaces or 4 ft. In the case of stacked heat exchangers only the bottom bundle need be withdrawn in the stacked position. Grinding of baffles to permit insertion is not acceptable.

3.5 Floating Heads

3.5.1 Split ring backing device design shall be in accordance with ASME Code Section VIII, Paragraph UA-53. In lieu of above, the Seller may submit with his quotation an alternate design procedure for Buyer approval.

3.5.2 Maximum tubeside design pressure for split ring-type exchangers shall be 600 psi.

3.5.3 Floating head covers shall be provided with lift lugs welded on each side at 45 degrees from top.

3.5.4 Floating head covers are to provide a minimum of 1-1/2 in between the end of any tube and the inside of the cover.

3.6 Channels and Shell Covers

3.6.1 When a bonnet-type head is used at the stationary end of a floating head or U-tube exchanger, the diameter of the fixed tubesheet shall be equal to the O.D. of the shell flange. Tapped tubesheet bolt holes are prohibited. The tubesheet shall be counterbored to accept collar studs. Approximately 25%, with a minimum of four, of the flange studs shall be collar studs. They are to be provided with lock nuts on the shell side of the flange.

3.6.2 Reduced diameter tubesheets are acceptable on removable bundles only when removable channel covers are specified.

3.6.3 Removable channel covers shall be provided with a lifting lug.

3.7 Shells and Shell Supports

3.7.1 Shells, where possible, shall be constructed of seamless steel pipe or one plate with a single longitudinal seam.

3.7.2 Minimum shell thickness shall be 1/4 in. Shells shall be checked for roundness with a template to insure bundle installation without binding.

3.7.3 Fixed tubesheet units shall be provided with expansion joints in the shell where required by TEMA Paragraph R-3.3.

It is the responsibility of the Seller to determine the need for shell expansion joints. When expansion joints are required they shall be heavy duty U-Span or approved equal joint. Manufacturer shall furnish complete details of the proposed joint for Purchaser's approval. Joints shall be protected against dimpling or damage by a protective cover.

3.7.4 On floating head-type units when one-pass tubeside construction is specified, the following limitations shall be followed:

a) A "packed gland" type is acceptable if only water or low pressure steam is present in the shell.

b) If any flammable or high pressure fluid is in the shell, then an internal bellows joint must be used. All internal bellows joints must be fabricated from Monel unless otherwise specified. A typical sketch of the internal joint assembly must be submitted with the quotation. Detailed mechanical calculations of the joint assembly must be submitted to the Buyer when requested.

3.7.5 Shell supports shall be provided in accordance with the manufacturer's recommended design and the following design conditions:

a) Shell supports shall be designed to withstand a vertical load including the heat exchanger weight, weight of heat exchangers stacked above, weight of water contained in the stacked heat exchangers, other specified loads, plus fifteen percent of the above loads, without distortion to the shells.

b) The horizontal support loading shall be as follows:

(1) The horizontal load induced by pulling a tube bundle from a heat exchanger unit without jacking screws shall be taken as 150 percent of the tube bundle weight or 2000 lbs, whichever is greater.

(2) The horizontal load induced on the support without slotted holes by pulling a tube bundle from a heat exchanger equipped with a jacking screws for breaking

the bundle loose shall be 33-1/2 percent of the tube bundle weight.

(c) Web height at vertical centerline shell shall be such that the support projects at least 1 in. below nozzles or other projecting components.

(d) Bearing plates attached to the shell shall be continuous seal welded as a minimum and be provided with a 1/2 in. vent hole or a 1/2 in. skip in weld on one side.

3.8 Flanges and Gaskets

3.8.1 All end flanges shall be checked for axial alignment and gasket face flatness after welding to the shell and stress relieving.

3.8.2 Hub-type body flanges are required.

3.8.3 The design method for the high pressure-low pressure body flange combination at the fixed tubesheet end must be approved by the Buyer.

3.8.4 The effect of pass rib gasket compression shall be considered in the design.

3.8.5 Jack screws shall be provided to assist in parting of gasketed joints over 12 in. in diameter, in accordance with Paragraph 3.3.2.

3.8.6 Gasket materials shall be limited by the following temperatures:

400°F	Asbestos only
400°F	Admiralty and Copper
700°F	Monel
750°F	Iron
800°F	Double-Jacketed Asbestos

Gasket material shall be in the annealed condition. Gaskets for all services except air, water and steam, shall be metal double-jacketed asbestos or solid metal suitable for conditions, unless otherwise specified. Nubbin facings are not acceptable for use with double-jacketed gaskets.

Gaskets for floating head joints shall be solid metal suitable for conditions.

Metal clad asbestos gaskets shall be double jacketed Armco iron asbestos filled, Metallo or Goetze type, Flexitallic or equal. Alloy clad asbestos gaskets, where specified, shall be of 12-14% chromium alloy.

Abbreviations for gasket types are as follows:

A - Asbestos
DJA - Metal double-jacketed with asbestos filler
SM - Solid metal
SWA - Spiral wound, asbestos filled
SWT - Spiral wound, Teflon filled

3.8.7 Bolting

Bolting materials shall be selected in accordance with Table 2.

Material selection shall be such as to prevent galling.

a) Bolting, when exposed to hydrogen sulfide, shall not exceed a hardness of 225 BHN. Appropriate allowable stress for specially tempered bolting shall be used in design. Specially tempered bolts shall be stamped B7-M for identification.

Table 2

Bolting Design Conditions		Bolting Material			Nut Material	
Temperatures	Flange Rating(lb)	Type (2)	Specification	Grade	Specification	Grade
-150°F to -21°F	any	Studbolts	SA-320	B 7	SA-194	4(1)
-20°F to 900°F	any	Studbolts	SA-193	B 7	SA-194	2 H
901°F to 1100°F	any	Studbolts	SA-193	B 16	SA-194	2 H

Note:

(1) Nuts require impact testing per ASTM A-320 to -150°F test temperature.

(2) If the exchanger flange is 18-8 S.S., use A-320 Gr. B-8 studbolts and SA-194 Gr 8F nuts.

a) External bolting threads and nuts shall be coated with a lubricant prior to final assembly. Internal bolting (floating head assembly bolting, etc.) shall not be coated. Any one of the following lubricants can be used within service requirements outlined below:

(1) Graphite and Oil - 650°F maximum. Graphite and oil in contact with stainless steel, whether bolting or flanges, is not acceptable.

(2) Molybdenum Sulphide - 750°F maximum.

(3) Colloidal Copper - 1000°F maximum.

(4) Collodial Nickel or Silver - (for austenitic stainless steel materials) all temperatures.

b) Additional bolting requirements:

(1) Hardened washers are required when the bolt diameter is 2 in. or larger.

(2) Bolting 2 in. and larger shall be provided with additional length for the use of a bolt tensioner. Washers shall be lubricant coated as specified in Paragraph 3.8.7 (a). Seller shall account for clearances required for proper bolt tensioner use, e.g., nozzle location.

(3) Castle-type nuts are not acceptable.

(4) Studded-in bolting is not acceptable unless specified or approved by the Buyer. When studded-in bolting is acceptable, the thread class, hole design, and nongalling properties shall be fully described for Buyer approval.

(5) All bolts shall be stud bolts with a minimum diameter of 3/4 in. and threaded full length. Threads shall be in accordance with ANSI B 1.1 for high strength bolting and shall be Coarse Thread Series for sizes 1 in. and smaller, and 8-Pitch Thread Series for larger sizes.

3.9 Nozzles

3.9.1 In general, nozzles shall be forged steel welding necks, with or without integrally forged reinforcement. Built-up nozzles of seamless steel pipe and forged steel welding neck flanges may be used, if these are more economical. For built-up nozzles 10 in, and over the nozzle neck may be steel plate rolled and double butt welded. All welds in built-up nozzles shall be ground to the I.D. of the nozzle. Slip-on flanges require Buyer approval.

3.9.2 Connections for washout, acid wash or chemical cleaning shall be installed in the exchanger nozzle(s). Sizes shall be a minimum of 1½" - 3000 lbs threadolet on nozzles 3" larger, and 1" - 3000 lbs threadolet on 3" and smaller nozzles.

Each "raised face" or "flat face" nozzle shall have a 1" thermowell connection. Thermowell connections may be omitted on nozzles less than 3" in diameter.

All "raised face"or "flat face" nozzles shall have a 1" pressure gauge connection. Vent connections at high points and drain connections at low points shall be provided (minimum size 1").

For "raised face"or "flat face" nozzles, screwed type connections shall be used in the side of the nozzles. Couplings shall be 6000# full lenth and welding shall be "full penetration" welding. If the manufacturer wishes to drill and tap, he shall provide a suitable boss in order to give full length thread plus 1/8". In addition, a drilled and tapped connection shall meet the strength requirements of all applicable Codes.

All screwed connections shall be plugged with steel bar plugs 3" long except for alloy construction, in which case alloy plugs shall be used.

3.9.3 Nozzle projections shall be sufficient to remove the flange studs from the exchanger side, considering the insulation thickness.

3.9.4 Intermediate flanged radial nozzles which are directly connected should have raised face facings and not RTJ facings.

3.9.5 The use of nozzle liners is prohibited.

3.9.6 Unless otherwise specified, nozzles in both shells and channels shall be cut off flush with the I.D., and sharp edges rounded off to at least 1/8" radius.

3.9.7 Steam heated equipment shall be provided with a 1-1/2" connection on the steam side for venting noncondensible gases. If the steam is flowing through the tubes, the vent shall be located at the high point of the second pass channel compartment. If the steam is on the shell side, the vent shall be located on the vertical centerline at the shell end opposite the inlet nozzle.

4. MATERIAL SPECIFICATIONS & WELDING

4.1 General

4.1.1 All material shall be as indicated on the individual data sheets. Unless specific material designations are made on the data sheets, material shall conform to the ASME specifications indicated in Section 8 of TEMA.

4.1.2 Admiralty tubes shall be ASTM B-111, Type B, C, or D.

4.1.3 In alloy exchangers the nonpressure parts such as baffles, tie rods, etc., may be the least expensive of the alloys considered suitable where more than one material is required in the fabrication of the exchanger.

4.2 Welding

4.2.1 Welding procedures and welders or welding operators must be qualified in accordance with Sections I, VIII, and IX of the ASME Code.

4.2.2 All welds shall be made by the SMAW, GTAW or GMAW process using electrodes of composition quality. Gas, bare wire, carbon-arc or forged welding will not be permitted. Welding by automatic or semi-automatic equipment will be permitted. All nozzles, small connections and their reinforcement shall be attached to the vessel with full penetration welds.

4.2.3 When equipment is fabricated of welded Type 347 stainless steel, the following shall apply:

(a) All Type 347 welding electrodes shall deposite metal containing only 3 to 5% delta ferrite.

(b) All shop welded components are to be annealed at 1925°F-1950°F following welding. The work piece shall be heated uniformly to annealing temperature. When piece to be annealed is of uniform thickness throughout, it may be charged to the furnace at the annealing temperature. On pieces of nonuniform thickness, a slower heating rate shall be used to minimize thermal distortion. It shall be held at temperature for a time based on one hour per inch of thickness, with a minimum holding time of one-half hour. The piece may be cooled in the furnace or uniformly in still warm air. Where weld is of uniform thickness or not under restraint, piece may be cooled in water spray. The faster piece is cooled, the lower the percentage of ferrite.

5. INSPECTION AND TESTING

5.1 General

5.1.1 The Buyer reserves the right to inspect at any time during fabrication. Inspection shall be by the Buyer or his authorized representative.

5.1.2 All welding and nondestructive testing shall be in accordance with Welding Specification

5.1.3 The approval or release for shipment by any inspector or representative of the Buyer does not relieve the Seller of any responsibility or any guarantee.

5.1.4 The Code Inspector shall certify "Manufacturer's Data Reports" and witness Code stamping where required.

5.2 Testing

5.2.1 Each exchanger shall be hydrostatically tested in accordance with procedure outlined in Paragraph R-1.31 of TEMA. Units designed with stacked shells shall be tested in shells stacked position.

5.2.2 All tests are to be made in the presence of the Buyer's inspector or authorized representative. An exception, however, is the individual testing of reinforcing pads before stress relieving.

Seller shall insure that water is completely drained from exchangers following hydrostatic testing.

5.2.3 Seller shall furnish the Buyer for approval the hydrostatic test procedure for testing items that have the internals designed for a differential pressure. It is required that the individual shell side and tube side pressure be recorded separately, particularly during the dropping of pressure at the end of the test.

5.2.4 The use of gasket "dope" other than graphite and oil or grease is prohibited, and shall not be used under any circumstances.

<u>NOTE</u>: Oil, graphite or other flammable materials shall <u>not</u> be used for oxygen service.

5.2.5 Upon successful completion of inspection and testing, a stamped nameplate of corrosion resistant material shall be prepared and attached to the exchanger. Any nameplate bracket attached to the unit shall be seal welded all around.

Nameplate data shall specify the maximum allowable working pressure of the heat exchanger as defined in Paragraph 3.1.2.

5.2.6 For items in which the internal components are designed for a differential pressure, the Seller shall provide a warning plate attached to the shell which identifies the internal components and the design differential pressure.

6. PREPARATION FOR SHIPMENT

6.1 General

6.1.1 All surfaces shall be thoroughly cleaned of weld spatter. All scale and debris shall be removed from the internal surfaces of the exchanger and the external surface of all welded joints.

6.1.2 Surface preparation and painting shall be in accordance with the referenced painting specification.

6.1.3 Shipping notices shall be forwarded to the Purchaser as directed in the purchase order.

7. GUARANTEES

7.1 The Seller, unless he expressly states any exceptions in his proposal, shall, without qualification, guarantee the units furnished by him to meet the Buyer's requirements with regard to mechanical design, transfer rate, pressure drop, capacity and suitability for satisfactory operation under the specified operating conditions. Upon satisfactory proof that the units furnished do not meet any of these conditions, the Seller shall furnish FOB the point of use any necessary additional equipment to meet the specified conditions, or make changes to the original equipment furnished as required.

8. SPECIFICATION CHECKLIST

Listed below are related specifications and drawings which may be included with the material requisition:

Specifications

- General Specification for Equipment Seller
- General Welding Specification
- Welding Tubes to Tubesheet Specification
- General Painting Specification
- Shop Preparation of Equipment

Drawings

M-505 - Head Handling Davits for Heat Exchangers (to be provided during Phase 1).

Fired Heaters—F

INDEX

FORM H-292 7-66

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△	[illegible]	REVISED CODE REF. & METRIC EQUIVALENTS			
△	7/23/80	ISSUE FOR PHASE ZERO			
△	4/80	Issued for Approval	VT	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
STANDARD SPECIFICATION
FIRED HEATERS

JOB NO. 14222

SPECIFICATION	REV
14222-F-1	2

1. SCOPE

1.1. General

1.1.1 The purpose of this specification is to cover, in general, the design, fabrication, testing and preparation for shipment of Fired Process Heaters.

1.1.2 Heater data sheet, which will include material specifications, fluid characteristics, design conditions, etc., will be supplied by the Buyer for each heater.

1.1.3 In case of conflict between the documents included in a material requisition, the order of precedence is:

a. Individual data sheets

b. Notes and referenced specifications in the material requisition

c. Addendum to this specification

d. This specification

1.2 Quotations

1.2.1 In order to receive due consideration, the Seller shall quote in strict accordance with this and other applicable specifications. Alternates may be submitted at the option of the Seller, providing such alternates are clearly indicated and quoted as additions or deductions to the basic bid.

1.2.2 The Seller shall calculate the heat transfer rate for each service and base his quotation on the minimum surface necessary for him to guarantee that the surface offered is satisfactory for the duty and any fouling factors specified.

2. CODE AND STANDARDS REQUIREMENT

2.1 Design, materials, fabrication and inspection of Fired Heaters shall be in accordance with the applicable portions of the following codes, standards and specifications, latest editions:

△ 2.1.1 API (American Petroleum Institute) Standards:

RP 530	Recommended Practice for Calculation of Heater-Tube Thickness in Petroleum Refineries
RP 550	Installation of Refinery Instruments and Control Systems, Part III, Fired Heaters and Inert Gas Generators.
RP 630	Tube and Header Dimensions for Fired Heaters in Refinery Service.

2.1.2 ANSI (American National Standard Institute) Standards:

B-16.1	Forged Steel Fittings, Socket-welding and Threaded
B-16.5	Steel Pipe Flanges, Flanges Valves and Fittings
B-16.9	Factory Made Wrought Steel Butt Welding Fittings
B31.3	Chemical Plant and Petroleum Refinery Piping
B36.10	Welded and Seamless Wrought Steel Pipe

2.1.3 AISC (American Institute of Steel Construction)

.Design, Fabrication and Erection of Structural Steel for Buildings

2.1.4 ASTM Standards

A-193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
A-194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
A-234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
A-297	Corrosion Resistant Iron-Chromium, Iron-Chromium Nickel, and Nickel Base Castings
A-319	Grey Cast Iron for Elevated Temperatures
A-320	Alloy Steel Bolting Materials for Low Temperature Service
A-403	Wrought Austenitic Stainless Steel Piping Fittings
A-422	Butt Welds in Still Tubes for Refinery Service
A-447	Chromium-Nickel-Iron Alloy Castings for High Temperature Service

A-608	Centrifugally Cast Iron-Chromium-Nickel High Alloy Tubing for Pressure Application at High Temperatures
C-64	Refractories for Incinerators and Boilers
C-155	Insulating Fire Brick
C-401	Castable Refractories
C-612	Mineral Fiber Block and Board Thermal Insulation
AWS	(American Welding Society)
D1.1	Structural Welding Code
ICBO	(International Conference of Building Officials) Uniform Building Code

2.2 Design, materials, fabrication and inspection for steam generating, steam superheating and boiler feedwater heating coils shall be in accordance with the applicable portions of the following codes:

2.2.1 ASME (American Society of Mechanical Engineers)

Section I, Power Boilers

Section II, Material Specifications

Section V, Nondestructive Testing

Section IX, Welding Qualification

3. DESIGN - PROCESS

3.1 The Bechtel Fired Heater Data Sheet shall be completed by heater vendor and returned with his proposal. All materials shall be identified by ASTM designation. Maximum fluid film temperatures, maximum tube metal temperatures, and maximum fin tip temperatures shall be specified.

3.2 Cylindrical updraft heaters shall be so arranged that the length of the radiant tubes shall <u>not</u> exceed 2.6 times the diameter of the tube circle. △1

3.3 The maximum length of vertical radiant section tubes in any floor fired heater shall not exceed 60'-0" (18.3 m). The maximum length of horizontal radiant section tubes for box heaters shall not exceed 80'-0" (24.400 m).

3.4 Radiant tubes shall be arranged in a single row and spaced on a center-to-center distance of not less than two (2) nominal pipe size diameters. Tubes shall be installed with a minimum clearance from refractory to tube outside diameter of one tube diameter.

3.5 For horizontal tube convection section there shall be at least two rows of bare tubes acting as shield rows.

3.6 Parallel flow passes and manifolds shall be designed to give equal flow paths. Mixed phase streams shall not be split within the heater proper. When mixed phase flow enters the heater a single flow pass heater shall be furnished.

3.7 Heater design shall insure against flame impingement on heater tubes, tube support castings and refractory, as well as provide uniform heat distribution.

3.8 The heater shall be airtight with the only air entering being that needed for combustion.

3.9 The guaranteed efficiency shall include minimum heat loss of 1-1/2% for all heaters except those with air preheater system. For heaters with air preheat systems the minimum heat loss shall be 2-1/2%.

3.10 The efficiency shall be based on the lower heating value of the fuel.

3.11 The burners and furnace draft shall be adequate to allow 120% of design heat absorption with design excess air and maintain a negative pressure of 0.05" (1.27 mm) at the top of the radiant section at the design ambient temperature.

3.12 Heaters shall be designed to permit continuous, stable and controllable operation at reduced flow. When reduced flow rate is not specified on the data sheet it shall be taken as 50% of the normal heater flow rate.

3.13 The calculated casing surface temperature shall not exceed 180°F (82°C) with an ambient temperature of 80°F (26.7°C) and still air.

3.14 The radiant section volumetric heat release shall not exceed 15,000 Btu/Hr-CuFt (0.155MW/m^3) when firing fuel oil, 15,000 Btu/Hr-CuFt (0.155 MW/m^3) when firing combination of fuel gas and fuel oil, and 18,000 Btu/Hr/CuFt (0.186 MW/m^3) when firing fuel gas only.

△1 3.15 Max. heat absorption shall not exceed 10,000 BTU/Sq. Ft./Hr. for single fired radiant tubes and 15,000 BTU/Sq.-Ft./Hr. for double fired radiant tubes. Convection rate shall not exceed 3500 BTU/Sq. Ft/Hr.

4. DESIGN - MECHANICAL

4.1 Structural

4.1.1 Structural design (including wind, earthquake, or other loads), fabrication and construction shall conform to the applicable requirements of referenced Codes and Standards, except as otherwise called for herein. Radiant and convection steel casings shall be a minimum of 3/16" (5 mm) thick plate. Radiant floor and arch plate shall be 1/4" (6 mm) thick plate. Steel casing shall be airtight and seal welded to the structural members to eliminate possible entry of moisture into crevices.

4.1.2 The radiant shells of vertical cylindrical heaters shall be designed as a minimum in accordance with the Chicago Bridge and Iron Company formula for the design of large fabricated tubular columns, Roark Formulas for Stress and Strain Part III. The minimum shell thickness "t" shall be 1/4". (6 mm).

4.1.3 The structural design of the heater shall be adequate for loads imposed by the stack(s) mounted on the heater.

4.1.4 One stack or one flue gas take-off shall be provided for each 40 ft (12.19 m) of effective convection section tube length.

4.1.5 The design of heater support columns from underside of heater floor to top of baseplate and all main floor support beams shall allow for 2" (51 mm) thickness of concrete fireproofing.

△1 4.2 Linings

4.2.1 Heater refractory may be premixed insulating castable refractory per ASTM C-401, insulating firebrick per ASTM C-155, or ceramic fiber. All materials used shall have a service temperature of at least 200°F (93°C) above the calculated or hot face temperature.

4.2.2 Castable refractories shall be gunned-on wherever possible; dry gunning is preferred. Pouring shall be employed only where areas are inaccessible.

Pouring must be followed up by packing and vibrating to prevent voids. All refractories shall be mixed, applied, dried out and cured in accordance with the manufacturer's recommendations and the following requirements:

△1 a) Surfaces for castable refractory shall be free of all dirt, grease, rebound materials, weld spatter, paint, loose scale, or other foreign material.

b) Only potable water shall be used to mix with refractory materials. Water temperature limits 45°F (7°C) minimum and 70°F (21°C) maximum.

c) Refractories must be kept from freezing after mixing until cured and air dried, or 72 hours after application, whichever is later. Curing may be performed by using a light spray of clean, cool water, or by the application of a resin based curing compound. When spray water is used the curing will continue without interruption until the concrete is at least 24 hours old.

△2 d) The heater casing must be kept above 40°F (4.5°C) and below 100°F (38°C) during application and curing of refractory.

e) When placement of castable is interrupted for thirty minutes or more the material in place shall be cut off at a place of full thickness. The angle between the cut surface and the applied surface shall be 90°.

f) A resin based membrane curing compound shall be applied to all refractory surfaces at the completion of each gunning shift.

g) The completed lining shall be tapped with a 1 lb (0.5 Kg) ballpoint machinist's hammer over the entire refractory surface, using a one meter grid pattern.

<u>Note</u>: During the hammer testing, when defective areas are encountered (voids or dry filled spaces) a dull sound will be heard.

h) Refractory application procedure must be submitted to the Buyer for approval.

i) Individual insulation anchors shall be used on all walls and arch construction. Anchors shall be a minimum of 3/16" (5 mm) diameter and shall extend to within 3/4" (19 mm) of the refractory hot face. V-type anchor with at least two bends in each leg shall be used. The anchor spacing shall be equal to twice the lining thickness, with a maximum spacing of 12" (305 mm) on a square pattern for walls, and 9"(229 mm) on a square pattern for overhead surfaces.

j) For linings not more than 2" (51 mm) thick, anchors shall be 1/8" 3.2 mm) diameter Wavi-Tak refractory pins, or chain link fence. Chain link fence shall be attached to the metal surface with 3/4" (19 mm) long welds at not more than 9" (229 mm) center to center. Tack welds are not acceptable.

k) For dual layer castable linings an anchoring system shall be provided for each layer.

l) Anchor materials:

Refractory Hot Face Temperature	Anchor Material	
To 1000°F (538°C)	Carbon Steel	
1001°F (538°C) to 1700°F (927°C)	Stainless Steel Type 410 SS	⚠
Above 1700°F (927°C)	Stainless Steel Type 410 SS	⚠

4.2.3 When ceramic fiber is used installation will be in accordance with fiber manufacturer's recommendations and the following minimum requirements:

a) Radiant Sidewall:

Insulation thickness shall be a minimum of 3" (76 mm) ceramic fiber. All joints will be staggered, and final joint will be overlapped a minimum of 4" (102 mm).

Maximum anchor spacing 9" (229 mm) x 12" (305 mm)

b) Radiant Arch:

Insulation thickness shall be a minimum of 3" (76 mm) ceramic fiber. All joints will be staggered, and final joint will be overlapped a minimum of 4" (102 mm).

The radiant sidewall outer layer will lap over the arch a minimum of 12" (305 mm).

Maximum anchor spacing 9" (229 mm) x 10-172" (266 mm)

c) Convection Walls:

Ceramic fiber may be quoted as an alternative only to insulating castable. Ceramic fiber thickness shall be a minimum of 3" (76 mm) ceramic fiber. Hot face material shall be rigidized wet blanket. All joints will be staggered.

Maximum anchor spacing 9" (229 mm) x 12" (305 mm).

d) Corrosion Protection:

When fuel oil is specified as a heater fuel the Seller's proposal shall describe materials of construction and installation details to prevent casing plate, anchor base and washer corrosion from heavy metals and sulfur contained in the fuel oil.

△1 e) Anchor Material: 410 SS

f) Vacuum foamed shapes shall be used at all tube openings.

4.2.6 When block insulation is used as an internal lining for combustion air ducts and burner plenum chambers, it shall be suitably anchored by studs and have the exposed face protected form shredding by the use of expanded metal, perforated plate, or wire mesh.

4.2.7 Burner tiles shall be pre-fired and have a minimum service temperature of 3000°F (1650°C).

4.3 Tube Supports and Guides

4.3.1 Insulated radiant and convection section end tube supports shall be manufactured from 1/2" (12.7 mm) carbon steel conforming to ASTM Specification A-36. When the calculated metal temperature exceeds 800°F (427°C), alloy material shall be used. RA-333 is preferred. RA-333-70 titania-coated welding electrode shall be used with RA-333. 1/8" (3.2 mm) thick ferrules △1 shall be provided to retain the insulation around the tube holes. 1/2" (12.7 mm) clearance shall be provided between the tube OD and the ID of the ferrule.

4.3.2 Radiant tube supports shall be designed to allow replacement with the tubes in place. The minimum supports design temperature shall be the bridgewall temperature plus 200°F (93°C).

4.3.3 Convection intermediate tube support material selection and design temperature shall be the temperature of the flue gas entering the tube section being supported plus 100°F (38°C).

4.3.4 The tube support maximum allowable stresses at design temperature shall be:

a) Dead load stress shall not exceed the following:

  (1) One-third of the ultimate tensile strength

  (2) Two-thirds of the yield strength (0.2% offset).

  (3) 50% of the stress required to produce 1% creep in 10,000 hours.

  (4) 50% of the stress required to produce rupture in 10,000 hours.

b) Dead load plus frictional stress shall not exceed the following:

  (1) One-third of the ultimate tensile strength.

  (2) Two-thirds of the yield strength (0.2% offset).

  (3) The stress required to produce 1% creep in 10,000 hours.

  (4) The stress required to produce rupture in 10,000 hours.

4.3.5 For castings a casting factor of 0.8 shall be applied to allowable stress value.

4.3.6 Loads shall be determined in accordance with AISC procedures for supporting continuous beams on multiple supports.

4.3.7 Friction loads shall be based on a friction coefficient of 0.30 minimum.

4.3.8 Friction loads shall be based on all tubes expanding and contracting in the same direction. Loads shall not be considered to be canceled or reduced due to tubes moving in opposite directions.

4.3.9 Casting Materials:

a) To 1200°F (649°C) - Heat Resisting Cast Iron A-319 Class 110

b) 1201°F - 1900°F (650 - 1038°C) - A-297 Gr HK When the fuel oil contains more than 75 ppm vanadium 50 Cr - 50 Ni, or 60 Cr - 40 Ni stabilized grade shall be used.

4.3.10 Tube bearing surfaces shall not have sharp points or ridges which could damage heater tubes. Supports which directly support extended surface tubes shall have a minimum bearing width of 2" (51 mm).

4.3.11 The maximum unguided length of vertical tubes fired on one side only shall be 35 times tube outside diameter.

4.3.12 The maximum unsupported length of horizontal tubes shall be the smaller of 35 times the tube outside diameter or 20' (6100 mm).

4.3.13 Tube support and tube guide casting bolts not exposed to flue gas shall be ASTM A-193 Gr 8C carbide solution treated; nuts will be ASTM A-194 Gr C.

4.4 Tubes

4.4.1 All coils in hydrocarbon services shall be seamless tube or pipe. The outside diameter shall conform to the "primary" sizes per API Standard 630.

4.4.2 Tube materials shall be specified on the data sheets. Convection section shield tubes shall be of the same materials as the radiant tubes.

4.4.3 The minimum thickness or the tubes in hydrocarbon service shall be based on the ASME power boiler code, △1 using a design stress not to exceed that which will produce a 1% creep in 100,000 hours at the design temperature; and pressure design tube metal temperature shall be 150°F higher than the design transfer temperature.

The minimum required (Tubewall) thickness shall be not less than 0.125" (3.2 mm) + C.

C + Corrosion allowance specified on data sheet,
inches (mm)

4.4.4 Tube design temperature shall be taken as the calculated maximum tube metal temperature plus 150°F. For △1 hydrocarbon service the calculated maximum tube metal temperature shall be based on heater design charge rate, and shall take into consideration an assumed coke laydown on 1/8" (3.2 mm) thick, which may be expected during an operating run.

4.4.5 Extended surface tubes shall not be used in the shield rows of the convection section.

4.4.6 Extended surface tubes may be furnished for the remainder of convection section. When finned tubes are furnished the following limitations shall apply:

a) Material:

Fin Material	Maximum Fin Tip Temperature	
Carbon Steel	900°F	(482°C)
11-13% Chrome	1200°F	(649°C)
18-8 Stainless Steel	1500°F	(816°C)
25-12 Stainless Steel	1900°F	(1038°C)

b) -Spacing:

△1 The minimum fin thickness shall be 0.10" (2.54 mm); the maximum fin height, 1" (25.4 mm). The ratio of extended surface to bare surface for extended surface tubes shall not exceed 3/1.

c) Attachment:

The fin attachment shall be a minimum of 90%. Fins shall be attached to the tubes by a continuous weld.

d) Seller shall submit the name of the proposed extended surface vendor, and on request of Buyer shall supply representative samples of tubes with extended surface attached. Buyer shall have the right of refusal or acceptance.

4.4.7 Austenitic and high nickel alloys subjected to high temperatures shall be protected from contact with lead, zinc, aluminum, vanadium, titanium, sulphur, phosphorus, or other elements that can attack these alloys at elevated temperatures. This includes materials containing these elements such as marking inks, crayons, paints, lubricants, etc.

4.5 Fittings

4.5.1 Headers, return bends and fittings shall be of the same material as the heater tubes, and shall be in accordance with the applicable ASTM Standard.

4.5.2 Tubes and fittings shall be arranged so there is sufficient space for field maintenance operations such as welding and stress relieving. A minimum of 4" (102 mm) shall be allowed between the tube to return bend weld and the end tubesheet. When practical, the heater arrangement shall allow for replacement of individual tubes without disturbing adjacent tubes or fitting.

4.5.3 Wrought fittings are preferred; when castings are used for return bends, header or terminal fittings, they shall meet the requirements of the ASTM specifications, and in addition they must meet the supplemental requirements of referenced specification.

4.6 Burners

4.6.1 Burners shall be suitable for the fuels specified on the fuel data sheet. The design firing duty of the △1 burner shall be 120% of heater design fired duty unless otherwise specified. Burner blocks shall be of prefired refractory shapes.

4.6.2 Burners shall be designed and installed so individual burner guns can be readily and safely removed for inspection and cleaning without shutting down the △ heater and without disturbing the setting, plenum chamber, or structure. Burner assembly shall be equipped with dual oil burner guns each rated at full firing duty of the burner register.

△ 4.6.3 Gas pilot burner must be designed for continuous firing duty and be stable when fired by itself under all air flow conditions. Pilot burner shall be generally rated at the lesser of 6,000 BTU/Hour or ten percent of the fired burner duty when operating at aproximately 5 psig gas pressure at the pilot. The pilot must be electric spark ignited. The max. pressure at the pilot shall be 15 psig.

4.6.4 Convenient "light-off" ports shall be provided so that all burners can be easily and safely ignited.

△ 4.6.5 Shutdown System: (VV Scanner)

A fail safe shutdown system is to be provided to shut off all fuel sources on flame failure, fan failure, or on loss of flow in any process coil. The following valves shall be used for safety shutdown system:

	Service Below 400°F	Service Above 400°F
△ First choice: Fisher Type 667-EC Quick Opening, 0 to 35# Air, Steel Body, 316 SST Plug and Seat Ring	CI Cage	17-4 pH Cage
△ Second Choice: Fisher 667-ES Quick Opening, 0 to 35# Air, Steel Body, 316 SST Plug	CI Cage	17-4 pH Cage

Packing - "TFE" for service below 450°F

△ "GRAF-OIL" for service above 450°F

Solenoid Valves - Fisher Type 169 Switching Valve #10A0897 with 750 ohm register.

One flame scanner shall be located on the side, and one scanner on the bottom of vertical fired heaters. For oil firing the scanner on the side shall be infra-red and the scanner on the bottom shall be ultra-violet.

4.6.6 Minimum distance between center line of radiant tubes and center line of burners shall be as follows:

Maximum Low Heat Release Per Burner Low Heating Value 10^6 Btu/Hr (MW)	Distance in Inches (mm)		
	To Center Line of Radiant Tubes Fuel Gas	To Center Line of Radiant Tubes Fuel Oil	To Hot Face of Unshielded Refractory Walls
2.25 (0.66) or less	33 (840)	39 (990)	39 (990)
Above 2.25 (0.66) but less than 6 (1.75)	39 (990)	45 (1145)	45 (1145)
6 (0.66) to 10 (2.93) inclusive	45 (1145)	51 (1295)	51 (1295)

4.6.7 Vertically fired heaters shall have a minimum clearance of 7'-0" (2134 mm) below burner piping.

4.6.8 Provision shall be made in the burner mounting design to permit proper positioning of the burner during construction when the burners are mounted in a noise abatement plenum or forced draft windbox.

4.7 Dampers

4.7.1 Dampers shall be provided for draft control. The dampers may be located in the stack or flue gas duct. Damper and damper shaft material shall be a minimum of stainless steel Type 18-8.

Louver dampers are preferable. They shall be designed to prevent seizing or binding in operation. Special care must be taken to prevent failure of insulation or refractory from causing the damper to become inoperative.

4.7.2 Damper shafts shall be supported on weather sealed self-lubricating grease packed antifriction bearings to permit ease of operation. Bearings shall be supported by an independent structural support. Operation shall be positive in both directions.

4.8 Doors and Header Boxes

4.8.1 Floor peep doors shall be provided to view the full length of representative radiant tubes.

4.8.2 A 9" x 4" (229 mm x 102 mm) minimum-opening sight door shall be provided for each floor-fired burner; doors are to be located in sidewall of the heater. When combustion air preheat is furnished, sight doors shall be designed for minimum air infiltration.

4.8.3 Access shall be provided to each heater section, preheater ducting, breeching and stack for maintenance purposes. Minimum door size shall be 16" x 20" (406 mm x 508 mm). Doors shall be gasketed.

4.8.4 Header boxes shall be fabricated from a minimum of 3/16" (5 mm) plate. Header boxes shall be insulated, gasketed, and made gas-tight to prevent air infiltration. The arrangement of the header box shall readily provide for header installation, ease of cleaning, and other maintenance and testing work.

4.8.5 The depth of header boxes shall be determined by allowing a minimum of 2" (51 mm) clearance between the outer extremity of the fitting and door insulation in the hot position.

4.8.6 Each combustion chamber shall have a minimum of two 18" x 18" (457 mm x 457 mm) explosion doors, hinged at the top and closed by gravity.

4.9 <u>Sootblower</u>

4.9.1 When fuel oil is specified as a heater fuel, sootblowers shall be furnished in the convection section. Sootblowers shall meet the following requirements:

△1 4.9.2 Soot blowers should normally be the retractable type as manufactured by Diamond or Copes Vulcan. Motive steam should be 450 psig. Automatic sequencing should be done electrically.

4.9.3 Sootblower coverage and distance from the lance to tube face shall be reviewed and approved by the sootblower manufacturer.

4.9.4 Each blower shall have a blower mounted NEMA 4 pushbutton.

4.9.5 Sootblower entrance port shall be stainless steel Type 304.

4.9.6 A NEMA 4 cabinet with Size 1 magnetic reversing starters, circuit breaker, control circuit transformer, and space heater, all factory wired and mounted.

4.9.6 Automatic sequential control panel shall be furnished. Panel shall be weather protected and complete with:

Operating switches and unit indicating lights for each blower

Control power circuit breaker

Alarm for blowing medium failrue

Automatic blowing medium turn-on

Timing device to allow warm-up period for steam piping

Unit space timer

Sequence finish light

Elapse time indication and alarm contact

4.10 Platforms, Stairs and Ladders

4.10.1 Access and working platforms shall be provided for all areas more than 6'-0" (1829 mm) above grade where observation of heater operation or performance of routine maintenance is required. This includes access to all operating controls, sight door, header box compartments, terminal flanges, and dampers. Minimum clear width of platforms shall be 4'-6" (1372 mm) for those requiring tube pulling access, 3'-0" (915 mm) at sight doors, and 2'-6" (762 mm) for all others.

4.10.2 A walkway shall be provided to connect the end platforms of horizontal tube heaters and convection sections. Stack damper platform shall provide access to both damper bearings.

4.10.3 Access to all operating platforms shall be by a stairway from grade. Stairway landing shall have a clear length of not less than 3'-0" (915 mm) in the direction of the stairway.

4.10.4 Access to the upper platforms shall be by ladders fitted with safety cages. Ladders shall provide for side step access to platforms.

4.10.5 Two means of exit shall be provided from all operating platforms.

4.11 Air Preheat System

4.11.1 The air preheat system will be complete with but not limited to:

4.11.2 Regenerative or recuperative type air preheater. Air preheater materials shall be based on fuels fired and ambient air temperature. Air preheater will be complete with cold air bypass, water wash facilities, drives, etc. Seller's proposal shall describe in detail the air preheater.

4.11.3 Flue gas ducts shall be a minimum of 3/16" (5 mm) thick plate and internally lined from the heater to air preheater inlet connection. Ducting from air preheater outlet connection. Ducting from air preheater outlet connection to the stack, including I.D. fan, will be externally insulated. Insulation and insulation supports shall be furnished by Seller. Flue gas ducting downstream of air preheater shall be a minimum of 3/16" (5 mm) thick Corten plate.

4.11.4 Hot air ducts and burner windbox plenum will be a minimum of 3/16" (5 mm) plate and internally insulated.

4.11.5 Expansion joints are to be installed in flue gas and hot air ducts.

4.11.6 Seller will furnish all dampers with pneumatic damper operators and control linkage.

4.11.7 The forced draft fan housing shall be split for rotor removal fabricated from a minimum of 3/16" (5 mm) thick plate. Fan will be furnished with antifriction oil lubricated bearings mounted on independent pedestals with pedestal caps. Access door and drain will be furnished.
△1 Backward curved blades with self-limiting horse power characteristics shall be supplied. Variable inlet vanes are required.

Air intake to fan will be a minimum of 16'-0" △1 △2 (4877 mm) above grade. When required, a silencer will be furnished to meet noise level requirements. Air intake will be furnished with a rain hood and 3/4" x 3/4" (19 mm x 19 mm) galvanized mesh bird screen.

The minimum test block rating will be:

Temperature: Maximum Ambient + 25°F (14°C)

Head, Static Pressure:

- Burner Loss + 1.50 x All Air Losses, (Except Burner Loss)

Capacity: Volumetric Flow x 1.25

4.11.8 The induced draft fan housing shall be split for rotor removal and fabricated from a minimum of 3/16" (5 mm) thick Corten plate. Wheel and shaft will be of a similar alloy construction. Fan will be furnished with water cooled bearings mounted on independent pedestals with pedestal caps. Access doors and drain will be furnished.

Radial or backward curved blades shall be supplied.

The minimum test block rating will be:

Temperature: Flow temperature = 80° + 25°F (14°C) = 105°F

Head, Static Pressure: All Gas Losses x 1.3

Capacity: Volumetric Flow x 1.20

4.11.9 I.D. fan and F.D. fan rotors are to be dynamically and statically balanced prior to shipment.

4.11.10 Overhung wheels are not acceptable for I.D. or F.D. fans. Drive shall be mounted on foundation furnished by Buyer.

4.12 Painting

Painting and/or galvanizing of exposed steel surfaces shall be as specified on the heater data sheet and referenced specification.

4.13 Instrument Connections

Sufficient instrument connections shall be provided to allow complete testing, balancing and operation of the heater.

4.13.1 Draft gauge connections 3/4" NPT (19.1 mm) with plugs shall be installed at least at the following points:

a) Burner level

b) Entrance to convection section

c) Outlet of convection section

d) Downstream and upstream side of each damper

e) Between each coil of different services in convection section

f) Each side of air preheater

△1 g) Base of Stack

△2

4.13.2 Flue gas thermowell connections 1" NPT (25.4 mm) with plugs shall be installed at the following points:

a) Entrance to convection section

b) Outlet of convection section

c) Between each coil of different services in convection section

d) Each side of air preheater

4.13.3 Provisions shall be made for oxygen analyzer sampling connections at the entrance to convection section and in the flue gas outlet duct.

△1 4.13.4 Sample connections for EPA stack tests shall be provided comprising two 3" flanged connections 90° apart to permit running traverses in two directions. Elevation must be a minimum of two (2) diameters above any flow disturbance in the stack (damper, change in diameter, etc.) and preferably up to eight (8) diameters above such disturbance. The number of samples required per test decrease from forty (40) if samples are taken two (2) diameters above disturbance to twelve (12) if samples are taken eight (8) diamters above disturbances.

Lugs or brackets shall be provided on the stack for the installation of temporary platforms.

△1 4.13.5 Stainless steel Type 18-8 Schedule 80 pipe sleeves will be furnished with all instrument connections installed in refractory surfaces.

4.14 Noise

Heater noise level measurements shall be made at 3'-0" (0.9 meter) from burners, burner plenum intake, and ID or FD fan inlet box.

4.15 Welding

Structural welding shall be in accordance with the requirements of AWS D1.1. Coil welding shall be in accordance with referenced specification.

5. INSPECTION AND TESTING

5.1 General

5.1.1 The Buyer reserves the right to inspect anytime during fabrication. Inspection shall be by the Buyer or his authorized representative.

5.1.2 Full radiography of the alloy steel welds and 100% of 10% of the total number carbon steel welds in pressure service is required. Each weld shall be fully radiographed circumferentially with a minimum of 3 shots per weld.

5.1.3 A hydrostatic test of all shop assembled coils or coil sections in accordance with the applicable Code is required. Water for testing austenitic stainless steels shall have a chloride concentration no greater than 100 ppm. Minimum temperature of water used for hydrotest shall be 60°F (16°C).

5.1.4 The approval or release for shipment by an inspector or representative of the Buyer does not relieve the Seller of any responsibility or of any guarantee.

5.2 Testing

5.2.1 All tests are to be made in the presence of the Buyer's Inspector or authorized representative.

6. EVALUATION

△1

Heaters will be evaluated on an erected basis using the fuel and power value given the Fired Heater Data Sheets. As Built Data Sheets will be supplied to the Buyer.

7. APPROVAL

7.1 Heater design and specifications are subject to the approval of the Buyer.

7.2 Heater proposals shall be accompanied by drawings showing the principal sections of the heater, locations of process stream inlets and outlets, tube support locations (top or bottom) for vertical heaters, estimated weight, and the specifications of critical items of construction.

7.3 Approval by the Buyer or the adoption of changes in design as recommended by the Buyer shall not relieve the Seller of any equipment guarantees.

8. TOOLS

Any special tools required for unheading or plug removal shall be provided. They shall be suitable for use with an air impact wrench.

9. DRAWINGS AND DATA

9.1 The Seller shall furnish completed Fired Heater Data Sheets with his proposal.

9.2 Proposal shall include pressure, temperature, vaporization, and velocity profiles for each coil.

9.3 A flue gas profile will be furnished for the convection section defining temperature entering and leaving a change in the extended surface configuration.

10. SPECIFICATION CHECKLIST

Listed below are possible related specifications to be included with the material requisition:

- Shop Preparation of Equipment
- Steel Stack
- Structural Steel
- Induction Motor
- Steam Turbine
- Painting
- Welding
- Noise
- Carbon Steel Casting
- Stainless Steel Casting

Pumps and
Drivers—G

1. SCOPE

1.1 This specification covers the material and design requirements for centrifugal pumps in petroleum refinery and chemical plant service, but does not apply to sump pumps or vertical submerged lube oil pumps.

1.2 Centrifugal pump data sheets showing rated service conditions, materials of construction, drive characteristics, type of drivers, etc, form a part of this specification. Copies of these data sheets shall be completed for each service by the Seller and returned to the Buyer.

1.3 Except as modified below, all pumps handling hydrocarbons and certain others when indicated on the data sheet, shall be in accordance with the API Standard 610, "Centrifugal Pumps for General Refinery Services". Small low-head pumps handling chemicals or water shall meet the requirements of ANSI Standard B73.1 or B73.2. Larger pumps handling water or chemicals shall be the Seller's most suitable pump-type for the conditions of service.

1.4 Where conflicts occur between this specification and the data sheets, the data sheets shall govern.

2. GENERAL

2.1 When the type is not indicated by the data sheet, preference is for center line mounted water jacketed, verticaly split, refinery type units with a common base plate (channel type preferred). The vertical type may be employed, where it is necessary or desirable to avoid placing pumps in a pit or where special economic or design consideration may dictate its use. Pumps shall be selected to allow maximum interchangeability of spare parts consistent with proper performance characteristics.

2.2 All pumps shall be designed for continuous full-load duty in outdoor service and for operation at standard (60-cycle) electric motor speeds, unless otherwise agreed to by the Buyer. Pumps driven by motors having drooping speed characteristics shall be rated at actual or predicted motor speed for the load conditions, not at motor synchronous speed.

3. DESIGN

3.1 Drivers

3.1.1 Drivers will be furnished and mounted by Buyer unless otherwise noted on the data sheet.

3.1.2 Seller's quotation shall recommend a motor size in accordance with API Standard 610, latest edition. Buyer will make final selection of motor size.

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR2717
GENERAL DESIGN SPECIFICATION
CENTRIFUGAL PUMPS

JOB NO. 14222
SPECIFICATION 14222-G-1
REV 1

3.2 Casings

3.2.1 For pumps of three or more stages and where it is not possible to design the casing for the maximum discharge pressure as defined in Paragraph 4 of API Standard 610, the limiting design conditions shall be so stated. Casing design shall comply with ASME Codes as applicable. (See Paragraph 12a of API-610).

3.2.2 All water-cooled pedestals, bearing housings, and stuffing boxes shall have the water connections so located as to facilitate drainage. Where this is not possible, drain plugs shall be provided.

3.3 Nozzles and Flanges

3.3.1 Suction and discharge connections shall be in accordance with ANSI Standards. When the locations of suction and discharge connections on horizontal centrifugal pumps for hydrocarbon services are not indicated by the data sheets, they shall preferably be at the top of the case.

3.3.2 Bolt holes on all flanges including nozzles, case-to-cover joints, etc, shall be back-faced or spot-faced. Bolt holes shall straddle center lines.

3.4 Impellers and Wear Rings

3.4.1 In general, pumps shall have the characteristics of decreasing head with increasing capacity from shutoff to maximum capacity. However, specific exceptions may be made subject to Buyer's approval, and in the case of transfer and loading where frictional line drop accounts for a major portion of the discharge head, a peaked curve may be permitted. Impellers with pulsating or surging characteristics are not acceptable in any case. Maximum diameter impellers for rated flow conditions shall not be used without specific approval.

3.4.2 It is preferred, where practical, that casing and impeller have replaceable wearing rings (of 12% hardened chrome) on both the front and back side of impellers. They shall be securely locked in place to prevent rotation.

3.5 Bearings

3.5.1 Oil lubricated, anti-friction bearings are preferred for small pumps for all services. Radial and thrust bearings shall be oil lubricated by ring, disc, or flood-oiling systems. An oil reservoir of adequate capacity shall be provided, preferably integral with the bearing housing. For large multistage pumps, the radial and thrust bearings shall be the Seller's standard.

3.6 Pump Packing and Seals

3.6.1 Shaft sealing shall be conventional packing or mechanical seals.

3.6.2 Conventional packing shall be furnished in dirty service, in liquid temperatures over 500°F, or in cases where a mechanical seal cannot be guaranteed. The stuffing boxes shall, when indicated on the data sheet, be designed to permit future installation of mechanical seals.

3.6.3 Where packing is specified, the pumps shall be shipped with temporary flax packing installed and two (2) sets of service packing shall be supplied for field installation.

3.6.4 All pumps handling clean liquids at temperatures below 500°F shall be equipped with mechanical seals provided the seal manufacturer will guarantee the seal for the service. The Seller shall be responsible for obtaining the full guarantee for the seals provided, and shall hold the seal manufacturer to the guarantee.

3.6.5 Outer seal plate shall be provided with connections for quench or vent and drain.

3.7 Couplings

Flexible all-steel couplings shall be provided for horizontal API-610 pumps. Rubber bushing parts are acceptable for horizontal chemical pumps meeting ANSI B73.1 provided that the driver size does not exceed 50 HP. Rigid couplings shall be furnished for vertical pumps, axially adjustable when necessary.

3.8 Coupling Guards

Coupling guards shall meet the requirements of API Standard 610, Paragraph 25f and the Occupational Safety and Health Act (OSHA) of 1970. In addition, they shall be able to support a live load of 200 lbs. (a man's weight) without damage.

3.9 Miscellaneous

3.9.1 Auxiliary Piping

On pumps which require any of the following:

a. Water cooling,
b. Seal piping,
c. Gland oil to lantern rings,
d. Flushing of throat bushings or other clearances,
e. Lube oil piping,

the harness manifolds shall be furnished by the Seller. Piping harnesses shall include all necessary piping, orifices, flow indicators, coolers, strainers, cyclones, gauges, (thermometers on gland oil outlet lines), all suitable for the conditions of service.

3.9.2 Where suction pressure is less than 5 psig, or can fall below 5 psig under any operating condition, a positive pressure in excess of 5 psig must be arranged on the stuffing boxes while the pump is running; but the pressure shall be limited to a value which will prevent excessive leakage.

3.9.3 Rotation of pumps shall preferably be counterclockwise, when viewed from the coupling (driver) end.

4. MATERIALS

4.1 Materials shall be as shown on the data sheet.

4.2 Repairs to castings by welding, or by other means, may be made only on approval of the Buyer's representative. Buyer's approval of welding and inspection procedures used for such repairs shall be obtained before the work is done. Major weld repairs shall be heat treated.

4.3 Unless otherwise specified, shafts shall be of SAE 4140 and shaft sleeves of stainless steel.

5. INSPECTION AND TESTS

5.1 The responsibility for inspection rests with the Seller. However, the Buyer reserves the right to inspect at any time during fabrication. Inspection shall be by the Buyer or his authorized representative. Any inspections made at a sub-seller's plant shall be made after prior notification through the Seller.

5.2 When performance tests are called for on the purchase order or pump data sheet, such tests shall be in accordance with the standards of the Hydraulic Institute for Centrifugal Pumps. The final acceptance of the pump shall be based on field test, handling the specified fluid under specified conditions.

5.3 All pump cases shall be hydrostatically tested in accordance with Paragraph 34 of API Standard 610, except all pumps may be tested to 1-1/2 times the maximum discharge pressure adjusted to 100°F in accordance with the method described in Paragraph 337.4.1, Chapter VI, of the ASA Code for Petroleum Refinery Piping B31.3, latest edition.

5.4 Exception to API-610, Paragraph 35(g) and 10 (d):

In the field, all pumps shall meet the vibration limits specified in Paragraph 10 (d) but, during shop tests, if the vibration exceeds these values, the seller shall either take corrective action and carry out another test run or show, on a basis of experience and judgement, that the predicted field vibration will be within the specified limits.

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
STANDARD SPECIFICATION
GENERAL PURPOSE STEAM TURBINES

JOB NO. 14222

SPECIFICATION	REV
14222-G-2	1

SHEET 1 OF 7

1.0 SCOPE

1.1 General

1.1.1 This specification covers the design conditions, the required mechanical design features and test requirements for General Purpose Steam Turbine Drivers and related auxiliaries listed in this specification.

1.1.2 In case of conflict between this specification and the accompanying documents, the order of precedence is as follows:

Inquiry or purchase order
Data sheets
This specification
API-611
Other Standards

1.1.3 In the event of conflict between these specifications and the equipment being quoted, the Seller shall take a specific exception in writing in his quotation.

1.1.4 Steam turbine data sheets outlining operating conditions, speed control, other conditions, and construction features are a part of this specification and are to be completely filled in and returned with the Seller's proposal.

1.1.5 Terms of measurements are all to be in English units.

1.1.6 Seller is to be aware that there may be a pre-commitment meeting and possibly several design audit meetings.

1.2 Code Considerations

Except as modified by this specification, all steam turbine drivers shall be in accordance with the First Edition of API Standard 611, "General Purpose Steam Turbines for Refinery Services" dated November, 1979. References to API paragraphs herein appear in parentheses.

2.0 DEFINITION OF TERMS

2.1 Throughout this specification, the term "Buyer" shall mean Bechtel and/or their Client, who will be responsible for the overall supervision and installation of the equipment. "Seller" shall mean the bidder, vendor packager, or actual manufacturer of the equipment to be furnished as a result of this inquiry. When referring to steam turbines, terminology from API Standard 611 is used.

2.2 Normal horsepower and speed (Par. 4.a) of the steam turbine is to be the horsepower and speed required by the driven equipment at the "driven equipment rated" conditions. This is the steam rate guarantee point.

2.3 Rated Horsepower (Par. 4.b) of the turbine is to be 110 percent of the horsepower required by the driven equipment at "driven equipment rated" conditions and at rated turbine speed which is to be the same as normal turbine speed, which is the 100 percent or rated driven equipment speed.

2.4 Maximum continuous speed (Par. 4.d) of the turbine shall be 105 percent (minimum) of the rated turbine speed.

2.5 Trip speed (Par.4.f) of the turbine shall be 110 percent (minimum) of the maximum continuous speed.

2.6 Speed range will be specified on the turbine data sheet.

3.0 PROCESS SPECIFICATIONS

The normal horsepower and speed shall be specified by the driven equipment manufacturer for his particular requirementand/or by the "Buyer" on the turbine data sheets.

4.0 BASIC DESIGN

API Standard 611 paragraphs not referenced herein shall either stand as written or are covered in the data sheets.

4.1 General

4.1.1 Winterization provisions (In Par.6.b) shall apply.

4.1.2 The driven equipment manufacturer shall have the primary responsibility for cooedination to ensure compatibility of the steam turbine and driven equipment. The steam turbine seller shall cooperate fully with the driven equipment seller in the supply and/or obtaining of all required information. Included among other data, will be torque, inertia, and start-up requirements of the turbine, coupling requirements, oil pressure, and quantities and location and size of all required connections.

4.1.3 All equipment shall be designed to operate continuously for a period of three years between scheduled shutdowns. A maximum of ruggedness and simplicity shall be incorporated to ensure reliability.

4.1.4 Area Classification is Class 1, Group D, Division 2 as defined in the National Electric Code of the USA unless otherwise indicated on the data sheet.

4.2 Casing

4.2.1 A sentinal warning valve (Par. 4.d) shall be supplied on the turbine casing.

4.2.2 Casing to have the steam exhaust located on the opposite side from the steam inlet.

4.3 External Forces and Moments (Par. 8)

Turbines shall be designed to withstand the following external loadings:

4.3.1 Vertical Component - Combined forces and moments due to all piping connections or to any one piping connection resulting in a vertical reaction (either upward or downward) at any support point of at least one-half the dead weight reaction of the turbine at the support point.

4.3.2 Horizontal Transverse Component - Combined forces and moments due to all piping connections or to any individual piping connection resulting in a horizontal transverse reaction at any support point of at least one-third the total dead weight reaction of the turbine at the support point.

4.3.3 Axial Component - Combined axial forces of all piping connections or axial force of any one piping connection resulting in an axial force on the turbine casing of at least one-sixth the turbine weight.

4.4 Auxiliary Piping

4.4.1 All lube oil and control oil piping (Par. 12.e) shall be of Type 304 stainless steel (including flanges) with the exception that piping stubs welded into steel turbine casings shall be carbon steel to avoid transition welds. Pipe weight shall be Schedule 80 minimum for 1-1/2 in. (38.1 mm) and smaller, and Schedule 40 minimum for 2 in. (50.8 mm) and larger. The use of threaded piping on steel casings is prohibited unless absolutely required. The gas tungsten-arc method using an internal inert gas purge shall be employed for the root pass weld of all butt-welded stainless steel lube and control oil piping.

4.4.2 Valves in these stainless steel lines shall have carbon steel bodies with 11"-13" chrome trim.

4.4.3 Instrument tubing shall be 304 stainless steel.

4.4.4 Tube fittings shall be Imperial Hy-Seal, or other approved compression type fittings.

4.4.5 Drains, including casing drains, shall be piped (Par. 11) to the edge of baseplates and terminate with a blind flanged valve.

4.4.6 All piping removed and shipped separately shall have metal tags attached to identify it to the Seller's drawings.

4.5 Bearings

4.5.1 Antifriction radial bearings (Par. 14.a) are not acceptable for any horsepower rating.

4.5.2 Thrust bearings (Par. 14.6) shall be in accordance with the following:

4.5.2.1 Single stage turbines above 1000 HP shall have pad-type thrust bearings.

4.5.2.2 The maximum actual specific loading of the thrust bearings, either antifriction or pad-type, shall not exceed 50 percent of the bearing manufacturer's rating.

4.6 Gear Units

4.6.1 Separate gears are preferred. Integral gears will be considered for ratings of 100 HP and less if they meet the criteria of Par. 23.c.

4.6.2 Gears shall be rated for operation at the turbines' maximum horsepower.

5.0 MATERIALS

5.1 Repairs to casting by welding or by other means may be made only on approval of the Buyer's representative. Buyer's approval of welding and inspection procedures used for such repairs shall be obtained before the work is done. Major weld repairs shall be heat treated (Par. 7.d).

5.2 All major castings, forgings, or other pressure containing parts shall be suitable for operating conditions specified, and should comply with an appropriate recognized standard (Par. 26.a).

5.3 Steel casings shall receive a stress relief heat treatment after fabrication is complete, before final machining.

5.4 All welds in carbon steel shall be continuous and closed both top and bottom and all sides, leaving no open crevices.

6.0 CONTROLS AND PROTECTIVE DEVICES

6.1 Governors

6.1.1 Oil-type governors are preferred.

6.1.2 Hand speed changer shall be furnished unless a control speed adjustment is specified on the turbine data sheet. If a control speed adjustment is specified, it shall be in accordance with Par. 30.a.

6.2 Hand-operated control valves shall be furnished to allow economical operation at all performance conditions shown on the data sheet. The seller shall select the highest efficiency at the normal condition.

6.3 Turbines with pressure oil systems shall have thermometers in thermowells in each oil outlet.

6.4 When bearing RTDs are specified on the turbine data sheet, the RTD elements shall be embedded in the bearing metal. RTDs shall be furnished in each journal bearing and on both sides of pad-type thrust bearings. Turbine manufacturer is responsible for furnishing and installing the RTDs.

7.0 TESTS AND PREPARATION FOR SHIPMENT

7.1 Quality Surveillance

All equipment and materials furnished under this specification shall be subject to Quality Procedures Specification NI-0003-950-99-901.

7.2 Hydrostatic Tests

7.2.1 Hydrostatic tests shall be in accordance with API 611 (Par. 33.a & b).

7.2.2 Hydrostatic tests shall be maintained for one hour (minimum).

7.3 Mechanical Run Test

7.3.1 All turbines shall be given a no-load running test in accordance with API 611 (Par. 34).

7.3.2 Turbine manufacturer will furnish test data in accordance with API 611 (Par. 36).

7.4 Preparation for Shipment

7.4.1 Equipment shall be adequately protected against entry of dirt or water during shipment. Standard industry practices undertaken by the seller for the protection of this equipment will generally be acceptable. All flanged openings must be sealed with 1/4-inch (or better) thick steel plates held on by at least two bolts and disposable gaskets.

7.4.2 Rust preventative compounds shall be applied internally and externally to all finished surfaces, and elsewhere as deemed necessary to protect metal parts.

7.4.3 The seller shall mark on, or securely attach to the equipment, or enclose in the shipping container, a list of the specific preventatives used to protect his equipment. He shall also include any special instructions he deems necessary to remove or replace any rust preventative, together with any special requirements of his equipment during the period of storage.

7.4.4 All equipment shall have metal tags attached showing equipment purchase order, item number, service.

7.4.5 The equipment shall be painted in accordance with the seller's standard painting procedure, unless otherwise specified.

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ASFI THE BRECKINRIDGE PROJECT AECI

U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717

STANDARD SPECIFICATION

GENERAL: INSTRUMENTATION

JOB NO. 14222

SPECIFICATION	REV
14222-J-1	1

SHEET 1 OF 43

1.0 SCOPE

1.1 Purpose

The purpose of this specification is to define the general requirements for instrumentation and control equipment.

1.2 Definitions

1.2.1 Where reference is made to Owner, it means either Owner or designated Managing Contractor, whichever applies in the situation.

1.2.2 Where reference is made to the Contractor, it means the firm responsible for engineering, procurement, and construction of the plant.

1.2.3 Where reference is made to the Seller, it means the firm selling equipment or materials for use on the project.

1.2.4 Where reference is made to Buyer, it means either Owner or Contractor acting as agent for Owner, whichever is appropriate.

1.3 Deviations

Where deviations occur between this specification and Contractor's final as-purchased instruments, installation drawings, etc., such deviations will represent the special approved requirements for the project. Contractor is responsible for obtaining approval from Owner, and for providing documentation of approval by conference record, letter, etc.

2.0 REFERENCE CODES, STANDARDS, AND SPECIFICATIONS

Note: Codes or standards not specifically referenced in the text may be used for general information as necessary.

2.1 American National Standards Institute (ANSI)

C 39.1 - 1972,	Requirements for Electrical Analog Indicating Instruments
B16 104 - 1976,	Control Valve Seat Leakage
M 96.1-975,	Temperature Measurement Thermocouples

2.2 American Petroleum Institute (API)

RP 520, Recommended Practice for the Design and Installation of Pressure-Relieving Systems in Refineries, Part I-Design, Fourth Edition, 1976 and Part II-Installation, Second Edition, 1963

RP-521-1969, Guide for Pressure Relief and Depressuring Systems

Std 526, Flanged Steel Safety Relief Valves, Second Edition, 1969

STD 527-1967 (ANSI B147.1-1972), Commercial Seat Tightness of Safety Relief Valves with Metal to Metal Seats

RP 550, Manual on Installation of Refinery Instruments and Control Systems, Part I-Process Instrumentation and Control, Second Edition, 1965 and Part II-Process Stream Analyzers Second Edition, 1965

Std. 1101, Measurement of Petroleum Liquid Hydrocarbons by Positive Displacement Meter, 1960.

Std. 2000, Venting of Atmospheric and Low Pressure Storage Tanks, 1973.

Publication 2530, Orifice Metering of Natural Gas, Plasticized, 1976.

Std. 2531, Mechanical Displacement Meter Provers, 1963.

Std. 2534, Measurement of Liquid Hydrocarbons by Turbine Meter Systems, 1970.

2.3 American Society of Mechanical Engineers (ASME)

PTC 19.5, Interim Supplement on Instruments and Apparatus: Application, Part II of Fluid Meters, Sixth Edition, 1971.

ASME Boiler and Pressure Vessel Code, Sections I and VIII.

2.4 Instrument Society of America (ISA)

RP 3.1-1960	Flowmeter Installation Seal and Condensate Chambers
RP 3.2-1978	Flange Mounted Sharp Edged Orifice Plates for Flow Measurement

RP 4.1-1950	Uniform Face to Face Dimensions for Flanged Control Valve Bodies
RP 4.2-1956	Standard Control Valve Manifold Designs (Carbon Steel Valves Only)
S5.1-1973	Instrument Symbols and Identification
S5.2-1976	Binary Logic Diagram for Process Operations
S5.4-1976	Instrument Loop Diagrams
RP 7.1-1956	Pneumatic Control Circuit Pressure Test
S7.3-1956	Quality Standard for Instrument Air
RP12.1-1960	Electrical Instruments in Hazardous Atmospheres
S12.4-1970	Instrument Purging for Reduction of Hazardous Area Classification
RP12.6-1976	Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations
RP18.1-1965	Specifications and Guides for the Use of General Purpose Annunciators
S20-1975	Specification Forms for Process Measurement and Control Instruments
RP31.1-1972	Specification, Installation and Calibration of Turbine Flowmeters.

2.5 National Electrical Manufacturers Association (NEMA)

IS 1.1-1975	Enclosures for Industrial Controls and Systems, 1973

2.6 National Fire Protection Association (NFPA)

No. 70	National Electrical Code, 1978
No. 493	Intrinsically Safe Process Control Equipment for Use in Class I Hazardous Locations, 1969
No. 496	Purged Enclosures for Electrical Equipment, 1974.

2.7 Scientific Apparatus Makers Association (SAMA)

PMC 22-11-1966	Functional Diagramming of Instrument and Control Systems, 1966.
PMC 23-1-1971	Hydrostatic Testing of Control Valves.

2.8 International Organization for Standardization (ISO)

R541-1967	Measurement of Fluid Flow by Means of Orifice Plates and Nozzles.
R781-1968	Measurement of Fluid Flow by Means of Venturi Tubes.

3.0 GENERAL SPECIFICATIONS

3.1 Specification Forms

Instruments will be specified on Contractor's standard forms, or by written description. Instrument data sheets shall be similar in content to ISA S20. Functional specifications may be used for systems in which hardware selection is primarily the responsibility of the system supplier (burner management, CRT display systems, in-line blending, etc.)

3.2 Installation Drawing and Schedules

Contractor will prepare all necessary drawings to show instrument location, piping, wiring, mounting, etc., to insure proper installation. The Instrument Installation Schedule will be used as a master control document with all necessary reference information.

3.3 Loop and Logic Diagrams

Instrument diagrams, showing each component and each connection (electronic or pneumatic) will be prepared by the Contractor. Format and content will be similar to ISA S5.4. Interlock schemes will be shown in logic diagram format. Format in content will be similar to ISA S5.2.

3.4 Instrument Symbols and Numbering

Instruments shall be shown on Contractor's P&ID's in general accordance with ISA S5.1. Special control diagrams such as those described in SAMA:PMC 22-11-1966 may be used with prior approval by the Owner. See Drawings J-G-0101 through J-G-0140.

3.5 Electrical Requirements

All instruments located in the process area will be furnished to meet the electrical classification of that area. Air purging may be used to reduce hazardous area classifications in accordance with ISA S 12.4, and NFPA496. Intrinsically safe systems will be utilized to satisfy hazardous area requirements wherever such systems are readily available. Installation of intrinsically safe instrument systems shall be in accordance with ISA RP12.1 and ISA RP12.6. Intrinsic safety certification shall be by the appropriate agency in the country of manufacture or by the equipment manufacturer in accordance to requirement of the appropriate agency.

3.6 Electronic Requirements

Analog signals from the process units to the central control room will be 4-20 mA current or direct connected thermocouples and RTD elements. Control signals will also be 4-20 mA, converted in the field to 0.2-1.0 kg/cm^2 (3-15 psi) air pressure as required for operation of final control elements. Electronic power supplies for multiple panel instruments shall be sized for at least 125% of the number of instruments. Battery back-up capable of supplying power for at least twenty minutes shall be provided for all control and shutdown systems. Electronic instruments shall be selected and installed such that the electromagnetic interference (EMI), including radio-frequency interference (RFI), normally found in refinery operations does not interfere with their function. All field mounted electronic transmitters will be provided with junction box with test jack.

3.7 Pneumatic Requirements

Pneumatic signal transmission will be 0.2-1.0 kg/cm2 (3-15 psi). Higher pressures may be used for actuating final control elements. Instrument air will be provided at nominal 7 kg/cm2 (100 psig); however, final control element actuators shall be sized for operation at ISA S7.3, Quality Standard for Instrument Air.

3.8 Alarms and Shutdowns

3.8.1 Dedicated alarms (one annunciator point for each alarm) will be provided for critical process measurements. Pre-alarms (variable approaching alarm condition) will be provided for those variables which can be prevented from going out of limits by operator action. Equipment malfunction alarms will be indicated individually on local panel annunciators with trouble and/or shutdown alarms at the operator's console.

3.8.2 Automatic shutdown functions will be provided as necessary to protect equipment from damage. Each shutdown will be provided with a "first-out" type alarm, a maintenance bypass, and if necessary a start-up bypass. Signal lights or alarms will indicate that emergency systems have been bypassed.

3.8.3 Alarm circuits will be normally closed (open to alarm). (Note: "Normally" refers to process conditions, not electrical "shelf" condition.) Alarms may be activated from either a process connected device or from a transmitted signal. Systems designed to shut down complex mechanical equipment, continued operation of which is vital to the process, even during a power outage or loss of instrument air, shall be arranged to do so on high instrument air pressure or through an energized electrical circuit. Loss of instrument air or control power shall not cause a shut down of equipment in this special category.

3.8.4 An alarm hierarchy system will be used to distinguish between critical alarms, which require operator action, and informational alarms, which may only require logging.

3.9 Process Control Functions

3.9.1 Process control functions shall, in general, be performed from the control room. However, local pneumatic controllers may be used on control loops where minimal operator attention is anticipated. Mechanical equipment systems, such as compressors or filters, will have local control panels, with malfunction alarms on the main panel.

3.9.2 The general design philosophy for analog control loops will be to provide capability for implementing advanced control concepts, such as feedforward, adaptive, or optimizing control, wherever significant operational benefits can be demonstrated. These benefits may be improved yield, ease of operation, or reduced utility consumption. Basic control functions may be provided for initial operation, while operating data is developed for use in defining advanced control applications.

3.10 Instrument Maintenance Considerations

Instrumentation systems will be designed or selected, wherever possible, to utilize "plug-in replacement" maintenance techniques, with self-diagnostic features, wherever possible.

3.11 Weatherproofing

All instruments exposed to the weather will be moisture and dustproof with no exchange of atmosphere except in Class 1, Group A,B,C, or D, Division 1 or 2 areas.

4.0 CONTROL ROOMS AND OPERATOR CONSOLES

4.1 General

Control consoles for the process units will be the color CRT type, with trend recorders and alarm loggers. CRT keyboards will provide the operator with setpoint and controller tuning adjustments. Process displays will include plant overview, group displays, and individual loop displays. Input-output multiplexers, power supplies, and other digital electronics will be mounted in racks separate from the consoles.

4.2 Charts and Scales

4.2.1 Measurement units and selection of ranges for charts and scales will be in accordance with Basic Engineering Design Data issued for the project.

4.2.2 Use of dedicated single pen recorders will be limited to the critical parameters for process operation. Multipoint recorders, with appropriate switching capability, may be provided.

4.2.3 Trend recorders will have 0-100 linear charts. All measurement symbols will be linearized for CRT display or trending.

4.2.4 Instrument ranges will be selected to have whole number multipliers. Wherever feasible, there will be only one significant digit other than 0 (i.e., 600, rather than 550). Exceptions may be made for 15, 150, and 1500.

4.3 Consoles

4.3.1 Process unit operator consoles will be at least a dual CRT station with associated keyboards. Use of custom keyboards will be permitted if user definable keys, in addition to standard keys, do not have sufficient flexibility for performing all operator functions defined on the Piping and Instrument Diagrams. The operator console will also contain an alarm annunciator panel for critical alarms and strip chart recorders for trending of process variables. Analog controllers provided as backup for the digital control system may also be located on the operator console.

4.3.2 Three types of CRT displays will be provided. These are overview, group, and detailed. Overview displays will be bar chart type, constructed so that operator attention is directed to more detailed displays which will provide information needed to diagnose and correct the problem. Flashing, reverse video, or color change may be used for this purpose. Group displays may contain graphical presentations, alpha numerics, or a combination of these. Analog group displays, alarm displays, and temperature group displays will be provided in this category. Color graphic displays will be provided to aid the operator in problem diagnosis. Individual loop, or detail displays, will provide the operator with all pertinent information for a single loop, including process data, tuning parameters, and loop configuration data.

5.0 CONSOLE MOUNTED INSTRUMENTS

5.1 Analog Backup Controllers (If Required)

Miniature controllers on control consoles shall be shelf mounted pull-out type with 100mm (4") vertical scale process variable and set point indication, balanceless, bumpless, automatic to manual transfe., and output signal indication. Electrical connection to (rack-mounted) components shall be plug-in cord accessible from the back of the case. Selection of full range or deviation type indication (from the set point) shall be appropriate to the normal operating limits of the process variable. Deviation type shall display 20% minimum of the total range for flow, temperature, or pressure. All other variables shall be limited to full scale type indication.

Controllers shall have a range of proportional band of 2 to 300% minimum and adjustable reset of 0.1 to 25 repeats per minute minimum by appropriate model selection. Controllers used for temperature control and long time constant application shall include derivative action 0.1 to 10 minutes minimum. All electronic controllers shall have a means for switching reset and derivative completely off.

5.2 Trend Recorders

Trend recorders on control consoles will be 3-pen, 100mm (4") vertical chart or horizontal chart. Point selection will be from the operators console. Any analog measurement in the system shall be available for trend recording. A minimum of three 3-pen recorders will be provided. Additional recording capacity will be dependent on the total number of variables.

5.3 Printers

At least two printers shall be provided. One shall be dedicated to alarm logging. The other shall be used for report generation and special printouts.

6.0 LOCAL PANEL INSTRUMENTS

6.1 Indicators

Indicators shall be vertical fixed scale type or they may be 4-1/2 inch diameter receiver gauges.

6.2 Potentiometer-Type Temperature Instruments

Potentiometer-type temperature recorders and indicators will be the null balance type with high impedance amplifier and will have automatic current standardization constant voltage supply, and cold junction compensation located in instrument case. Printing will be with number and dot, or continuous line. Chart speeds and printing speed will be selected to satisfy process requirements. Point selection for indicators will be 1) toggle type DPDT spring return to neutral switches, or 2) interlocked push buttons, or 3) digital keyboard.

6.3 Alarms

Alarms located on local panel will be back lighted windows in a box with flashing sequence and an audible device. Alarm relays and flasher will be hermetically sealed or solid state plug-in circuit board type. Test acknowledge, and reset (when required) push buttons will be provided. All alarm field contacts are to be 24 V DC circuit.

High and low annunciator alarm may be combined in non-critical service when the process variable is indicated on the local panel.

7.0 PRIMARY FLOW DEVICES

7.1 Meter Runs

For piping design purpose, meter runs will conform to Transactions of the ASME, July 1945, page 346, based on orifice to pipe diameter ratio 0.75. Longer meter runs will be provided for custody transfer meters. Minimum size standard meter run diameter will be 2 inch. For meter runs less than 2 inch, calibrated meter runs shall be considered. If necessary, meter run will be increased in diameter in order not to exceed maximum ratio requirement. Weld neck orifice flanges with flange taps to be used for line sizes 12" and smaller. Line sizes 16" and greater, slip on flanges and Vena contracts taps may be used.

7.2 Meter Ranges

Meter ranges will, wherever practical, be 2500mm H_2O (100"). Higher or lower ranges may be used, if required.

7.3 Metering Rangeability for Orifice Type Meters

Metering rangeability shall not exceed 3.5 to 1. Design flow shall be at approximately the mid-point on the chart, which 70% of maximum flow on a square root scale.

7.4 Primary Flow Elements

7.4.1 Concentric Orifice Plate

Concentric orifice plates with flange taps will be used wherever practical. A d/D ratio of .2 to .7 will normally be used. ISO R 541-1967 will be used for guidance in orifice plate flow metering.

7.4.2 Eccentric or Segmental Orifice Plates

Eccentric or Segmental Orifice plates will be used for horizontal orifice runs handling slurries.

7.4.3 Averaging Pitot Tube ("Annubar") or Pitot-Venturi Elements

Averaging Pitot Tube or Pitot-Venturi elements may be used in large diameter lines for clean fluids such as water or air and where the permanent pressure loss through an orifice is uneconomical.

7.4.4 Flow Tubes or Venturis

Flow tubes or venturis of the low permanent pressure loss type will be used on large centrifugal compressor suctions and other services where required. ISO R781-1968 will be used for guidance in Venturi tube flow metering.

7.4.5 Flow Nozzles

Flow nozzles may be used to improve accuracy or protect against erosion, and/or as a substitute for flow tube when economics or installation considerations require.

7.4.6 Magnetic Flowmeters

Magnetic flowmeters will be considered on conductive viscous or slurry streams, and where wide rangeability is required.

7.4.7 Turbine Meters

Turbine meters will be considered for flows of clean low vicosity liquids requiring errors less than 0.25%. API Std. 2534 will be used for guidance in turbine meter applications.

7.4.8 Orifice Plates

Orifice plates will, in general, be per ISA RP 3.2. Plate material will be Type 304 stainless steel (minimum). Plate shall be made of other material if required for corrosion.

7.4.9 Orifice calculations may be made by Contractor or Seller. Instrument sellers of primary flow devices other than orifices will be required to furnish calculations.

7.4.10 Orifice bore shall be rounded to nearest one thousandth of an inch.

8.0 FLOW INSTRUMENTS

8.1 Differential Pressure Transmitters

Differential pressure transmitters may be force balance or strain gauge type. Wetted parts of the bodies will be suitable for the service (316 stainless steel minimum) and will be rated for 70 kg/cm^2 gauge (1000 psig) minimum static pressure. Transmitters will be provided with 1/2 inch NPT process connections, universal pipe mounting bracket and provision for adjustment of range. The differential pressure sensor will be able to withstand over-range pressure, equivalent to the meter body rating. For small flows, the integral orifice type transmitter will be considered. Pneumatic transmitters will have a receiver gauge, and electronic transmitters will have a milliamp indicator, located near the control valve. All differential pressure type flow meters will be the dry type.

8.2 Liquid-Filled Bellows-Type Meters - Local

Liquid filled bellows type meters will have 70 kg/cm^2 gauge (1000 psig) minimum carbon steel body, 316 stainless steel bellows, 1/2 inch NPT process connections, universal pipe mounting bracket. Meters will be able to withstand over-range pressure equivalent to meter body rating. Indicators will have 150mm dials. Recorders will have 12" charts, spring wound chart drive, combination 24-hour or 7-day movement for Division 1 service. Where electric supply is available, chart drive will be electric if area classification permits. Controllers will have 4-position transfer switch.

8.3 Rotameters

Rotameters used in hydrocarbons or hazardous chemical service will be armored variable area, tapered tube, and float type. Float position will be sensed by magnetic coupling. Rotameters will be heat traced, if required. Transmitters will be indicating type with weatherproof case. Other rotameters will be specified of materials suitable for the service. They will be used where liquid being handled or required rangeability in flow, precludes the use of an orifice plate. Utility stream flow under 1-1/2" line size will employ armored type rotameters.

Purge rotameters, equipped with needle valves and differential pressure regulator (where required for process operation), shall be used to measure and regulate purge flows.

8.4 Magnetic Flowmeters

Magnetic flowmeters used on slurry applications will be lined with Teflon, neoprene, or suitable resilient material. Flush electrodes will be used to minimize erosion. The flowmeter will be mounted in an upflow vertical line where possible to minimize sanding. Transmitter is to be separately mounted from the meter and connected using coaxial cable.

Transmitter amplifiers will be indicating type with weatherproof case. Accuracies of ± 1% will be suitable for process control applications; however, accuracies of ± 1/2% are required on applications for mass flow computations.

Magnetic flowmeters will be considered on conductive viscous or slurry streams to decrease erosion of flow elements.

8.5 Turbine Meters

Turbine meters will have stainless steel body and 150 psi ANSI flanges (minimum) with maximum flow pressure drop not more than 0.5 kg/cm^2 (7 psi). Accuracy will be ± .15% of normal flow over rated flow range of at least 10 to 1 for standard meters and 7 to 1 for pipeline meters. Custody meter will incorporate temperature compensation. Electrical transmitters shall provide at least 30,000 pulses per minute at maximum meter flow. Rate of flow indicators, totalizers, and printers will be selected as necessary for each application. Meter provers will be provided as necessary for custody transfer meters.

8.6 Local Flow Indicators

Local indication of flow other than 8.2 & 8.3 will utilize an orifice or other differential device, a pneumatic differential pressure transmitter, and a locally mounted receiver gauge with 0-10 square root scale.

9.0 PRESSURE INSTRUMENTS

9.1 Range and Pressure Element

All pressure instruments will be specified with a range approximately twice operating pressure, except where process conditions dictate otherwise. Pressure element materials will be compatible with any corrosive agents present in the process media being measured. Suppressed range instruments will be required in certain application to improve accuracy and controllability. Bronze elements will not be used in field instruments.

9.2 Viscous and Corrosive Fluids

All instruments used for handling viscous or corrosive materials will be sealed. Seals may be the liquid type employing seal pots, or the chemical type, employing a diaphragm and the pressure element of the instrument. Diaphragm seals are preferred for applications within their temperature limitations. Capillary tubing, if required, will be stainless steel 1/8 inch O.D. and will be protected by a stainless steel spiral wound armor. Temperature limitations on use of diaphragm seals will be specifically considered.

9.3 Transmitters

Transmitters may be strain gauge or force balance type. Process connection will be 1/2 inch NPT and instrument will be equipped with pipe mounting yoke. Blind, narrow span, force balance transmitters may be used for special applications. Pneumatic transmitters will be supplied with air supply gauges. Blind transmitters will be equipped with output indicators.

9.4 Local Pneumatic Recording Controllers

Pneumatic recording controllers will have a minimum of 0-200% proportional band and will have reset action and a 4-position transfer switch. Recorders will have spring wound chart drives, 24-hour or 7-day movement, for Division 1 service and where electric supply is not available. For Division 2 service where electric supply is available, chart drive will be electric.

9.5 Local Pneumatic Indicating Controllers

Local pneumatic indicating controllers of the narrow proportional band type will have 2-position transfer switch and 0-25% proportional band. Controllers requiring wide proportional bands will have a 4-position transfer switch and a minimum 0-200% proportional band with reset action. Mounting will be pipe yoke type.

9.6 Pressure Gauges and Pneumatic Receiver Gauges

9.6.1 Pressure gauges will be 100mm (4") diameter, 1/2 inch NPT bottom connection, plastic, white laminated phenol dials with black graduations cases shall be of polypropylene.

Process gauges will be solid front with filler plug and safety glass; movement rotary geared stainless steel. Accuracy to be ± 1% of full scale. Bourdon tube, socket, and tip will be made of alloys suitable for the specific services. Bronze bourdon tubes shall not be used for process gauges. Liquid fill is preferred for vibration damping.

9.6.2 Receiver gauges will be 100mm (4") diameter, with 1/4 inch NPT back connection, plastic case, and white dial with black graduations. Bourdon tube to be extra wide with brass socket and tip. Movement to be rotary geared stainless steel. Accuracy to be 1/2 of 1% minimum.

9.6.3 Diaphragm seals shall be used where applicable.

9.6.4 Standard ranges for process gauges shall be 30" Hg Vac-0-2.1 kg/cm^{2}g (30" Hg Vac-0-30" psig), 2.1 kg/cm^{2}g (0-30 psig), 7 kg/cm^{2}g (0-100 psig), 0-21 kg/cm^{2}g (0-300 psig), 0-42-kg/cm^{2}g (0-600 psig), 0-70 kg/cm^{2}g (0-1000 psig), 0-105 kg/cm^{2}g (0-1500 psig), and 0-210 kg/cm^{2}g (0-3000 psig).

9.7 Pressure Switches and Differential Pressure Switches

Pressure switches will be DPDT or SPDT with adjustable set-point and fixed or adjustable differential as required, and will be suitable for the electrical classification of the area. Pressure element materials will be suitable for the service.

9.8 Differential Pressure Instruments

Differential pressure transmitters, as defined in Paragraph 8.1, will be employed for all applications within the available range of the type of instrument. Outside of this range, differential pressure instruments will be liquid-filled bellows type with 1000 psi minimum carbon steel body and stainless steel bellows. Indicators will have 150mm (6") round dial. Transmitters may have eccentric scales.

10.0 TEMPERATURE INSTRUMENTS

10.1 Indicating Transmitters - Filled Type

Indicating temperature transmitters will be narrow span, gas or mercury filled, force balance type. Spans of 50,100, or 200 degrees will normally be used for control applications. Bulbs will be stainless steel 1/2 inch diameter maximum, and 150mm (6") maximum length. Capillary will be stainless steel with stainless steel armor cover. Bulbs will have a bendable neck and adjustable union connection. Instruments will have over-range suitable for start-up and shut-down conditions. Bulb type instruments may be used to maximum temperature recommended by manufacturer, in general 420°C to 540°C, (790° to 1000°F).

10.2 Blind Transmitters - Millivolt to Current Type (TC)

Millivolt-to-current blind temperature transmitters will be the electronic thermocouple transducer type which converts a millivolt input signal to a proportionate milliamp d-c signal as required. Cold junction compensation will be incorporated. Narrow span fixed range type with upscale thermocouple burnout feature will be used for control applications.

10.3 Blind Transmitters - Resistance to Current Type (RTD)

Resistance to current blind temperature transmitters will be the electronic resistance transducer type which converts a millivolt input signal to a proportionate milliamp d-c signal as required. Narrow span fixed range type will be used for control applications.

10.4 Local Pneumatic Recording Controllers

Pneumatic recording controllers will conform to Paragraph 9.4. Thermal system may be gas filled or liquid filled type with stainless steel bulb, bendable neck with adjustable union connection, and stainless steel capillary protected with stainless steel armor.

10.5 Local Pneumatic Indicating Controllers

Pneumatic indicating controllers will have 2-position transfer switch and a minimum 0-25% proportional band. Thermal system may be gas-filled or liquid filled type with bulb and capillary as in Paragraph 10.4. Controllers requiring wide proportional bands will have a 4-position transfer switch and a minimum 0-200% proportional band with reset action. Mounting will be pipe yoke type.

10.6 Temperature Switches and Differential Temperature Switches

Temperature switches will be DPDT or SPDT and will be suitable for area electrical classification. Thermal system may be liquid filled with stainless steel bulb, capillary, and armor and will include union connection or bi-metallic switch type or thermocouple relay type. Temperature setting and differential adjustment will be external to switch housing whenever suitable electrical rating can be met.

10.7 Thermowells

Thermowells will be a minimum of 316 stainless steel. Other materials to suit service conditions may be used. Screwed or flanged wells will be provided to suit process considerations, with a minimum of 1" connection for screwed and 1-1/2" connection for flanges. Bore will be as required to accommodate insertion of bulb, thermocouple, or resistance temperature detector with good grounding. Test wells will be equipped with brass plug and chain or other material to suit ambient conditions.

10.8 Dial Type Thermometers

Dial thermometers will be bimetallic, "any-angle" type with 158 mm (6") dials and will be furnished with separable sockets conforming to 10.7.

10.9 Thermocouples

Thermocouples will be copper constantan (T) to 260° C, (500 °F), iron constantan (J) 260-540° C (500°-1000°F), and chromel alumel (K) above this temperature. Thermocouple shall meet special limits of error per ANSI-MC96.1 - 1975.

Thermocouples in general applications are to be encased in ceramic insulating material which is firmly compacted within a metallic sheath. The thermocouple is to be connected to the terminal block in the head using plastic covered interlock armor over the outer jacket of the cable. The cable/armor entrance to the head is to be sealed with a replaceable grommet. A spring shall be located on the thermocouple between the moveable bushing, and the adjustable sleeve.

10.10 Resistance Temperature Detectors (RTD)

Resistance temperature detectors are to be three wire, 100 OHMS with platinum resistance elements to 650°C (1200°F). RTD in general applications are to be encased in ceramic insulating material which is firmly compacted within a metallic sheath. The RTD is to be connected to the terminal block in the head using plastic covered interlock armor over the outer jacket of the cable. The cable/armor entrance to the head is to be sealed with a replaceable grommet. A spring shall be located on the RTD between the movable bushing, and the adjustable sleeve.

10.11 Thermocouples in Temperature Controller Service

In general, panel-mounted temperature controllers will use a dual thermocouple in a single well with one element connected to a multipoint indicator or recorder in the control room and the other to the temperature controller, or its input converter.

10.12 Thermocouples and RTD's in Temperature Recorder Service

All multipoint TR points will terminate at the recorder. Multipoint TI points may be terminated at the indicator or at the input multiplexer for digital systems. Use of junction boxes between primary elements and readout devices is to be minimized.

10.13 Resistance Temperature Detectors in Temperature Controller Service (Special Service)

In general, panel-mounted temperature controllers will use two resistance temperature detectors (RTD) in separate wells. One RTD will be connected to a multi-point indicator or recorder in the control room and the other to the temperature controller, or its input converter.

11.0 LEVEL INSTRUMENTS

11.1 Gauge Glasses

11.1.1 All gauge glasses will be steel armored transparent or reflex type with 3/4" top and bottom connection. Gauge glasses in low temperature, low boiling point service will be large chamber reflex type with 2-inch flange connections. Lucite frost shields will be included and will extend through the gauge glass insulation. All gauge glasses must have a rating equal to the vessel design pressure and temperature and not be equipped with gage valves.

11.1.2 Reflex gauges will be used on all clean services, except liquid level interface. Transparent gauges will be used on acid, caustic, or dirty materials and liquid interface. Suitable shields (mica, etc.) on inner face of gauge will be considered for steam, caustic and other process fluids which may adversely affect glass.

11.1.3 All transparent gauges will be equipped with plastic wedge type illuminators that meet area electrical classification requirements.

11.1.4 Gauge glass and tank connections will be 3/4 inch NPT or 1-1/2" flanged except large chamber type to be 2-inch flanged. Vent and drain connection size will be 1/2-inch NPT.

11.1.5 Gauge glasses will be used in the following visible lengths only: 7-7/8, 12-5/8, 17-1/4, 26-3/4, 40-7/8 and 55 inches, except for large chamber gauge glasses which will be supplied to required single length wherever practical. Gauge columns may be used for multiple gauge installations, and on horizontal drums or exchangers when required for structural support of gauge glass.

11.1.6 Gauge glasses will be selected on the basis of total visible glass length equal to, or greater than, level measurement range.

11.1.7 Pipe columns and column connections to vessels shall be 2" size with 1" balance lines as required. For a two-fluid system, one or more balance lines may be required if the liquid is foaming, stratified, or at a high temperature. For a three-fluid system, a balance line shall be required and so located that the point where it connects to the vessel is covered by the middle fluid for all expected fluctuations of the middle fluid level.

11.1.8 Gauge glasses in services where weld-in installation is required will have a 150mm (6") extension seal welded by the Seller, and cut to fit in the field.

11.2 Float Type Switches

Liquid level switches will have external 500 psig at 100°F (minimum) steel float cages with one-inch NPT connections, stainless steel float and micro or mercury type DPDT or SPDT switch. Electrical requirements shall meet the particular area classification. Mercury switches shall not be used where vibration may occur.

11.3 Displacement Type Controllers and Transmitters

11.3.1 External displacement type level controllers will have fabricated or cast steel float chamber with a minimum of a 2-inch flanged connection. Floats will be stainless steel with K-Monel torque tube. Other materials may be used, if required by service conditions. Controllers will have 0-100% minimum proportional band. Controllers and transmitters will have rotatable head flange if side connections are employed. Top and bottom connected level controllers or transmitters do not require rotatable head flange. Air fin extensions will be provided for all non-condensing vapor services that exceed 200°C (400°F) and all condensing vapor service over 120°C (250°F). The float length is to be selected to take advantage of as much surge capacity as possible. Displacement type will not be used beyond range of 1200mm (48"), unless the use of a differential pressure transmitter present unusual sealing problems.

11.3.2 Controllers will not be located on the same gauge column with gauges and level switches.

11.4 Differential Pressure Level Transmitters

Differential pressure level transmitters will be in accordance with Paragraph 8.1, except that range shall have suppressed zero or elevated zero as required.

11.5 Tank Gauging Systems

Tank gauging systems shall be float type, with 4-20 mA signal of level and temperature to remote readouts in central control rooms. Accuracy shall be ± 0.4cm (level) and ± 2°C (2°F) (temperature) of true measurement.

12.0 ANALYZERS

On-line analyzers will be used for monitoring or control of the process stream composition during operations, and to develop process data for possible future application of compositional process control. Analyzer requirements will be defined on the Process Flow Diagrams.

13.0 RELIEVING DEVICES

13.1 General Requirements

13.1.1 Safety Valves, Relief Valves, Safety Relief Valves and Rupture Disc

All safety valves, relief valves, safety relief valves, and rupture discs shall be sized, selected and manufactured per ASME Section I (Steam) or Section VIII (Pressure Vessels) as applicable.

13.1.2 Venting of Storage Tanks

All atomosphere and low pressure tanks (non-refrigerated) venting devices shall be sized, selected and manufactured per API Standard 2000.

13.1.3 Type of Relieving Devices

Type of relieving devices will be determined by the Contractor.

13.2 Relief Valves

13.2.1 Construction

13.2.1.1 Flanged relief valves will be enclosed spring (except for air and steam) with bolted bonnet, screwed cap, full nozzle type with stainless steel nozzle, disc, guide and spindle, and cast carbon steel bodies. Alloy steel bodies or trim other than stainless steel may be used, if required, for the particular service. Body pressure ratings for all flanged valves shall be the same rating as valve inlet flange. Lightweight bodies will not be acceptable. Area of flange discharge opening shall not be less than four times area of valve seat. Screwed valves may have screwed bonnets and may be used where small orifice areas are required. Screwed valves will not be full-nozzle type. Air and steam flanged relief valves may have an open spring. Carbon steel springs will be supplied for all valves in temperature service 232°C (450°F) and below. Tungsten steel springs will be supplied for valves in service above 232°C (450°F) maximum relieving temperature. Other spring materials may be used, if required, for the particular service.

13.2.1.2 Lifting Levers and Springs

Open lifting levers will be supplied on all valves, used on piping and unfired pressure vessels for steam and air service. No lifting levers are required for process valves.

13.2.1.3 Pressure Balanced Valves

Pressure balanced valves with stainless steel bellows shall conform to Paragraphs 12.2.1.1 and 12.2.1.2. These valves shall be used for varying back pressure applications where the variable superimposed back pressure exceeds 5 percent of the set pressure or built-up back-pressure exceeds 10 percen* of the set pressure of the relief valve.

13.3 Rupture Disc

A rupture disc unit will normally consist of an insert type hold-down and base, disc, vacuum support (when required), and pressure gauge with vent valve when used in conjunction with a relief valve. All rupture disc units will be investigated for proper application and special units will be installed where applicable.

14.0 SOLENOID VALVES

Solenoid-operated valves will be of the continuous duty type equipped with a minimum of a Class B encapsulated coils and will meet the area electrical classification. Solenoid valves requiring manual reset will use a relay and reset button as the preferred arrangement. Mechanical latch type solenoids will be used only with Owner approval or to comply with local regulations pertinent to the project.

15.0 CONTROL VALVES

15.1 Size, Type and Rating - Globe Body Valves

All globe type valves shall be one-inch minimum body size except that 3/4-inch valves may be used for 3/4" line size. Valves 3/4" and smaller shall have connections as specified on the data sheet which shall be in accordance with piping specifications, except that flanges shall be used where piping specification require socket weld. Minimum rating of screwed valves to be 600# . All valves 1" and larger shall be flanged. Rating for steel valves 1" thru 8" shall be 300# ANSI minimum. Cast iron valves 1" thru 8" shall be 250# ANSI minimum rating. Valves 10" and larger shall follow the same rating as block valves of the applicable piping specifications. Material selected for control valve bodies shall be in accordance with that specified in the job piping specifications for flanged block valves except that all valves in flashing water service shall have 1-1/2 CR-1/2 Mo alloy steel bodies. Valve bodies on flashing service shall normally be at least one size larger than trim size.

Three-way valves and soft seat valves may be skirt guided type. Angle valves, split body and one-inch body and smaller size valves may be top guided only. Single seated or unbalanced cage trim valves shall be used where positive shut off is required.

All valves shall have inner valve removable through the top of the valve body. All valves that close on air failure shall be equipped with reverse acting valve actuators. All valves shall have removable seat rings, solid type plugs, and valve travel indicators.

15.2 Valve Selection

15.2.1 General Service

Double-port-top and bottom-guided or balanced-cage trim globe, characterized-ball or eccentric-disc plug valves may be used in general service. The trim shall be replaceable from the top for globe-type valves.

15.2.2 Tight Shut-Off

Single-port, unbalanced quick-change or cage-trim globe, or characterized-ball valves shall be used for tight shut-off. The trim shall be replaceable from top for globe-type valves.

15.2.3 Positive Shut-Off

Valves with soft seats may be used within the limitations of the seating material for positive shut-off. The trim shall be replaceable from the top of the globe type valves.

15.2.4 High Capacity - Low Operating ΔP

Butterfly valves shall be considered in sizes 4" or larger for high capacity low operating ΔP. They should be wafer type with metal-to-metal or soft lined or soft seated. Butterfly valve designs for low leakage, superior flow characteristic or high temperature shall be considered with due consideration to the limitations of high recovery valve designs during the selection of the valve.

15.2.5 High Capacity - Moderate Operation ΔP

Characterized ball valve shall be considered in sizes 3" or larger with due consideration to the limitations of high recovery valve designs. Ball valves should be considered for wide rangeability applications. The valve shall be flangeless body with line flange studs to be furnished with the valve body.

15.2.6 Mixing, Splitting or Diverting

15.2.6.1 Three-way valve body shall be used through 6" size for the following service:

(1) Quick opening plug for mixing, (blending), or diverting (change of direction) flow. The body is to be a modified single port design for mixing and a double port for blending.

(2) Characterized plug for splitting flow. The summation of plug port areas must remain nearly constant throughout valve travel. The body is to be modified double port design.

15.2.6.2 Assembly on a tee of two butterfly valves with one actuator may be considered in 8" or larger size. The two butterfly valves with individual actuators may be used if application dictates, such as:

(1) Valves widely separated.

(2) Use of linkage is inadvisable due to weather or possibility of damage.

(3) Need for use of different flow characteristics in each valve.

(4) Requirement for fairly constant total flow.

15.2.6.3 Three-way plug or ball valves should be considered for diverting service.

15.2.7 Potential Cavitating, Flashing, High Noise Level, Cryogenic or Errosive Service

15.2.7.1 The valves should be selected that are particularly designed for these services. Valves using frictional paths, multiple port cages, vortex flow or other methods of velocity and noise control, shall be considered.

15.2.7.2 Valves which cannot conform to these requirements for economic or mechanical reasons shall be considered individually based upon the following approaches:

(1) Reappraisal of operating conditions.

(2) Use of piping configurations conducive to minimizing noise warrant special consideration.

(3) Reappraisal of necessity for minimizing noise from the stand-point of geographical location, frequency and length of operating cycle effect upon personnel.

15.3 Actuators

15.3.1 General

Spring opposed pneumatic diaphragm or spring or pneumatically opposed piston actuators shall be first choice for an actuator. Dually loaded pneumatic or hydraulic piston, electric or other actuators are only to be used when service or valve design dictates.

15.3.2 Application of Diaphragm and Piston Actuators

15.3.2.1 Diaphragm actuators shall be used on any valve which may be positioned by a spring opposed diaphragm actuator with a 1419 sq. cm. (220 sq. in.) diaphragm or less using a

1.4 kg/cm2g (20 psig) (preferable) supply or 2.45 kg/cm2g (35 psig) if required.

15.3.2.2 Piston actuators shall be used on any valve which may be positioned by a pneumatically opposed actuator with a 1419 sq. cm. (220 sq. in.) piston or less using the recommended supply pressure up to 7 kg/cm2g (100 psig).

15.3.3 Construction of Diaphragm Actuators

15.3.3.1 Yoke shall be made of cast or ductile iron.

15.3.3.2 Diaphragm cases shall be bolted pressed steel.

15.3.3.3 Diaphragm shall be nylon reinforced neoprene or Buna N. Maximum allowable deviation from rated effective area is ± 15% through entire travel.

15.3.3.4 Actuator-valve stem connection shall be a bolted-threaded split clamp.

15.3.3.5 The fail position of a valve shall be "Fail Open", "Fail Closed", "Fail Locked" or "Fail Indeterminate". Actuator failure mode must accomplish the valve positions. Where "Fail Locked" position is selected the valve action in case of signal failure shall be specified.

15.3.3.6 Valve position shall be indicated on a scale on the actuator yoke or by marking on the end of the stem of a rotary type valve.

15.3.4 Dual Loaded Piston

15.3.4.1 Dual loaded piston actuators may be used when they are an integral part of the valve design.

15.3.4.2 Dual loaded piston actuators may be used for high force output.

15.3.4.3 Construction of a Dual Loaded Piston.

(1) Yoke (where required) shall be cast or ductile iron.

(2) Actuator shall be designed for low shaft and piston friction and low leakage by the piston.

(3) Piston actuators are to be sized to supply the specified force using no more than 5.6 kg/cm2g (80 psig) air, but must be suitable for pressures up to 8.75 kg/cm2g (125 psig).

(4) Failure modes shall be the same as 15.3.3.5. Capacity tanks and valves shall be mounted on the actuator and piped by the manufacturer.

15.3.5 Actuators (piston and diaphragm) shall be sized for positioning the inner valve against 1.25 times the maximum differential pressure that may develop under normal or start-up operation.

15.3.6 Electrically powered actuators will be selected for service and specified on the data sheet. The actuator must conform to the electrical area classification as shown on the data sheet.

15.3.7 The Seller is to provide to the Buyer sizing data and methods for sizing all actuator.

15.4 Valve Trim Selection

15.4.1 Material and Application

15.4.1.1 Shut-off P Determination

The maximum shut-off pressure will be considered rather than the maximum operating P for trim selection and actuator sizing.

15.4.1.2 Material Determination

All valve trim material shall be selected from the published tables of the specific valve seller. In cases where the table does not provide adequate information, valve trim shall be determined with the specific valve seller.

15.4.1.3 Reduction in Trim Size

Trim reduction shall not normally be more than two port sizes except in a 1" valve. If velocity considerations require a larger body, a check of the ability of the body design to allow further reduction should be made.

15.5 Valve Fail Position

The required fail position of a valve shall be determined by analysis of the process.

15.6 Positioners

15.6.1 Positioners may be force or motion balance type.

15.6.2 All pneumatic positioners are to be furnished with three gauges and bypass valve except the bypass valve is to be omitted on all split range or 0.4 to 2.0 kg/cm^2 (6 to 30 psi) output positioners.

15.6.3 Electro-pneumatic positioners are to be weatherproof and suitable for the electrical area classification.

15.6.4 Valve positioners shall be furnished on diaphragm or piston actuators for the following functions:

15.6.4.1 To obtain split range from the output pressure of a controller or an electro-pneumatic transducer. Three way split is <u>not</u> recommended without pneumatic relays.

15.6.4.2 To amplify or convert to a required actuator pressure if a booster relay is not applicable.

15.6.4.3 To change the effective flow characteristic of a control valve. Positioner must be the cam type for this service.

15.6.4.4 To position a springless piston or diaphragm actuator.

15.6.4.5 To position a valve in which a large unbalanced force exists. For pressure differential greater than 14 kg/cm2 200 psi).

15.6.4.6 On temperature control valves, except "On-Off" service.

15.6.4.7 On level control valves.

15.6.5 Valve positioners shall be considered on diaphragm or piston actuators under the following operating conditions:

15.6.5.1 On pressure control or a low pressure, large volume gas system.

15.6.6 Use of volume boosters and ratio or bias relays will accomplish some of the functions of a positioner and should be considered.

15.6.7 Positioners are not to be used on most fast control loops such as flow or liquid pressure.

15.6.8 A pneumatic positioner with separate I/P transducer is used in electronic control loops in 15.6.4 and 15.6.5 where vibration is a known problem and will be specified on the data sheet.

15.6.9 An electro-pneumatic positioner is used in pneumatic control loops as indicated in 15.6.4 and 15.6.5 unless vibration is a known problem.

15.6.10 Mounting & Tubing

All positioners shall be side-mounted on diaphragm actuators and may be top-mounted on a piston actuator.

15.7 Valve Accessories

15.7.1 Pneumatic Relays

Pneumatic relays will be mounted on the valve by the Seller.

15.7.2 Tubing and Tube Fittings

Instrument air tubing will be polyvinyl covered copper.

Process tubing will be 316 stainless steel.

Brass fitting will be used with copper tubing and stainless fittings with stainless steel tubing. All copper bearing alloy fittings shall be vinyl coated.

15.7.3 Extension Bonnets

Extension bonnets shall be used on all valves handling material between 232°C and 538°C (450°F and 1000°F), and 0°C (32°F) and below service. The valve supplier will be consulted for valve handling material above 1000°F.

15.7.4 Bellows Seal Bonnets

Bellows seal bonnets are to be used to prevent leakage along the valve stem and out of the packing box. The valve supplier will be consulted for the bellow seal pressure-temperature ratings.

15.7.5 Construction and Packing

Valve bonnet and blind flange shall be the bolted type with retained type gaskets and of the same material as the body. Gaskets shall be corrugated 316 SS unless otherwise specified. Stuffing boxes shall be the bolted gland type. Valve packing material shall normally be Teflon packing for all valves handling fluids at temperatures to 232°C (450°F). Packing for temperatures above 232°C (450°F) shall be Durametallic packing equipped with silicone grease lubricators and isolating valves or recommended packing for the service. All valve stems shall be finished to 2 micro-inches RMS. Stems for valves employing Durametallic packing shall be hard chrome plated. Valve stem shall be threaded and pinned to the valve plug and its connection to the diaphragm stem shall be adjustable, with positive locking of the adjustment.

15.7.6 Handwheels and Limit Stops

Handwheels, where specified, shall be top mounted (where possible) or shall be of the side mounted continously connected type with provisions for limiting valve travel at the top or bottom portion of the valve stroke. Where a limit stop only is required, the valve shall be equipped with a handjack. Handwheels for butterfly valve shall be mounted on the valve shaft, and shall include a clutching and declutching arrangement.

15.8 Angle Valves

Specifications for angle valves shall conform where applicable to Paragraph 15. Construction of the top guide of the valve stem shall be of the heavy duty, long sleeve type.

15.9 Hand Control Valves

Hand operated control valves may be selected for applications where operating conditions and cost do not warrant instrument operation. These valves shall have high lifts, fine threads, travel indicator and scale, and characterized valve plug. If noncritical control of flow is required standard piping specification type globe valves may be used.

15.10 Butterfly Valves

Control valves 2" and larger where tight shutoff is not required and with pressure drops that do not exceed the butterfly design limitations (check with Seller) may be butterfly valves. For handwheels, see Paragraph 15.7.9. All application for butterfly valves requiring tight shut-off will be specially considered. Valve manufacturer will check the butterfly valves on liquid service and state the minimum recommended closing time to avoid possible water hammer damage. Butterfly valves shall be heavy pattern type with outboard bearings. Valve operators may be the piston operating type to provide higher torque if necessary.

15.11 Cage Valves

Cage valves shall have sleeve assembly with equal percentage or linear characteristics. The valve shall have a slip-in cage with integral seating surfaces. Gaskets will be standard in both the balanced and unbalanced seated versions.

15.12 Ball Valves

Ball valves shall be of the "Full-Port-Flow" type with downstream seal and shall include a floating ball with slotted stem-to-bail connection, non-rising blow-out proof stem and reinforced Teflon stem seals with external spring loading for automatic wear compensation. Secondary metal seats for fire-safe operation may be required.

15.13 Eccentric Disc Plug Valves

Eccentric disc plug valve shall have an eccentric mounted rotating plug with upstream disc plug seal, valve shaft with bearings and packing.

15.14 Block and By-Pass Manifolds

15.14.1 The use of block and by-pass valves shall be determined by P&ID review.

15.14.2 Block and by-pass valves shall be provided for the following conditions:

15.14.2.1 Steam reducing stations (main headers).

15.14.2.2 All valves where inability to operate would endanger plant equipment and personnel.

15.14.2.3 Critical service where shutdown cannot be tolerated.

15.14.2.4 Control valves, 2 inch port size and smaller.

15.14.3 Block and by-pass valves shall generally not be provided for the following conditions:

15.14.3.1 Control valves in emergency or intermittent service, such as steam control valves for standby turbine-driven pumps or generators, dump valves, (but not steam reducing stations).

15.14.3.2 Systems operating in parallel, where the shutdown of one or more streams is tolerable.

15.14.3.3 Where shutdown of side stream processing facilities may be tolerated or where temporary elimination of a process step may be tolerated.

15.14.3.4 Designs where process time constants make operation under manual control impractical for period required to replace or repair control valve, such as reboiler heat sources, etc.

15.14.3.5 Where three-way valves are used.

15.14.3.6 For high pressure hydrogen content service.

15.15 Manual Operation

15.15.1 Application

Where local manual control appears necessary for operating continuity, a manual operator shall be specified for all control valves that do not have block and by-passes.

15.15.2 Top or Side Mounted Handwheel

The handwheel may also be used for diaphragm valves to limit travel.

15.16 Determination of Valve Characteristic

The guidelines for the use of equal percentage (=%) or linear valve characteristics are given in the following table:

Applications (Factor Controlled) Signal	% of System Drop Across Valve	Valve Characteristics
1. Flow sq. rt.	<20%	=%
2. Flow-linear	<40%	=%
3. Flow sq. rt.	>20%	linear
4. Flow-linear	>40%	linear
5. Pressure	100%	linear
6. Pressure	<20%	=%
7. Liquid Level	<40%	=%
8. Liquid Level	>40%	linear
9. pH	<50%	=%
10. pH	>50%	linear
11. Temperature	>50%	=%

Quick Opening valve characteristic is to be used for OFF-ON service where water hammer effect is not significant.

15.17 Determination of Valve Size

15.17.1 Control valves will be sized from the latest data available from process flow diagrams, hydraulic calculation sheets, line designation tables and other sources. The sizing and selection of control valves shall be checked by the Seller.

15.17.2 Valve Sizing

15.17.2.1 All valves with linear flow characteristics will be sized on the basis of normal flow not exceeding 75% of valve capacity.

15.17.2.2 All valves with equal percentage flow characteristics will be sized on the basis of normal flow not exceeding 65% of capacity.

15.17.2.3 Where only maximum flow is known, 90% of capacity will be used for sizing valves mentioned in the above paragraphs.

15.17.2.4 All butterfly valves shall be sized so that design flow rate does not require a valve disc opening greater than 60° for all valves in throttling service. Ninety degrees (90°) opening is permissible for valves in on/off service.

15.17.2.5 All control valves shall be sized using the method recommended by the specific valve seller.

15.17.2.6 All valves will be checked for cavitation and flashing using the method recommended by the specific valve Seller.

15.17.2.7 All valves will be designed to meet a maximum noise level or 85dba at 910mm (3 ft) distance. Noise prediction methods shall be those recommended by the specific valve Seller.

15.17.3 Generally, piping, pumps and equipment will be sized to allow the control valve to absorb at least thirty percent (30%) of the system friction loss (not including valve) at the normal operating design flow rate.

15.17.4 Differential pressure for sizing should normally not be less than 1 kg/cm2 (15 psi). If the system cannot permit more than 1 kg/cm2 drop through the valve, a ball, butterfly or eccentric disc plug valve should be considered.

15.17.5 There are some applications where the basic "30% rule" will not apply, namely:

(1) Where the drop is predetermined by process conditions (i.e., pressure letdown service, pressure systems discharging to atmosphere, pressure reducing systems).

(2) When the piping in a system is very long, unusually high frictional losses, etc., under which circumstances the drop assigned to the valve may be reduced to

approximately 15% to 20% of friction losses not including valve, depending on the particular system conditions.

(3) Where the expected static pressure variations and system contingencies indicate special consideration.

(4) Boiler feedwater valves normally require about 5% of the relief valve set pressure as a minimum drop under relieving conditions.

15.18 Regulators

Use of a self-contained or pilot operated regulator should be considered under the following operating conditions:

15.18.1 The variable is pressure, level or temperature.

15.18.2 The variable may be directly sensed by the regulator or pilot.

15.18.3 Operating conditions do not require variable proportional band, automatic reset and/or derivative action.

16.0 INSTRUMENT MOUNTING AND LOCATION

16.1 All field instruments will be mounted at grade, or platform. Force balance flow transmitters will be line-mounted, wherever possible, except in cases where the line suffers vibration, in which case the transmitter will be mounted off-line. All the field instruments will be accessible, from grade or platform, or if this is not possible, from a portable ladder, in which case the bottom of the orifice run shall not be more than 3.7m (12 ft) above grade. Level instruments on vessels may be accessible from vessel ladders only where platform access would require a separate platform.

16.2 Orifice runs for field-mounted recorders and indicators will be minimum of 2.4m (8ft) above grade.

16.3 All field-mounted indicating or recording instruments will be mounted so that chart or scale is 1.4m (5') above grade or platform and will be located as close to primary connection as possible consistent with instrument accessibility.

16.4 All instruments in steam, liquid, liquid sealed, and condensible hydrocarbon service, will be located below their process connection point and connections will slope down to instrument 6.35mm per 300mm (1/4-inch per foot) minimum, wherever practicable. Close coupled pressure gauges will be mounted above the process connection.

Instrument in dry gas services may be located either above or below their process connection point.

16.5 Dial thermometers, pressure gauges, thermowells, etc., that are line-mounted, will be plainly visible and accessible from grade or platform. Where excessive vibration of line or equipment is present, instrument will be separately mounted.

17.0 PRIMARY INSTRUMENT CONNECTIONS

17.1 General

17.1.1 All primary instrument connections will be shown on area piping drawings. Where piping specifications allow screwed or socket weld fittings, a 3000# minimum F.S. coupling will be used for pressure, differential pressure, level switches, and gauge glasses where a single gauge is required. Size of coupling or flange for these services will be per Basic Engineering Design Data.

All temperature points on process lines will be 1" NPT screwed or 1-1/2" flanged as shown on the individual piping specification drawings.

17.1.2 Primary Connections Nipple and Block Valve

Primary connection nipple will be Schedule 80 seamless steel minimum.

Block valves will be in accordance with individual piping specifications. Where piping specifications require socket weld block valves a F.S. adapter POE-TOE female will be socket welded to downstream side of valve. Size of nipple and block valve will be:

a.	Pressure and differential pressure	3/4" x 1/2" Swage nipple and 1/2" valve
b.	Pressure test point	3/4" x 1/2" Swage nipple and 1/2" valve and plug
c.	Temperature	Per Piping Specification
d.	Level switch	1" nipple and 1" valve
e.	Single gauge glass	3/4" nipple
f.	2 or more gauge glass on Strongback	3/4" nipple
g.	Flow instruments	1/2" nipples and valves

17.1.3 Orifice Tap Orientation

Orifice taps will be horizontal except for gas or gas with a slight amount of entrained liquid. Where vertical orifice runs are used, the measured material should flow upward.

18.0 INSTRUMENT PROCESS PIPING

18.1 Valves

All valves, following the primary block valve, used for instrument piping, will be in accordance with an instrument piping specification to be prepared by the Contractor. All conventional primary valves will be according to individual piping specifications.

18.2 Pipe, Tubing and Fittings

18.2.1 All process instrument piping, where pipe is required for meter manifolds will be Schedule 80 seamless steel and 3000# F.S. fittings minimum.

18.2.2 All other process instrument piping will consist of a minimum of 1/2" O.D. x 0.035" wall fully annealed stainless steel tubing. Tubing fittings will be of the compression type. Suitable alloys will be used where required for corrosion.

18.2.3 Piping for d/P line-mounted flow transmitters will be with 3 valves including orifice valves and equalizing valve. Meter piping for remote-mounted flow instruments, in addition to the orifice valves, will include a minimum of 2 block valves and a by-pass.

18.2.4 Direct connected pressure gauges and switches will have 1/2" vent or drain valves, as required by service. Pigtail syphons will be used on all steam service.

18.2.5 Remote-mounted pressure instruments will have block valve and vent or drain plug at instrument.

18.2.6 Level instruments will have vent plug and drain valves.

18.2.7 Single gauge glasses will have drain valve and plugged vent conection. Multiple gauge glass assemblies on strongback will have 1/2-inch vent and drain valves on strongback.

19.0 INSTRUMENT AIR SUPPLY

19.1 Instrument air supply headers and branches will be in accordance with the applicable piping specification. A 1/2 inch valve will be provided at the end of each air supply header and branch.

19.2 Air supply connections to individual instruments will be 1/2 inch pipe size with 1/2 inch block valve at air header and 1/4 inch gate valve at supply side of instrument filter regulator. Connections from instrument filter regulator to instrument will be with pneumatic tubing, as specified in Paragraph 20.1.

20.0 PNEUMATIC TUBING (Field)

20.1 Individual pneumatic tubing will be 1/4 inch O/D. x .030 inch wall spray coated or polyvinyl covered copper tubing routed in 3/4" conduit or U-channel support and terminated in a junction box.

20.2 Major instrument tubing runs will employ multi-tube bundles consisting of 4, 7, 12, or 19 multiple high density polyethylene tubes 1/4 inch O.D. x .040 inch wall thickness contained in an extruded vinyl sheath (3/16 inch minimum), with asbestos layer and vinyl jacket. Each tubing bundle will contain a pair of 22 gauge telephone wires. All tubing bundles will contain approximately 14 percent spare leads for future use. Fittings for joining polyethylene tubes will be special finger tightening type with tube support and polyethylene sleeve.

Appropriate unions will be used for joining polyethylene tubing to metal tubing.

20.3 All tubing bundle transitions from large to smaller size bundles or to individual leads will be made by using weatherproof steel junction boxes. Individual leads emanating from junction boxes will employ bulkhead tubing fittings installed in the junction box wall.

20.4 Tubing bundle runs into individual areas may also terminate in junction boxes suitably located. Individual leads will be handled as above.

20.5 Cable trays for multi-tube bundle are to be galvanized steel, with ladder rung or expanded metal bottom.

20.6 Fittings for plastic or copper tubing will be of the brass compression type with inserts (where required).

20.7 All instrument filter regulators that supply instruments that do not have an air supply gauge will be equipped with a 51mm (2-inch) gauge. Each field-mounted instrument that requires air will have a combination air filter regulator.

20.8 Where conduit is used to route instrument tubing, the conduit shall contain tubing only. Electrical wiring shall run in separate conduit.

20.9 All pneumatic transmitter output tubing will be provided with a plugged tee for installation of a calibrating pressure gauge.

21.0 INSTRUMENT AND PIPING SUPPORTS

21.1 All instruments will be adequately supported to insure proper operation. Where pipe stanchion supports are required, they will be 2-inch, Schedule 40 pipe. Where fittings are required, they will be 150# M.l.

21.2 All instrument leads to vessels, leads, or equipment will be properly supported to relieve strain on connections at equipment and instrument. Care shall be taken to avoid anchoring of these leads to "moving" structures or piping such as expanding or hot piping systems.

21.3 Method and location of mounting shall particularly avoid subjecting instrument to vibration. Flexible tubing and conduit connection may be required and will be considered on an individual instrument basis.

22.0 CALIBRATION, TESTING, AND INSPECTION

Requirements for instrument calibration, testing, and inspection are outlined in Drawing J-9-0105 (to be provided during Phase 1).

23.0 REFERENCE DRAWINGS

J-G-0101	Instrument Identification	Refer to Specification 14222-A-1, Basic Instruction for P&ID Development.
J-G-0103	Instrumentation P&ID Symbols	
J-G-0104	Instrumentation P&ID Symbols Typical	

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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL DESIGN SPECIFICATION
INSTRUMENT WINTERIZATION AND WEATHER PROTECTION

JOB NO. 14222
SPECIFICATION 14222-J-2
REV 1

SHEET 1 OF 13

1. SCOPE

1.1 This specification establishes the winterization required to keep instruments operating during cold weather, and to protect instruments prior to start-up. This specification also establishes the weather protection required to keep instruments operating during snow, rain, and high winds.

2. GENERAL REQUIREMENTS

2.1 Winterization for Continuous Operation

The winterization method selected shall insure continued reliable operation of each instrument at minimum design temperature.

2.2 Weather Protection

All outdoor instrumentation shall be weather protected to ensure no instrument damage and continued reliable operation during rain or snow driven at maximum wind velocity.

2.3 Instrument Air

Instrument air will not require winterization. It is to be dried to a dew point below minimum ambient temperature.

2.4 Design Meteorological Conditions

See Specification 14222-A-3, Basic Engineering Data.

3. INSTRUMENT WINTERIZATION REQUIREMENTS

3.1 General

In general, some outdoor mounted transmitters, recorders, and controllers will require protection by heated instrument enclosure. Specific requirements are given in this section. The winterization method selected, along with winterization design details, for each individual instrument winterized, is given on instrument installation schedules.

3.2 Indoor Installation

Instruments may be installed in control rooms, heated buildings, heated equipment enclosures, etc., to simplify winterization, weather protection, and servicing.

3.3 Minimum Temperatures

3.3.1 Instruments

When in operation each instrument is to be maintained at or above its minimum operating temperature as listed on the P&ID's. (see instrument winterizing code legend on P&ID)

3.3.2 Water Containing Fluids

All instrument bodies and instrument process lines that contain water, or a fluid that could contain water, including all hydrocarbons, under normal or upset conditions, shall be maintained at +40°F or above.

3.3.3 All process fluids in instrument bodies or instrument process lines shall be maintained at or above the holding temperature listed on the P&ID's.(see instrument winterizing code legend on P&ID)

3.3.4 Process Purge Fluids

All process purge fluids shall be maintained 5°F or more above their respective, freezing points, at operating pressure.

3.3.5 Walk-In Housings

Walk-in housings shall be heated to a minimum of +50°F.

3.4 Maximum Temperature

3.4.1 Instruments

No instrument is to be heated above its maximum operating temperature.

3.4.2 Boiling

No process liquid in any instrument process line or analyzer sample line shall be heated above its boiling point or bubble point at system pressure.

3.4.3 Electric Heat Tracing (Only special applications)

Electric heat tracings, especially those with plastic or elastomer insulations, can be overheated. If process temperatures are above the maximum electric heat tracer operating temperature, provision must be made to avoid overheating the electric heat tracer.

3.5 Instrument Enclosures

Instruments installed outdoors normally shall be installed in instrument enclosures in all of the following cases:

3.5.1 The instrument case is not weatherproof.

3.5.2 The instrument must be maintained above minimum ambient temperature and indirect heating is not feasible or permitted.

3.6 Walk-in Housings

Instruments installed outdoors shall be considered for installation in walk-in housings in all the following cases:

3.6.1 All on-line analyzers.

3.6.2 Large, complex instrumentation systems, or complex manifolds that are too large to fit into instrument enclosures.

3.3.3 Where instrument temperature must be maintained above ambient to avoid freezing, to insure accurate and reliable operation, or to insure accuracy during calibration and testing.

3.6.4 Where personnel protection from the weather is needed during maintenance of complex instrumentation systems.

3.6.5 **Remote multiplexing stations.**

3.7 Instrument Process Lines

General preference guidelines for winterizing instrument process lines are:

3.7.1 Diaphragm or bellows seals with liquid filled tubing or capillary systems.
3.7.2 **Steam tracing.**
3.7.3 Electric heat tracing.

3.7.4 Liquid filled open seals.

3.7.5 Purging (keep applications to a minimum).

3.8 Specific Design Considerations

3.8.1 Analytical Instruments

Sample lines shall be winterized as needed to prevent condensation, freezing or excessive viscosity. The method selected will depend on the specific application.

3.8.2 Control Valves

Control valve bodies are to be insulated, and heat traced with the associated process line heat tracer.

3.8.3 Diaphragm or Bellows Seals

Diaphragm or bellows seals are preferentially mounted as close to the process line or vessel as feasible, and heat traced with the process heat tracer if required. Temperature limitations of the diaphragm or bellows seals are to be checked against maximum process temperature and maximum tracer temperature.

3.8.4 Direct Heating

Direct heating, see section 4.3, is the preferred method for winterizing control valve bodies, level gauges, displacement type level instruments, and float type level switches. Displacement type level instruments and float type level switches shall be preferentially electric traced. If the process temperature exceeds the temperature limit of the electric heat tracing, steam tracing shall be used.

3.8.5 D/P Instruments

Care must be taken in design to ensure that both instrument process lines of D/P instruments are heated to the same temperature to avoid errors caused by density differences. This is especially important for long instrument process lines and narrow ranges. Diaphragm or bellows seals are not to be used on D/P flow transmitters.

3.8.6 Flow Meters

Orifice impulse lines to the D/P instrument which requires tracing are to be traced bundles to assure that both lines are heated to the same temperature.

3.8.7 Liquid Level Gauges

Electric heating is preferred for heating liquid level gauges.

3.8.8 Pressure Gauges

Pressure gauges on steam lines outdoors shall be winterized and pressure gauges on water service outdoors are to be winterized using diaphragm seals. See paragraph 3.8.3.

3.8.9 Thermowells

Test wells and thermowells with the element removed shall be sealed with a threaded plug treated with thread compound.

4. WINTERIZATION AND WEATHER PROTECTION METHODS

4.1 General

A variety of different winterization and weather protection methods are needed for instruments, depending upon the particular application. Design specifications for each method are given in this section.

4.2 Unprotected Operation

Some instruments for outdoor installation are available with weatherproof cases and operate satisfactorily between minimum and maximum ambient temperature. Examples would be a dial thermometer and some temperature transmitters. These instruments do not require winterization or weather protection.

4.3 Direct Heating

4.3.1 General

In some cases, instruments can be directly heated with heat tracing, jacketing, etc. In these cases, heated instrument enclosures or walk-in housings will not be needed.

4.3.2 Process Tracer Heating

Instruments and associated piping that are mounted in or on process lines may be heated with the process heat tracing. Typical examples are root valves and control valve bodies. Vessel mounted level instruments may be traced from the vessel trace supply. Each such design shall be reviewed to ensure that the maximum operating temperature limitation of the instrument is not exceeded.

4.3.3 Removable Insulation

If direct heating is used, insulation shall be molded to fit the instrument and clamped over the heat tracing. Openings shall be left for viewing and adjustment. See paragraph 4.10.7.

4.4 Instrument Enclosures

4.4.1 General

Instrument enclosures are small housings designed to shelter a single instrument and its accessores. Access is through a door, or doors, or a removable cover.

4.4.2 Heating

Electric heating is to be used in instrument enclosures. Heating may not be required in all cases.

4.4.3 Windows

If the enclosed instrument has recorder charts, indicators, or gauges that must be read for operating convenience, a weatherproof window is to be installed in a location that permits easy viewing.

4.4.4 Instrument Accessibility

Instruments protected by enclosures shall be accessible so that all normal field maintenance and adjustments can be readily performed, including replacement of the instrument. Enclosures shall be so designed that all tools used for maintenance and adjustment can be easily used. Requirements for special tools are to be minimized.

4.4.5 Penetrations

Process penetrations into instrument enclosures shall be continuous pipe or tubing through bulkhead plates. The preferred location of bulkhead plates is on the side of instrument enclosures. Drain and instrument electrical penetrations do not require bulkhead plates. All penetrations are to be weatherproofed.

4.5 Walk-In Housings

4.5.1 General

Walk-in housings are small shelters, equipped with a man door, and large enough for maintenance personnel to work inside with the door shut.

4.5.2 Heating

Walk-in housings are preferably steam heated. Heating is required in all cases.

4.5.3 Instrument Accessibility

All housed instruments shall be readily accessible from the inside for adjustment, maintenance or replacement.

4.5.4 Penetrations

All penetrations for sample lines or instrument process or special penetrations lines are to be through bulkhead fittings.

4.5.5 Utilities

The following utilities are to be installed in all walk-in housings:

4.5.5.1 Lights that supply 80 foot candles of light on the housed instruments. Light switches are to be both inside and outside. (Switches and fixtures must be suitable for electrical area classification. - See 4.5.5.4).

4.5.5.2 115 volt, 60 Hz, AC outlet suitable for the electrical area classification. (See 4.5.5,4).

4.5.5.3 Instrument air.

4.5.5.4 Combustible gas alarm and fresh air purge system if required by the process fluid.
4.5.5.5 **Steam, water, inert gas for specific housings.**

4.6 Seals

4.6.1 Filled Systems

Filled systems are a means of preventing the process fluid from entering the instrument body. Process pressure is transmitted through a diaphragm or bellows and capillary by a fill liquid. Filled systems are to be winterized by using a fill liquid that remains fluid at minimum ambient temperature.

4.6.2 Open Seals

Open seals do not use a diaphragm or bellows. The instrument process lines are filled with the sealing liquid which which contacts the process fluid directly. Seal pots may be used. The sealing liquid is retained by density difference. It must be immiscible with the process fluid.

4.6.3 Sealing Liquids

Sealing liquids must remain fluid at minimum ambient temperature and not boil at maximum operating temperature under operating pressure. Some sealing liquids are tabulated below.

Liquid	Freezing Pt. °F	Boiling Pt. °F	Sp Gr	Cost Factor
Ethyl Benzene	-139	+277	0.867(20/4)	2
Isopropyl Benzene (Cumene)	-140	+306	0.862(20/4)	1
Meriam 175 Blue Fluid	-170	+150	1.75(55°) 124.	100
Silicone Oil, Type	Below -60	Up to 500	0.92	15
Glycol & Water	-31	500	1.05	1

Others may be used in special applications following engineering review. All sealing liquids must be reviewed by the project control system supervisor to assure compatibility with the process fluid.

4.7 Electric Tracing and Heating

4.7.1 Electric Heat tracing shall be in accordance with Specification 14222-P-7, Electrical Heat Tracing.

4.7.2 Excess Capacity

All electric heat tracing and heaters are to be designed with 20% excess heating capacity at maximum heating duty.

4.7.3 Types of Electric Heat Tracer

The parallel circuit, self-limiting, electric heat tracer shall be used, whenever available in the required temperature range and capacity. Outside self-limiting tracer limits, parallel circuit electric heat tracing is to be used to the extent feasible. Series circuit, mineral insulated, electric heat tracers are to be used only where parallel circuit types cannot be used. Maximum temperature limits of tracers are not to be exceeded if the tracer is heated by the process fluid.

4.7.4 Hazardous Areas

All electric heat tracing in hazardous areas must meet the requirements of the Class, Group, and Division for the area in which it is to be installed.

4.7.5 Electric Traced Bundles

Whenever feasible, the electric heat tracing is to be used in electric traced bundles containing the heat tracer, instrument process lines, insulation, and coverings. Performance curves, based on test data available, are to be used.

4.7.6 Interfaces

Where different heating circuits interface, or where instrument heat tracing interfaces with process heat tracing, no gaps or cold spots are to be left. Extra electric heat tracing is to be applied around flanges, valves, connections, etc., to compensate for higher heat losses.

4.7.7 Temperature Control

All electric heaters in instrument enclosures are to be thermostatically controlled. Thermostats are to be used on electric heat tracers if the application cannot tolerate the temperature range without thermostats.

4.7.8 Thermostat Failure

In the event of thermostat failure leaves heater or tracer power on, each heater or tracer circuit is to be designed to prevent or limit damage from overheating at maximum ambient temperature or less as follows:

4.7.8.1 Any contained liquid must not be heated to its boiling point or bubble point at system pressure.

4.7.8.2 The maximum temperature limits of the heater element, tracer, insulation, or sheathing must not be exceeded.

4.7.8.3 No instrument is to be heated above its maximum storage temperature limit.

4.7.8.4 The outside surface temperature of insulation is to comply with Specification 14222-N-2.

4.7.8.5 Copper tubing is not to be heated above 400°F.

4.7.9 Overheating Prevention

The following design methods shall be used to prevent damage from overheating in order of preference.:

4.7.9.1 Design so that heat loss through insulation equals heat input before any of the limits are reached.

4.7.9.2 In some cases a high ambient temperature cut out for a group of heater or tracer circuits can be used to expand applications of method in paragraph 4.7.9.1.

4.7.9.3 Include a high temperature fuse that will melt before overheating occurs.

4.9 Purging for Winterization

4.9.1 General

If instrument process lines are winterized by purging, a fluid that doesn't condense, freeze or develop excessive viscosity at minimum ambient temperature is to be used. The purge fluid is metered in the instrument process line and flows out into the process.

4.9.2 Process Purging

In some cases a high pour point purge oil, water, or purge fluids that will freeze above minimum ambient temperature are used for process reasons. This is not a winterizing method. Such purges will have to be winterized by heating.

4.9.3 Purge Gases

Purge gases shall be restricted to instrument air and nitrogen. No other sources of purge gas will be acceptable. All purge gases must be dried to a dew point below minimum ambient temperature. The use of instrument air results in a cross connection between process fluids and the instrument air system. Each case must be reviewed and designed so that process fluid cannot flow into the instrument air system under upset conditions such as instrument air failure, relief valves blowing, excessive levels, etc. The purge gas selected must be compatible with process requirements.

4.9.4 Purge Pressure

All purge fluids shall be supplied at a sufficiently high pressure to insure a minimum pressure drop across the purge flow control valve of 10 psi.

4.9.5 Point Of Entry

The point of entry of the purge into the instrument process lines should be as near the instrument root valves as is possible to hold the pressure drop in the instrument process lines, as a result of flow, to a minimum. However, each design must be reviewed to ensure that the complete instrument process line will actually be purged at all times of fluids that may condense or solidify. If good design requires purging the complete instrument process line, pressure drop due to purge flow rates variations must not cause a significant instrument error.

4.9.7 Purge Rotameters

Purge rotameters, equipped with needle valves and differential pressure regulator (where required for process operation) shall be used to measure and regulate purge flows. A Wallace & Tiernan Catalog 20A123-SI-XX,or equal,is to be used for water, instrument air, and nitrogen. A Wallace & Tiernan Catalog 5120 M1211,or equal,is to be used for purging hydrocarbons. The purge meter will be used with a Moore 63 SD-L differential regulator,or equal,with a needle valve for the flowrate and pressure drop. This is required on all application where the manufacturer's standard purge meter-assembly pressure rating is less than the supply pressure.

4.9.8 Purge Flow Rates

Some suggested purge flow rates, from API RP 550, Part I, Section 8, for instrument purges are as follows:

Meter Type	Service	Gas Flow SCF/HR	Liquid Flow US Gal/HR
Level, D/P	General	1-1.5	--
Flow	General	1	3

In other cases, a velocity of 15"/minute in purged lines can be used.

4.10 Insulation

4.10.1 General

All heated instrument process lines, instruments, instrument enclosures, and walk-in housings are to be insulated to conserve heat, maintain design temperature, and to protect personnel from surfaces hotter than +140°F. Unheated instrument process lines, enclosure, instruments, and housings need not be insulated.

4.10.2 Personnel Protection

All insulation of instrument process lines, instruments, instrument enclosures, and walk-in housings shall meet the personnel protection requirements given is Specification 14222-N-2.

4.10.3 Instrument Process Lines

Instrument process lines may be inslulated in accordance with either of the following:

(a) Per Specification 14222-N-2 or 14222-N-3

(b) Insulation supplied with bundle.

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4.10.4 Instrument Enclosures

Instrument enclosures, if required, may be insulated with either of the following materials:

(a) Rigid polyurethane, meeting the requirements of ASTM C-591, may be used to line a metal enclosure or may be formed into part of the enclosure.

(b) Johns-Manville, fiberglass, Spin-Glas, Type 814, 3 lbs/ft^3 density, FSK facing, 1" thick, or equal.

4.10.5 Prefabricated Bundles

Prefabricated bundles are to be insulated with flexible polyurethane foam. The polyurethane foam is to remain flexible at minimum ambient temperature. Fiber glass fillers may be used around double tubes in double tube bundles.

4.10.6 Walk-in Housings

Walk-in housings if required shall be insulated with Johns-Manville, Fiberglass, Spin-Glas Type 814, 3 lbs/ft^3 density, FSK facing, 1" thick, or equal.

4.10.7 Direct Heated Instruments

The preferred method of insulating direct heated instruments is with preformed rigid polyurethane meeting the requirements ASTM C-591. Refer to Section 4.3.

4.11 Prolonged Idleness Protection

4.11.1 Housings

If instruments that are to be protected by instrument enlcosures or walk-in housings are installed in their completed instrument enclosures or walk-in housings in the factory prior to shipping to the jobsite, then the housings with instruments inside are to be installed in the field as a unit. Instruments are to remain in their housings between installation and start-up.

4.11.2 During prolonged idleness no heat tracing or heaters will be available, so design on the basis that instruments will be cooled to minimum ambient temperature.

4.11.3 Filling Liquid

Filling Liquid shall be left in filled systems protected by diaphragm or bellows seals.

4.11.4 Freeze Protection

No fluid that can freeze at minimum ambient temperature is to be left in any instrument. All instrument process lines not protected by diaphragm or bellows seals are to be drained. After any leak or hydrotesting is completed, the instrument process lines are to be disconnected at the root valves, drained, blown out, and plugged.

4.11.5 Desiccant

To avoid condensation of moisture, a bag of desiccant is to be placed in each instrument enclosure or the case of unsealed and unhoused instruments. The humidity card is to be visible through any window present. Desiccant is to be Drierite Desiccant Bags, 8OZ, with humidity card, manufactured by W.A. Hammond Drierite Co., Xenia, Ohio, or equal.

4.11.6 Desiccant Replacement

Humidity cards shall be checked every two weeks and exhausted desiccant replaced, as indicated by a pink humidity card.

4.11.7 Physical Damage Protection

Instruments in locations subject to physical damage from construction activity shall not be installed until such activity is completed. If such delay is not acceptable, the instrument is to be removed, with its enclosure, after installation. All connections are to be plugged, taped, greased, etc., to protect from damage. The instrument and instrument process lines are to be drained of all liquids that freeze at minimum ambient temperature or above. The instrument, in its housing, is to be stored in a dry warehouse until reinstalled.

4.12 Heated Storage

Instruments that contain components that will be damaged by cooling to minimum ambient temperature shall have a minimum storage temperature above minimum ambient tempe*ature. These instruments are to be kept in a heated warehouse above their minimum storage temperature and are not to be installed in the field until shortly before start-up and after the heating system for them is operational. They are not be shipped to jobsite during times when temepratures below their minimum storage temperature are expected unless provision is made to keep them heated during shipment.

5. REFERENCES

Specifications

14222-N-2	Insulation of Hot Piping and Equipment
14222-N-3	Insulation for Cold Piping and Equipment

Standards

API RP 550	3rd Edition, Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control, Section 8, Seals, Purges, and Winterizing.

Plant—8 Unique
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BRECKINRIDGE PROJECT

PLANT 8

HYDROGEN PLANT

PLANT ERECTION PROCEDURE

TITLE

HYDROGEN PLANT -- UNIT #8

PLANT ERECTION PROCEDURE

General

A concentrated effort will be placed on designing the hydrogen plant components as shop assembled units that are piped, instrumented, wired and tested for both pressure integrity and operating performance. Where a skid type assembly is not practical, a complete system will be shop assembled, tested and disassembled as large elements to make field erection an easy task. The items that will be received in the field are as follows:

1. Mechanical Equipment: Four compressors (K-70, 30, 20, 10), one compressor/expander (P-58), and one refrigeration unit (V-59). A total of six items.

2. Cryogenic Hydrogen Purification: Prefabricated boxes, one containing the brazed aluminum exchangers and the other containing the liquid/vapor separators. A total of two items.

3. Warm Hydrogen Purification: The adsorber vessels, a set of prefabricated piping and a skid mounted reactivation system that contains the reactivation blower, heater and cooler (K-1, E-3, 4). A total of three items.

4. Miscellaneous Item: Small components consisting of flash tank (Y-103), pumps (P-104 A, B), inlet separator (Y-19), and final filters (Y-16 A, B). The inlet separator and final filter will be prepiped with block valves, bypasser and instrumentation as required. Start up supplier consisting of 155,000 pounds of molecular sieve (a total of 520 fifty-five gallon drums) and drum lots of lubricating oil for the plant compressors.

Mechanical Equipment

The weight, size, horsepower etc. of the mechanical equipment is given in the following table:

AIRCO CRYOPLANTS CORPORATION

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TITLE HYDROGEN PLANT -- UNIT #8

PLANT ERECTION PROCEDURE

Mechanical Equipment (continued)

ITEM NO.	DESCRIPTION	HORSE-POWER	L X W X H (Feet)	WEIGHT (TONS)	HOW SHIPPED
K-70	Nitrogen Comp.	4500	26 X 12 X 10	50	Rail
K-30	Pipeline Fuel Comp.	12500	40 X 12 X 12	80	"
K-20	Heavy Hydrocarbon Comp.	4000	24 X 10 X 10	40	"
K-10	Inert Gas Comp.	500	15 X 6 X 10	5	Truck
V-59	Refrigeration Unit	125	15 X 5 X 9	4	"
P-58	Compressor/Expander	---			"
Lube Oil Skids K-20,30&70		---	15 X 10 X 6	14	Rail

All units will be completely shop assembled and performance tested before preparation for shipment. The two largest compressors will be partially disassembled after the shop performance test. K-70 will be shipped with an intercooler and the aftercooler dismounted. K-30 will be shipped with two intercoolers and the aftercooler dismounted. The intercoolers and aftercoolers of these two compressors will have to be reinstalled in the field. Field instillation for each unit will involve lifting, setting on a foundation, aligning, piping up the process and cooling water connections, providing power to the motor junction box and running the unit to verify that it operates properly.

Cryogenic Hydrogen Purification

The cryogenic hydrogen purification unit will consist of two preassembled steel boxes. The first box will contain the brazed aluminum heat exchangers E-5 through E-9, interconnecting piping, valving, and instrumentation. This box will be 12' X 20' X 80' and weigh 110 tons. The second box will contain separators Y-96 through Y-99, interconnecting piping, valving and instrumentation. Box dimensions are 12' X 16' X 60' and it will weigh 90 tons.

TITLE . HYDROGEN PLANT -- UNIT #8

PLANT ERECTION PROCEDURE

Cryogenic Hydrogen Purification (continued)

Field assembly will consist of lifting, setting on a foundation, interconnecting the process piping that runs between the two boxes, pressure testing and then packing the boxes with rockwool insulation.

Warm Hydrogen Purification

The most important components of the adsorption system are the timer that activates the operating sequence and the automatic valves that are controlled by this timer. The complete system, consisting of the three vessels, reactivation components, valves, and timer control will be shop assembled and operated through several reactivation cycles. Any corrections, repairs or modifications that are deemed necessary, will be made at this time. The adsorbers will then be disassembled and shipped to the field for permanent instillation. Following field assembly, the system must be pressure tested, charged with molecular sieve, insulated and again carried through several operating cycles to confirm that the valving is switching in the correct sequence and at the allocated time intervals. Field assembly will consist of lifting and setting the three adsorber vessels, reactivation skid and the refrigeration unit. The vessels weigh 50 tons each and the dimensions are available in the item data sheet. The reactivation skid will be 40' X 20' X 8' and weigh 15 tons. The refrigeration unit is a relatively small item as are the inlet separator and final filters and are extremely simple to set and pipe up.

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PLANT 8

HYDROGEN PLANT

TIMER CONTROL FOR THE MOLECULAR SIEVE ADSORBERS

TITLE HYDROGEN PLANT - UNIT #8

Timer Control for the Molecular Sieve Adsorbers

General

The purpose of this document is to describe the pneumatic valves, restrictive orifices and the valving sequence that will occur during an adsorption cycle. The pneunatic valves and the timer that controls their operation are the most important elements in the system.

Restrictive Orifices

These orifices are sized to limit the rate at which the adsorbers are pressurized and depressurized. The controlled rate, which was chosen as 50 pounds per minute, will minimize the external pressure loading that will act to crush the adsorbent and the internal pressure pulse that will occur as compounds are rapidly adsorbed and desorbed within the molecular sieve particle. The orifices required are the following:

Quantity	Line Size (in.)	Orifice Diameter (in.)	Flange Rating	Description
6	2	3/4	300 lbs.	For pressurizing and initial depressurizing
3	3	1-1/2	300 lbs.	For final depressuring

Pneumatic Valves

The mechanical requirements of the pneumatic valves are dependent on their location in the process system. The reactivation valves located at the adsorbers experience the severest service conditions. They must seal bubble tight at a 700 pound differential and will be exposed to a temperature operation. The valves mentioned above are shown on flow sheet 0-252-4Y-14. The pneumatic operators for these valves are small because the valves will be opened and closed at a minimal pressure differential. However, the operators for the two inch and three inch pressurizing and depressurizing valves must be large enough to open and close these valves against a 700 pound differential.

The valves associated with the regeneration system (Dwg. No. 0-252-4Y-13) will operate at low pressure and will be exposed to the reactivation

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HYDROGEN PLANT - UNIT #8

Timer Control for the Molecular Sieve Adsorbers

Pneumatic Valves

temperature swing from 30°F to 600°F.

Quantity	Valve Size (in)	Type or Make	Seat	Flange Rating (#)	Body Material
6	14	Wafer sphere/ McCanne Lock	soft	300	Carbon Steel
6	12	Wafer sphere/ McCanne Lock	Metal to Metal	300	Carbon Steel
6	2	Ball	soft	300	Carbon Steel
6	3	Ball	soft	300	Carbon Steel
4	12	Wafer Sphere/ McCanne Lock	Metal to Metal	125	Ductile Iron

Each valve will be supplied with mechanically activated limit switches that operate at the full open and full closed positions. They will also be provided with locally mounted operators so that the valve may be manually opened and closed. The timer should be overriden when ever a valve is being manually operated.

Reactivation Timer

The reactivation timer will operate through a complete cycle every eight hours. The reactivation cycle described here starts with all three adsorbers on line, carries a single adsorber through shut-off, depressurization, reactivation, repressurization, and ends when this adsorber is placed on line with the two operating units.

TITLE

HYDROGEN PLANT - UNIT #8

Timer Control for the Molecular Sieve Adsorbers

Reactivation Timer (continued)

The steps in the reactivation sequence are as follows:

Step	Time in Hours Start—Finish	Condition or Operation
0	0-0	All three adsorbers are on line
1	0-0	Close the outlet and then the inlet valve of the adsorber. Valve Limit Switches must indicate the closed condition before proceeding.
2	0-3	Open the two-inch depressurizing valve and hold open until the pressure in the adsorber is 125#. A pressure switch will signal the pressure level. shut this valve and check its position by using the Limit S
3	.3-.5	Open the three-inch depressurizing valve and hold it open for 10 minutes. Then close and check Limit Switch on the valve.
4	.5-.5	Open the inlet and outlet reactivation valves. Check Limit Switch.
5	.5-2.5	Open the inlet valve to the reactivation heater. When the adsorber reaches 500°F., as indicated by a temperature switch, close this valve and check the Limit Switch.
6	2.5-4.5	Open the inlet and outlet valve to the reactivation cooler. Close the outlet valve when the adsorber temperature switch reaches 130°F. The temperature switch used to sense 130°F must dete this limiting temperature from a falling condition (500°F down to 130°F). At step 5 this switch will be at 30°F and rise up to 500°F passing through 130°F as it rises. On step the starting point is 500°F and the switch is cooled through 130°F.
7	4.5-6.5	Open the inlet valve to the freon unit. Check its position through the limit switch. After the two hour time period shut the outlet reactivation valve at the adsorber, the outlet valve of the freon unit and the inlet valve to the reactivation cooler.

TITLE

HYDROGEN PLANT - UNIT #8

Timer Control for the Molecular Sieve Adsorbers

Reactivation Timer (continued)

Step	Time in Hours Start—Finish	Condition or Operation
8	6.5-7.8	This is a designated inactive period that is allocated for routine maintenance of the system. An operating light should denote this condition.
9	7.8-8	Open the two inch repressurizing valve. When the differential pressure switch across this valve shows a 20# differential reading, open the inlet valve to the adsorber. When fully open, shut the pressurizer valve and then open the discharge valve.

The timer should remain in a particular operating step should a valve failure occur, and it must provide an alarm on a malfunction. Also, all valves on the three adsorbers and the reactivation system should shut off if an excessive flow rate is sensed by a flow switch in the plant feed line.

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PLANT 15

OXYGEN PLANT

ERECTION SPECIFICATION

TITLE ERECTION SPECIFICATION

This narritative covers the field erection of the air separation plant, nitrogen liquefier, oxygen compressors, storage for the cryogenic liquid products and the argon purification system. A pictorial representation of these items is given by the process flow diagrams 0-251-4Y-2 through 0-251-4Y-6. The following descriptive material should be read in conjunction with these drawings.

The following tables list the overall dimensions and weights of the individual pieces that will be received in the field.

COMPRESSION EQUIPMENT

Item No.	Flow Sheet No.	LxWxH/ xL Ft.	Weight Tons.	Equipment Description
15-K-1A	0-251-4Y-2	17x10x17	55	Steam Turbine
15-E-113A	0-251-4Y-2	9 x30	143	Surface COndensor
15-K-11A	0-251-4Y-2	54x23x22	38	Air Compressor
15-K-5A	0-251-4Y-5	12x9x7	23	Steam Turbine
15-E-509A	0-251-4Y-5	6 x28	24	Surface Cond.
15-K-50A	0-251-4Y-5	14x13x11	18	Oxygen Compressor
15-K-55	0-251-4Y-4	40x14x14	72	Cycle N_2 Compressor
15-K-63	0-251-4Y-4	20x8x15	17	High Level Compressor
15-K-65	0-251-4Y-4	20x8x12	12	Low Level Compressor
15-K-76/77	0-251-4Y-4	22x8x8	13	Expander Compressor
15-P-35-1A & 2A	0-251-4Y-3	9x12x15	6	Expander Generator
15-K-41	0-251-4Y-6	9x9x12	5	Argon Compressor

The first three compressors (air, oxygen, cycle N_2) will be shipped with the intercoolers off mounted. Remounting the coolers for the air and oxygen machines will be done using prefabricated spool pieces. The coolers for the Cycle N_2 machine will require rebolting to the compressor body.

The lube oil consols for the air and oxygen compressors will also be shipped as separate skids and are approximately 7'x6'x5'.

The remaining five systems will be shipped as self contained skids. The high level and low level compressors will be densly prepackaged units because these two skids will contain the freon condensor, receiveraand evaporators that make up the freon loop.

The field work involved in assembling the air compressor consists of setting the steam turbine, air compressor and surface condensor on their respective foundations. These items are then interconnected with particular attention given to aligning turbine and compressor shafts. This will be done under the direction of the manufactuer's field engineer. Next the lube oil skid will be set, piped in, flushed with oil to remove all foreign matter and finally filled with clean lubricant. Connecting steam, cooling water, and instrumentation will prepare the machine for initial run in at minimum load.

The above procedure is typical to all the compression equipment with the degree of complexity decreasing according to the order in which they are listed.

AIR SEPARATION COLD BOXES

All elements of the air separation plant with the exception of the reversing exchangers will be shipped as prepiped units housed in structural steel frames that are covered with carbon steel sheeting. The prepackaged boxes listed below are shown on flow sheets 0-251-4Y-3 and 0-251-4Y-6.

ITEM No.	BOX No.	LxWxH Ft.	WEIGHT Tons.	EQUIPMENT DESCRIPTION
15-C-25A	1	21x21x50	70	High Pressure Column
15-C-30A	2	21x21x95	120	Low Pressure Column
15-E-	3	21x14x50	55	Heat Exchangers on 0-251-4Y-3
————	4	21x7x95	50	Interconnecting Piping
15-Y-	5	21x21x25	30	Oxygen and Rich Liquid Absorbers
15-E-31A-A	6	21x21x30	35	Supplemental Condenser
15-E-31A-A	6A	21x21x30	35	Additional Supplemental Condenser
15-C-29A	7	21x15x95	60	Crude Argon Column
————	8	9x12x15	6	Interconnecting Piping
15-C-49	9	16x16x50	25	Pure Argon Column (0-251-4Y-6)

The individual cold boxes will be set in the fabrication shop to assure that all pieces are correctly alligned. Filed erection will consist of positioning the boxes, leveling, interconnecting the process piping that runs between the boxes, seal welding and then filling the boxes with insulation. Insulation of the cold boxes will be done after a thorough flow sheet check has been made and a twenty four hour leak test has been successfully passed.

The most difficult assembly operation involves welding the high pressure and low pressure columns together to form a single tower. This technique has been thoroughly developed through coordination of shop and field erection methods and will be a simple task.

REVERSING AND N_2 LIQUEFIER HEAT EXCHANGERS

The heat exchangers for the nitrogen liquefier will be handled the same way that the air separation plant components are. The exchanger will be shop mounted within a steel structure, piped, pressure tested and shipped to the field. The single box will be 10x12x70 and weigh 45 tons.

The reversing heat exchanger will consist of three sub assemblies that will operate independently of each other. The exchangers will be positioned in parallel, the process flow will travel through them in parallel, however, the process streams passing through the exchangers will be reversed at different time periods. Because of this out of phase reversal, the exchangers must be field erected. Three prepiped sub assemblies will be required for each air separation plant. A sub assembly will be 12x13x34 and weigh 50 tons. Each sub assembly will be mounted on a concrete foundation and a steel cold box fabricated to enclose them. This box will be 46x18x42 and will weigh 200 tons uninsulated.

The reversing check valves and associated piping must be installed between the reversing exchangers and the high pressure column box of the air separation plant. The cold box containing the check valves could be fabricated at a satelite site.

CRYOGENIC STORAGE TANKS FOR LIQUID OXYGEN AND NITROGEN

The design, off site component fabrication and field erection of tanks T-80 and T-81 will be sub contracted. CB & I and Graver Tank are two vendors that have cryogenic design expertiese.

OTHER SIGNIFICANT EQUIPMENT ITEMS

The dimensions and weight of three items that would classify as being large are listed in the table below.

The remaining components of the air separation plant are pumps, silencers, and assundry tube and shell heat exchangers. These items are all small; it will be a simple task to install them, and the information present on the flow sheets is sufficient to give a feel for the size of the items involved.

ITEM NO.	FLOW SHEET NO.	LXWXH/ XH FEET	WEIGHT TONS	DESCRIPTION
15-Y-IOA	0-251-4Y-2	26 X 24 X 21	23	Inlet Filter
15-E-13A	0-251-4Y-2	14 X 44	60	Direct Cooler
15-Y-47	0-251-4Y-6	12 X 20 X 12	20	Skid assembly containing all the warm argon process equipment

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INLET AIR FILTERS

F-10 A, B, C

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15Y-10 A/B/C

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TITLE INLET AIR FILTERS F-10 A, B, & C

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WRITTEN BY T. Larsen DATE 10/80 APPROVED

TITLE **INLET AIR FILTERS F-10 A, B, & C**

1.0 SCOPE

1.1 General

This Specification defines the requirements for the design, fabrication and delivery of an air filter package for filtering air at the inlet of anaxial flow compressor. All equipment furnished shall be for unprotected outdoor installation in a heavy industrial atmosphere including coal handling facilities. Three complete units are required.

1.2 Destination

Breckinridge, Ky.

1.3 Changes in Scope of Supply

The Vendor shall cleary define, in writing, all areas where his scope of supply deviates from the scope of supply of this Specification.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this Specification to extent indicated herein.

2.1 Codes

National Electric Code.

O.S.H.A.

2.2 References

National Bureau of Standards (N.B.S.)

A.S.H.R.A.E.

3.0 REQUIREMENTS

3.1 General Requirements

Each filter unit shall consist of one (1) or more stages of cloth fabric filter elements assembled

TITLE INLET AIR FILTERS F-10A, B, & C

3.0 REQUIREMENTS

3.1 General Requirements (continued)

in an enclosure suitable for outdoor installation. The unit shall be designed to maximize filtration efficiency while maintaining a reasonable service interval and economy of operation.

All equipment must be suitable for the service intended. All flow conditions to compressor including possible compressor surge must be considered.

Self cleaning type filters will be considered if feasible for the service specified. Complete details are required for evaluation.

3.2 Process Requirements

3.2.1 Site Conditions

Altitude	420 ft. above sea level
Ambient Temp. Range	-10 to +105°F.
Relative Humidity Range	0-100%
Design Wind Loading	25 psf

3.2.2 Operating Conditions

Normal Operating Air Flow Range	167,000 CRM
Design Air Flow	176,000 CFM
Duty	Continuous, 24 hr./day 360 days/year

3.2.3 Performance

Filtration Efficiency	95%, 2 microns & larger 85% average N.B.S. Test Rating
Max. Pressure Drop	0.2 PSI Dirty 1" H2) Clean

3.0 REQUIREMENTS (continued)

3.3 Design Requirements

3.3.1 Enclosure

All hardware shall be completely assembled in its own enclosure. The enclosure shall provide protection from the weather, and allow operation in driving rain and snow storms.

The unit shall have a coarse screen at the inlet to provide protection against ingestion of large objects.

A coarse exit screen or grating shall be provided to insure against a filter element or other large object being ingested by the compressor.

The filter housing shall be fabricated from heavy gauge sheet steel. All seams and access doors shall be air tight. Louvers and screens shall be galvanized.

Frames, supports, mounting brackets, etc., shall be arranged to support all filter elements and prevent element collapse.

If filter elements require frequent changing, provisions must be incorporated to allow element replacement during compressor operation. If filter aid powders are used, a by-pass or a compartment isolation must be incorporated to allow shake down during compressor operation. Housing to be equipped (on the downstream side) with hinged, weighted vacuum relief door sized to open if the pressure on the discharge side of the filter falls to 11" H_2O below barometric pressure. Location shall be such that there is no danger of freezing shut.

TITLE <u>INLET AIR FILTERS F-10A, B, & C</u>

3.0 REQUIREMENTS

3.3 Design Requirements

3.3.2 Filter Elements

Air must be oil-free. No oil or grease type coatings may be used on the elements.

No elements that are subject to media migration shall be used.

3.3.3 Instruments and Safety Devices

Vendor shall furnish and install differential pressure gauges across each element type filter stage. Suitable guards shall be included for all drive systems.

3.3.4 Electrical

All electrical equipment shall conform to the provisions of the National Electric Code.

Electric power for controls and motors up to one-third horsepower shall be 115 volts, 60 cycles, single phase.

Electric power for motors larger than one-third horsepower shall be 460 volts, 60 cycles, three phase.

All motors shall be TEFC.

3.3.5 Special Tools and Spare Parts

Special wrenches or tools required for erection or maintenance of the equipment shall be furnished by the Vendor. Upon receipt of the purchase order, the Vendor shall immediately prepare a list and quotation for recommended spare parts, and submit to the Purchaser.

TITLE INLET AIR FILTERS F-10A, B, & C

3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.6 Minimum Cleaning Requirements

The units shall be delivered to the job-site clean and free of any loose foreign material such as scale, rust, flux, dust, sand, weld splatter, cutting chips and grease as determined by visual inspection.

3.3.7 Painting

All surfaces are to be painted to provide proper protection in an outdoor unprotected environment. Vendor to define type of painting in proposal.

3.4 Administrative Requirements

3.4.1 Information to be Supplied with Proposal

1. Completed forms from Appendix A - Design Details.
2. Price and delivery definition.
3. List of all places where proposed unit deviates from requirements of this Specification.
4. Performance guarantee and mechanical warranty.

3.4.2 Drawings and Manufacturing Schedule

Within twelve (12) weeks from date of purchase order, the Vendor shall submit one (1) reproducible copy of the following drawings for Purchaser's review and approval. These shall include, but not be limited to:

TITLE

INLET AIR FILTERS F-10A, B, AND C

3.0 REQUIREMENTS

3.4 Administrative Requirements

3.4.2 Dwgs. & Manufacturing Schedule (continued)

1. Assembly Drawings - Giving details on envelopes, instrument locations, connection locations, required accessibility dimension, and installation requirements.

2. External drawings of all auxiliary items that require some sort of connection or installation by Airco.

The Vendor shall supply one (1) reproducible and six (6) copies of certified drawings of the above within six (6) weeks after return of approved drawings by Purchaser.

One (1) complete set of final drawings is to be included in each Operating and Maintenance Manual.

Within three (3) weeks from date of purchase order, Vendor shall prepare and submit a manufacturing schedule showing scheduled dates for completion of engineering, purchasing, fabrication and assembly of major components. This schedule shall be revised with actual dates of completion of the above activities and reissued on a monthly basis until the unit is shipped.

Drawings and manufacturing schedules shall be sent to:

Airco Cryoplants
460 Mountain Avenue
Murray Hill, NJ 07974

Attention: Central Files

TITLE INLET AIR FILTERS F-10 A, B, & C

3.0 REQUIREMENTS

3.4 Administrative Requirements (continued)

3.4.3 Operating and Maintenance Instructions

Six (6) copies of Operating and Maintenance Instructions Manual with parts list shall be furnished by the Vendor.

This manual shall give full details of all parts included in the order. The manual shall, for all equipment, cover all conditions of operation including initial run-in and start-up, and regular inspection and maintenance procedures. The above must be furnished a minimum of two (2) weeks before shipment of the unit.

4.0 TESTING

4.1 Inspection

All material is subject to inspection in Vendor's shop and Vendor's suppliers' shops. Vendor shall give Purchaser the opportunity to visually inspect assembled unit prior to shipment.

4.2 Guarantees

Vendor's proposal shall include guarantee of performance in accordance with this Specification.

The Vendor shall guarantee against incorrect design, defective materials, poor workmanship and failure from normal usage. During the guarantee period, he shall repair or replace the defective equipment at his expense. He shall also state the terms and conditions of his guarantee.

5.0 DELIVERY

5.1 Schedule

Delivery schedule shall be specified starting from the date of receipt of order.

TITLE INLET AIR FILTERS F-10 A, B, & C

5.0 DELIVERY (continued)

5.2 Shipping

The Vendor shall adequately support or crate the unit to withstand all shipping loads without damage. The Vendor shall adequately tie the unit down on the shipping vehicle to prevent damage en route.

It shall be the Vendor's responsibility to insure that the packages are sized to allow delivery to the job site.

It shall be the Vendor's responsibility to repair or replace these items damaged during shipment. All insurance claims shall be processed by the Vendor.

Vendor shall notify Airco of all shipping dates which shall include all pertinent shipping information, including but not limited to: Name of Carrier, Way-Bill Number, estimated time of arrival at the job site.

5.3 Acceptance

Final acceptance of this unit shall be reserved until installed, operated and continuous performance for a minimum of 24 hours shows that design requirements are met. Operation and continuous performance shall be witnessed by the accepting Airco representative.

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TITLE INLET AIR FILTERS F-10A,B, & C

APPENDIX "A"

DESIGN DETAIL QUESTIONAIRE

Fill in information requested. Attach requested schematics, lists, etc.

Vendor________________ Model____________ Date____________

Signature of Person Completing form________________________

ITEM	PROPOSED UNIT
1. Vendor's make and model.	
2. First Stage Filter:	
a. Make and model	
b. Type	
c. Media Material	
d. Estimated performance, attach curve.	
e. Flow Capacity	
f. Pressure drop - clean/dirty.	
g. Collapse Pressure	
h. Pressure drop and grain load at which element should be replaced.	
i. Number of Elements	
j. Cost of replacement element.	

Plant 15 Inlet Air Filters Sheet 11 of 13

WRITTEN BY L. Larsen DATE 10/30 APPROVED

AIRCO CRYOPLANTS

☐ STANDARDS
☐ INSTRUCTIONS
☒ SPECIFICATIONS
☐ DATA

NO. 0-251-12-2

TITLE INLET AIR FILTERS F-10 A, B, & C

APPENDIX "A" (continued)

ITEM	PROPOSED UNIT
2. First Stage Filter: continued	
k. Replaceable while in service?	
l. Estimated life before replacement.	
m. Number of times element can be cleaned.	
3. Second Stage Filter:	
a. Make and model.	
b. Type.	
c. Media Material	
d. Estimated performance - attach curve.	
e. Flow Capacity.	
f. Pressure drop - clean/dirty.	
g. Collapse Pressure.	
h. Pressure drop and grain load at which element should be replaced.	
i. Number of elements.	
j. Cost of replacement element.	
k. Replaceable while in service?	
l. Estimated life before replacement.	
m. Number of times element can be cleaned.	

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AIRCO CRYOPLANTS

☐ STANDARDS
☐ INSTRUCTIONS
☒ SPECIFICATIONS
☐ DATA

NO. 0-251-12-2

TITLE INLET AIR FILTERS F-10 A, B, & C

APPENDIX "A" (continued)

ITEM	PROPOSED UNIT
4. Inlet Screen/Discharge Screen	
a. Material	
b. Mesh Size	
5. Approximate total weight.	
6. Approximate dimensions.	
7. List of similar applications now in service.	
8. Enclosure Materials.	
9. Method of Weather Protection.	
10. Painting Definition.	
11. Flange Size and Location.	
12. Motors: (If Required)	
a. Manufacturer	
b. Type	
c. Frame	
d. NEMA Enclosure	
e. Horsepower	
f. Speed	
g. Voltage	
13. Vacuum Relief Setting	

WRITTEN BY L. Larsen DATE 10/80 APPROVED

CN 1714 - 3/76 PRTD. IN USA

Airco Cryoplants

☐ STANDARDS
☐ INSTRUCTIONS
☐ SPECIFICATIONS
☐ DATA

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WRITTEN BY L.P.L. DATE 2-25-80
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REVISION																
PAGE																
DATE																
WRITTEN BY																
APPROVED BY																

MAIN AIR COMPRESSOR CP-11 (A,B,C)

BRECKINRIDGE PROJECT

15K-11 A/B/C

AIRCO Industrial Gases

☐ STANDARDS
☐ INSTRUCTIONS
☐ SPECIFICATIONS
☐ DATA

NO. 0-251-1Z-3

TITLE MAIN AIR COMPRESSOR CP-11

INDEX

WRITTEN BY L. [illegible] Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

1.0 SCOPE

1.1 General

This specification defines the requirements for a large capacity air compressor to furnish oil free air to an Air Separation Plant. The compressor shall be a multi-stage design consisting of axial or axial and centrifugal stages with suitable intercooling to form an energy efficient unit . If mutiple units are specified in Section 3, this specification will apply to each unit.

All equipment furnished shall be suitable for service and installation as defined in this specification and shall be suitable for the site conditions defined in Section 3.

1.2 Destination

Breckinridge, Kentucky

1.3 Changes in Scope of Supply

The vendor shall clearly define, in writing, all areas where his scope of supply deviates from the scope of supply in this specification.

TITLE MAIN AIR COMPRESSOR CP-11

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent indicated under Section 3.

2.1 Codes

ASME Code for Unfired Pressure Vessels, Section VIII, Division 1, latest editions, revision or supplements to.

Code for Pressure Piping ANSI B31.3, latest edition, revision, or supplement to.

National Electric Code.

Federal, State and Local Codes, and ordinances including OSHA, where applicable.

2.2 Standards

NEMA
ANSI - Standards for Motors
IEEE - Standards for Motors
AGMA

TEMA
API 612 - Special Purpose Steam Turbines
AGMA 421

TITLE MAIN AIR COMPRESSOR CP-11

3.0 Requirements

3.1 General Requirements

3.1.1 Design

The compressor is required to furnish oil-free process air to a reversing type air separation plant. All equipment shall be suitable for the entire range of operating conditions defined in this specification without danger to personnel or equipment. Vendor shall clearly define any operating limitations of his equipment.

All equipment offered shall be rated heavy duty for continuous service. Equipment shall be designed for economy of operation, ease of installation, and rapid and economical maintainance.

Vendor Shall define and furnish any additional device not covered by this specification but required for proper operation of the equipment, or protection of the equipment or personnel.

3.1.2 Alternate Design

Vendors Proposal shall clearly define all areas where his design deviates from this specification.

Proposals for equipment of a different type than intended by this specification will be considered only if a clear and definite advantage to the purchaser is indicated.

Purchaser reserves the right to reject any proposal not in compliance with this specification.

TITLE MAIN AIR COMPRESSOR CP-11

3.2 Process Requirements

3.2.1 General

Number Required:	3	Each as Specified herein
Driver Type :	1	Electric Motor
	2	Steam Turbine

3.2.2 Design Ambient Conditions

Altitude	420	ft. above sea level
Barometric Pressure	14.5	psia
Rated Dry Bulb Temperature	96	°F
Rated Wet Bulb Temperature	78	°F
Summer Maximum Temperature	110	°F
Winter Minimum Temperature	-10	°F

Equipment Installation:

Outdoors Unprotected

Site Environmental Conditions:

Coal Processing Facility

The ambient conditions specified are designed point conditions. The compressor must be capable of operation at ambient and cooling water extremes without adverse effects on the compressors' or drivers' mechanical integrity.

Vendors proposal shall include performance curves defining expected operation at ambient and cooling water extremes defined herein in addition to specified design conditions.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 Requirements

3.2.3 Design Operating Conditions

	Case A (Normal)	Case B (Rated)
Capacity -SCFM	151,830	160,000
Discharge Pressure at Discharge Flange - psia	102.6	102.6
Inlet Pressure, psia	14.3	14.3
Inlet Temperature, °F	96	96
Discharge Temperature, °F (at compressor discharge flange)	Vendor to define in proposal	
Cooling water supply Temperature, °F	85	
Cooling water supply pressure, psig	50	
Cooling Water Temperature, rise °F	20	
Max. Cooling Water Δp, psi	10	

The compressor must be capable of meeting the specified conditions for Case A (normal) with a guaranteed horsepower at the motor shaft. The compressor must be capable of meeting the conditions specified as Case B (Rated) with a guarantee of no negative tolerance on capacity and pressure.

The capacity specified is for the net dry basis air delivered at the compressor outlet flange. Compressor seal loses, drain trap blowdown and contained moisture must be allowed for in the inlet capacity by the compressor vendor.

The base for measurement of scf is dry gas at 14.7 psia and 70°F.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.2 Process Requirements

3.2.3 Design Operation Conditions continued

The inlet pressure specified is based upon an allowance of 0.2 psi pressure drop through the inlet air filter. Vendor shall make allowance for any other expected pressure drop such as necessary inlet pipe runs or control devices.

Vendor shall advise what horsepower advantage can be realized if the compressor design is based upon an inlet filter drop of 0.1 psi in lieu of 0.2 psi as specified.

The unit shall be capable of a turndown to 70 % of Case A flow at 95 psia without blow-off or by-pass. The unit shall be capable of operation at Case A conditions during winter ambients without by-pass or blow-off. Specified ambient inlet conditions and cooling water data are design point data only. The compressor must be capable of operation at ambient extremes and with cooling water temperatures variations caused by seasonal and weather changes at the site. The compressor and all components must be capable of operation anywhere within an envelope bounded on the left by a line 5% away from surge and bounded on the right by motor winding temperature limitation. Any other operating limitations must be defined in the proposal by the vendor.

Operation of the plant is such that approximately every 10 minutes a reversal takes place. This reversal consist of series of valve blocking the air stream downstream of a surge drum for approximately one second and then opening it to an air stream at about 30 psig This action results in the compressor discharge pressure increasing 3 to 5 psi during the blockage and then dropping 20 to 30 psi in one or two seconds following the reopening. The control systems will be designed and adjusted to prevent surge during these reversals. The compressor must not be adversly effected by these reversals.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements

3.3.1 Compressor (3 Required)

The compressor shall be a multistage axial or combined axial and centrifugal type with intercooling to obtain maximum horsepower efficiency. Design using a single horizontally split case are preferred. Designs requiring more than one case will be considered if a power advantage can be realized and the installation cost is not prohibitive.

Adjustable stator vanes shall be furnished to obtain maximum turndown capability without blow-off. If a turbine driver is specified, vendor shall recommed method of capacity control including adjustable stator vanes and /or speed control. All apparatus required for stator vane adjustment including linkage and actuator with positioner shall be furnished by the vendor.

Shaft seals shall be provided to prevent leakage out of, or into, the compressor over the range of specified operating conditions. Seal operation shall be suitable for variations in suction conditions that may prevail during startup and shutdown of the compressor. Seals shall not require any external seal gas and shall have a vented atmospheric space beteen the oil and process sides. Vendor shall completely describe his seal system operation.

WRITTEN BY L.P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.2 Cooling Water System

Cooling water to the unit will be supplied from a closed system furnished by purchaser. Cooling water design data is supplied under Section 3.2.3. Vendor shall define water flows, pressure drop, and temperature rise for all coolers.

3.3.3 Coolers and piping

Vendor shall furnish all intercoolers and interstage air piping, Coolers shall have removable tube bundles and accessibility for bundle removal. Tubes shall be admiralty.

On non-intergral coolers, where attainable air pressure exceeds water design pressure, rupture discs shall be furnished and installed by Vendor to relieve overpressure in the event of water passage failure. Rupture discs shall come with vacuum supports.

Design pressures of interstage piping and accessories shall be no less than the gas side design pressure of the coolers.

All coolers shall be matched for water pressure drop, for example the oil cooler design water pressure drop shall be the same as the intercoolers.

The mechanical design of all coolers shall conform to TEMA "C" as minimum. Air is the shell coolers shall have copper fins offered as an option. Air side velocity shall not cause damage to the exchanger. Baffles shall be used where necessary.

All water in shell coolers shall have copper alloy or non-metalic baffles.

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.3 Coolers and Piping

All water passages to be self draining to prevent freezing damage to coolers and piping in the event of an emergency shutdown in winter.

Each exchanger shall be complete with a gas side drain valve and water side vent and drain valves.

All exchangers shall be designed for a water side fouling factor of 0.002 hr.-sq.ft.-°F/BTU.

All coolers shall be designed to cool the air stream to not more than 10°F above the incoming water supply temperature. Options for coolers with closer approach will be considered provided power saving is clearly defined.

No cooler, including oil and motor coolers shall have tube diameters less than 5/8 inch.

Vendor shall also furnish a water separator and automatic condensate trap for each cooler. Water separators shall be designed for efficient removal of water entrained in the air stream. Each trap shall include block and bypass valves. For each intercooler, a level switch shall be included, which will be used to sound an alarm in the event of trap malfunction causing a build- up of water level. Level switch to be offered as an option.

All piping shall be in accordance with the latest issue of the Code for Pressure Piping ANSI B31.3.

All pressure vessels such a coolers, separators, etc., shall be fabricated in accordance with the requirements of the latest edition of the ASME Code for Unfired Pressure Vessels, Section VIII, Division I, (Code U Symbol). Stamping is required by the commissioned inspector of the National Board. Inspector must be licensed by the State in which the pressure vessel is to be used. This information to be noted on U-1 forms.

Five (5) copies of manufacturer's data reports and nameplate rubbings shall be furnished. Data reports to be signed by a commissioned inspector of the National Board.

TITLE **MAIN AIR COMPRESSOR CP-11**

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.4 Lubrication System

A complete system for bearing and gear lubrication shall be supplied by vendor. The system shall include a full flow oil cooler, dual full flow filters with a transfer valve, pressure relief valve, control valves, interconnecting piping, pressure gauges, temperature indicators, shaft driven main oil pump and electric driven auxiliary oil pump. The system shall be capable of furnishing oil to all bearings and gears during coastdown periods subsequent to complete electrical power failure. The shaft driven system shall be designed to provide sufficient oil to all users in the event of reverse rotation of the compressor because of discharge check valve failure. The compressor shall be designed so as not to be damaged in the event of reverse rotation.

An Amot type valve shall be included, which will automatically control oil temperature by bypassing oil around the oil cooler.

Filters and remove all particles of 10 micron and larger.

Oil cooler tubes shall be 5/8" minimum diameter.

Vendor shall also furnish an electric oil heater with thermostat control, sized to heat the oil prior to start-up during cold weather conditions. The auxiliary oil pump and oil heater shall each be rated for 460 volts, 3 phase, 60 Hz service.

The pump motor shall be non-overloading with respect to pump characteristics.

Vendor shall furnish all lube oil piping within the confines of his equipment such that purchaser need only connect supply and return lines between the equipment and the lube consol.

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.4 Lubrication System continued

It is intended that the system will furnish lubrication to all users including the main drive motor or turbine, gears, and couplings (if continuously lubricated). In addition, the system may be used to furnish hydraulic power to speed governors or stator vane actuator devices. High pressure pumps, control valves, etc. required for hydraulic power shall be included if required.

3.3.5 Gears and Couplings

Speed increasers and reducers shall be in accordance with AGMA Standard 421 and shall be sized for the maximum horsepower and speed of the driver, including all service factors.*

All couplings used shall be selected to satisfy the torsional characteristics of the drive train. Couplings and spacers shall be dynamically balanced and couplings halves mounted by the vendor or supplier of the driver.

Vendors quotation shall completely define proposed couplings. Bendix type couplings are preferred for high speed couplings.

Removable coupling guards shall be suitable for all operating conditions and comply with all applicable safety codes including OSHA.

Vendor shall supply complete design characteristics of all gear units including torsional data and critical speeds. AGMA service factors shall be based on the maximum output power of the driver including any driver service factor.

* Vendor to state normally applied service factor in accordance with AGMA. Airco has a stated preference for an actual service factor which exceeds normal by 0.25, or more.

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.6 Electric Motor Drive (One Required)

The compressor drive motor shall be designed for operation with three phase, 60 hertz 13,800 Volt supplied to the motor terminals. The motor shall have the following characteristics:

Type:	Synchronous
Enclosure	T.E.N.A.C
Insulation	Class
Horsepower	32.000
Service Factor	1.0
Power factor	1.0
Type Connection	Wye
Excitation	Brushless
Speed	1200 rpm max.
Motor Starter	Across the line (furnished by purchaser)

Nameplate rating of the motor, including all service factors, shall equal or exceed the maximum potential power requirement of the driven equipment. In addition, the motor shall be suitable for voltage variations of ± 10% under all load conditions.

The motor nameplate shall show design voltage, phase,cycle, full load amperes, service factor, etc.

Motor Starting Will Be As Follows:

Across the line. Purchaser will furnish a 15 KV Class Circuit Breaker.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE **MAIN AIR COMPRESSOR CP-11**

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.6 Electric Motor Drive continued

The motor shall be furnished with minimum of six (6) embedded resistance temperature detectors (10 OHM copper),2 per phase, in the windings, with leads brought out to a separate terminal box.

In addition, vendor shall furnish a complete monitor package capable of determining the temperature rise of the motor cage bars, cage end rings and rotor field winding. A complete system including readout meter such as G.E. Rotector or equal shall be furnished.

The motor shall be furnished with space heaters with leads brought out to a separate terminal box.

The motor is to have brushless excitation. 125 VDC Pilot exitation voltage will be furnished by purchaser.

Motor shall be supplied with a free standing terminal box.

The terminal box shall be :

4 ft. wide x 4 ft. deep x 6 ft. high and made of #10 gauge sheet steel with both sides and front removable. The stator and neutral leads in the box shall be in the form of a bus braced to withstand 750 mva short circuit and taped to insulation level of 15 kv ungrounded.

Motor vendor shall furnish and install lightning arrestors and surge capacitors. Connection between the bus and lightning arresters and surge capacitor shall be made with nonshielded cable rated 15 kv ungrounded.

Motor vendor shall supply and install three (3) self-balancing window type differential current transformers. Current transformer ration shall be 50/5 with wiring terminated at a four (4) point terminal block. These items are to be housed in the motor terminal box.

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requrements continued

3.3.6 Electric Motor Drive continued

A rectangular bus duct shall be furnished between the motor stator and the back of the terminal box.

The duct shall contain six (6) copper bars, three (3) for the stator and three (3) for neutral leads, and all shall be braced to withstand 750 mva short circuit. Bolted connections shall be used between the bus bars and stator leads.

Continuous current rating of all bus bars shall be 125% of stator current, both in the duct and in the terminal box.

A Dynalco proximity pick-up device with two contacts shall be furnished. The low speed contact shall be normally closed and used as part of the locked rotor protective arrangement. The normal open high speed contact will be used (at Airco option) as part of the exciter field application control circuit.

If a WP II enclosure is specified, inlet air filters shall be furnished and mounted by the motor manufacturer.

If a T.E.W.A.C. is specified, the water to air cooler(s) shall be side or bottom mounted. Cooling water supply is outlines in Section 3.2.3. A loss of cooling water flow switch shall be included for each cooler furnished.

Two (2) grounding brushes to be provided by vendor to take stray currents off motor shaft, and ground to bearing pedestral feet.

A reference mark shall be permanently scribed on the motor shaft so that actual F.L. Magnetic center with respect to the motor housing can be easily located for initial field arrangement.

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.6 Electric Motor Drive continued

The motor half of the drive coupling shall be mounted on the motor shaft by the motor manufacturer.

If available, an option shall be offered for a low noise level design motor. Complete details for evaluation shall be included. The motor starter will be furnished by purchaser.

The motor rotor shall be balanced such that vibrations will be limited to 1.0 mils peak to peak maximum, as measured on bearing cap.

It shall be the compressor vendor's responsibility to perform a complete torsional analysis of the drive system to insure proper operation of all equipment. A torsional analysis report is required.

The motor supplier shall furnish complete engineering details of field pole and stator coil winding and assembly, including dimensioned drawings. Only motor vendors willing to furnish complete design information requested will be considered acceptable bidders.

Airco reserves the right to select the motor which will become part of the purchase order. Vendors quotation must clearly define cost differences, if any, for purchasers evaluation.

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.7 Steam Turbine Drive (Two Required)

Steam turbine drivers, when specified, shall be in accordance with API Standard 612. The turbine shall be rated to deliver the required horsepower for the Case B Rated conditions. The steam rate guarantee shall apply to Case A normal conditions.

The turbine shall be rated for the following steam conditions:

- Steam inlet pressure, psig 900
- Steam inlet temperature, °F.750
- Steam exhaust pressure, psig -13
- steam exhaust temperature, °F. 116

The main steam condenser, if required, will be furnished by purchaser. Air ejector and overpressure relief shall be included in the scope of supply.

The turbine vendor shall furnish gland condensers as required to minimize steam loss. Gland condensers shall be TEMA "C".

Labyrinth seals are preferred.

Bearing lubrication shall be supplied from the common lube system specified in paragraph 3.3.4.

A sentinel warning valve shall be furnished.

A separate trip and throttle valve shall be supplied.

The turbine speed governor shall be NEMA Class D or better. The govenor shall be furnished with an actuator arranged to receive an external signal to set the control point of the governor.

WRITTEN BY L.P. Larsen DATE 2/8 APPROVED

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.7 Steam Turbine Drive continued

Purchasers control signal will be 4 to 20 milliamps, 24 V.D.C.

Vibration probes of the displacement type shall be furnished for X-Y and axial displacement protection. Vendor shall furnish probes, cables and oscillator - demodulators suitable for use with Bently-Nevada series 9000 or 7200 or equal monitor. All vibration equipment shall be wired to a common terminal box. A key phasor (optional) to be provided to permit a complete and accurate analysis at any time.

A local panel shall be furnished by the turbine vendor and shall include pressure gauges for steam inlet and exhaust, seal pressure, lube oil pressure, and control oil pressure (if applicable); speed indicator, and necessary local control components required for local starting of turbine.

In addition, primary control components for the turbine operation and startup, including a tachmoter, shall be furnished for mounting in purchaser's main control room panel.

The turbine vendor shall recommend any additional controls or equipment necessary for proper operation of the turbine.

TITLE **MAIN AIR COMPRESSOR CP-11**

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.8 Inlet Air Filtration

Purchaser will supply the inlet air filter. A dry type filter with a nominal efficiency of 95% at 2 microns is anticipated with a average pressure drop of 0.2 psi. A system with a lower average pressure drop such as 0.1 psi may be considered if a significant power savings can be realized.

The compressor design shall be such that its performance is not impaired by the residual dirt not caught in the filter.

The compressor shall not require cleaning of the internals more than once every three years.

Vendor shall advise filtration requirements for maximum efficiency and maintainance interval of the compression equipment.

TITLE **MAIN AIR COMPRESSOR CP-11**

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.9 Capacity Control

Variable stator vanes including linkage and actuator with positioner shall be furnished for capacity control. If turbine drive is specified, vendor may propose variable speed control and/or variable stator vane control in order to obtain maximum turndown capability. Purchaser will furnish an electrical actuation signal of 4 to 20 milliamps at 24 VDC. If a pneumatic signal is required, it will be 3 psig to 15 psig.

Airco will furnish the anti-surge valve.

Blow-off valve shall be sized so that with full compressor flow through the valve, no more that 60% of full discharge pressure can be obtained.

A NEMA 4 limit switch shall be furnished with the stator vane actuator to be wired by purchaser into a permissive start circuit. Limit switches to be SPDT.

The purchaser will supply a control panel with the capacity control and anti-surge system. Control system details will be furnished to vendor for his review and certification that the systems are acceptable and their use in no way compromises the compressor warranty.

WRITTEN BY L. P. Larson DATE 2/81 APPROVED

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements contained

3.3.10 Instrument and Protective Devices

The vendor shall provide tapped and capped 1/2" connections for the purchaser to connect to for remote indication of the following:

1. Discharge and inlet pressure of each compression stage or section.
2. Oil pressure to the bearings

The vendor shall supply and locally mount on the compressor or compressor piping the following instrumentation:

1. Dual element, type T copper-constantan thermocouples in a 3/4" stainless steel thermowell complete with wiring to a terminal strip in a NEMA IV head with screwed conduit connection.
    a. Inlet and discharge each compression stage or section
    b. Lube oil supply header
2. Bearing temperature thermocouples, type T, copper - constantan wired to terminal strips in common NEMA IV conduit boxes for the compressor, speed increaser gear, and driver.
3. 3/4" plugged connection inlet each stage for purchaser supplied thermowells and temperature switches.
4. Temperature switch with thermowell for lube oil supply temperature alarm and shutdown.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.10 Instruments and Protective Devices continued

5. Dial Thermometers With Thermowells (5" dial)
   a. Lube oil sump
   b. Lube Oil supply header
   c. Vendor standard supply

6. Pressure Gauges (4-1/2" dial size)

   a. After lube oil pump
   b. After lube oil filters

7. Sight Flow Indicators
   a. Each lube oil return line

8. Pressure Switches
   a. Lube oil system (alarm at decreasing oil pressure)
   b. Lube oil system (start auxiliary lube oil pump)
   c. Lube oil system (shutdown machine if oil pressure continued to fall)
   d. Lube oil system (close interlock to allow starting main drive.)

9. Flow Switch - loss of water flow to motor cooler (if applicable)

10. Level switches
    a. Oil level - alarm on low oil level
    b. Condensate level each intercooler - alarm on high condensate level. (optional quotation)

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.10 Instrument and Protective Devices continued

11. Vibration Probes

Vibration probes of the displacement type shall be furnished for X-Y protection of all shafts including compressors, gears, and drivers, and for axial displacement of all high speed shafts. All probes shall include cable and proximeters (oscillator- demodulators) mounted in local NEMA IV conduit boxes. Purchaser will connect all vibration equipment to a Bently-Nevada Series 9000 or equal monitor. Vendor shall quote option for keyphasor probe.

12. Limit Switches (NEMA 4)

1. Stator vane positioner - prevents starting unless inlet is closed.

All pressure gauges shall be supplied with isolating valves to allow removal for service during operation.

All alarm, shutdown, and permissive devices shall contain two (2) DPDT switches. Alarm and shutdown devices shall have contacts rated for 120 volts A.C., 10 ampere minimum. permissive devices shall have contacts rated for 125 volts D.C. with a minimum 10 ampere contact rating. All switches shall be wired by the vendor to terminal strip inside a machine mounted terminal box and clearly marked.

All pneumatic fittings shall be Swagelock.

Dial thermometers to be 5 inch dial, hermetically sealed, external calibration and every angle designed. Airco will furnish and install a local control panel including vibration monitors, annunciators, etc.

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.11 Vibration Limits (Compressors & Turbines)

Vibration levels including shaft runout during shop test or during operations in the field shall not exceed the following value or 2.0 mils, whichever is less.

$$\text{Double amplitude in mils} = \sqrt{\frac{12,000}{\text{shaft rpm}}}$$

Electrical runout or "glich" shall not exceed 0.25 mils. If the vendor can demonstrate that this is present but does not exceed 0.25 mils, he may add this to the above limits.

3.3.12 Noise

All equipment shall be designed for quite operation. Vendor's quotation shall include expected sound level data for his equipment and optional extras available to reduce noise levels of his standard equipment.

Sucessful vendor will be required to supply noise level data for his equipment for purchaser's use in evaluating equipment layout and plant noise control.

Sound pressure level data shall be expressed as db ref 0.0002 microbars or daA. Sound power level data shall be expressed as db ref 10^{-12} watts. Data shall be shown for octave band center frequencies of 63, 125, 250, 500 1000, 2000, 4000, and 8000 Hz, and overall levels.

Vendor shall quote optional extra for noise hoods lagging etc. to reduce noise to 90 dbA at 3 ft. from any surface.

WRITTEN BY L. P. Larsen DATE 2/81. APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.13 Special Tools

Special wrenches or tools required for erection or maintenance of the equipment shall be furnished by the vendor.

3.3.14 Spare Parts

Vendors proposal shall include a priced list of spare parts as follows:

1. Compressor rotor
2. Gear set
3. High speed coupling
4. Turbine rotor (if applicable)
5. Motor stator coils
6. Motor Field Pole
7. Compressor bearing (set)
8. Motor or turbine bearings (set)
9. Speed increaser bearings (set)
10. Compressor (and turbine if applicable) seals
11. Gaskets, shims, O-rings, etc. required for startup and first year operation

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.15 Tagging and Marking

Each and every component and accessory shall be identified by name and number if assigned. Metal or plastic tags wired to the item are acceptable. A suitable substitute can be pressure sensitive backed plastic tape with embossed numbers and letters provided that clean, flat and smooth surfaces are available for application.

All wiring terminals in junction boxes and control panels shall be identified with letters and/or numbers corresponding with the wiring schematics.

3.3.16 OSHA Regulations

All equipment furnished shall conform to all applicable regulations of the Occupational Safety and Health Adminsitration when properly installed and maintained.

3.317 Maintenance

The unit shall be designed to minimize required maintenance shutdowns. The ability to run continous for 365 days without a required maintenance shutdown is required. Any maintenance task that requires a shutdown at intervals less than 365 days shall be specified in the proposal.

Plastic tube type markers shall be used to identify all electrical wiring.

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.3 Design Requirements continued

3.3.18 Painting

All equipment shall be painted in accordance with manufacturers standard for the service intended. Vendor's proposal shall completely describe proposed paint schemes.

TITLE MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.4 Adminsitrative Requirements

3.4.1 Information to be Supplied with Proposal

The vendor shall supply the following in the Proposal:

1. Completed forms = Bechtel Data Sheets
2. Price and Delivery Definition.
3. List of all exceptions to this specification.
4. Performance guarantee and mechanical warranty.
5. Recommended spare parts list including prices.
6. Description of all tests to be performed including descriptions of test procedures and data to be supplied purchaser to confirm reported test results.
7. Performance Curve
8. Schedule of promised drawing submittal

3.4.2 Drawings and Manufacturing Schedule

Within twelve (12) weeks from date of purchase order, the Vendor shall submit one (1) reproducible copy of the following drawings for purchaser's review and approval. These shall include, but not be limited to:

1. Gas flow schematics
2. Lube system schematic
3. Electrical schematic - as applicable; defining HP or KW of all pumps, heaters, etc.
4. Bill of materials for all supplied hardware

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.4 Administrative Requirements continued

3.4.2 Drawings and Manufacturing Schedule continued

5. External Drawing - Giving details on envelopes, instrument locations, connection locations, required accessibility dimensions, and installation requirements.
6. External drawings of all items that require some sort of connection or installation by Airco
7. Water schematic
8. Thermal rating sheets for coolers
9. Bechtel Data Sheets
10. Motor Winding Information Data Sheet

The Vendor shall supply one (1) reproducible and six (6) copies of certified drawings of the above within six (6) weeks after return of approved drawings by Purchaser.

One (1) complete set of final drawings is to be included in each Operation and Maintenance Manual.

Within three (3) weeks from date of purchase order, Vendor shall prepare and submit a manufacturing schedule showing scheduled dates for completion of engineering, drawings, purchasing, casting, machining and assembly of major components. This schedule shall be revised with actual dates of completion of the above activities and reissued on a monthly basis until the unit is shipped.

Drawings and manufacturing schedules shall be sent to the following:

Airco Cryoplants
460 Mountain Avenue
Murray Hill, N.J. 07974

Attn: Central Files

TITLE

MAIN AIR COMPRESSOR CP-11

3.0 REQUIREMENTS

3.4 Administrative Requirements continued

Six (6) copies of Operating & Maintenance Instructions Manual with parts list shall be furnished by the Vendor.

This manual shall give full mechanical details of all parts included in the order. The manual shall, for all equipment, cover all conditions of operations including initial run-in and start-ups from cold to warm condition and regular inspection & maintenance procedures.

The manual must be specifically written for the purchased machine and its support systems and accessories. It must not be a general booklet containing information not applicable to the purchased machine. Any statements in the supplied material and subvendor material not applicable to the purchase machine shall be crossed out.

All subvendor material shall be marked by an identifyiing name or number which clearly defines what piece of equipment it is and where it is used.

The manual shall define all required lubricants. It shall specify the type (e.g. oil grease, etc.) the basic characteristics (e.g. lithium base, viscosity, etc.) and various brand definitions (e.g. Shell #3, etc.) including quantity requirements and service intervals.

The above must be furnished a minimum of two weeks before shipment of the unit.

In addition, vendor shall furnish five (5) copies of all test reports and torsional and lateral analysis reports as soon as available. Performance test reports shall include all data, sample calculations, test loop diagrams, and certified test performance.

TITLE MAIN AIR COMPRESSOR CP-11

4.0 TESTING AND GUARANTEES

4.1 Inspection

All material is subject to inspection in Vendor's shop and Vendor's suppliers shops. Vendor shall give purchaser at least one (1) week notice prior to hydrostatic test, mechanical test, and performance test so that a representative of purchaser may be present.

4.2 Testing

4.2.1 Shop Tests

Compressor shall be given a mechanical running test and full performance test at the Vendor's shop. Vendor shall furnish a complete performance test report containing the compressor performance curve showing the pressure, thru-put and power relationship plotted from at least five test points, vibration log data, bearing oil temperatures, interstage pressures and temperatures, etc. Sample calculations for flow, pressure, and HP shall be provided.

Compressor casings are to be hydrotested at 150% of design pressure.

Vendors proposal shall include a complete description of his test procedures for purchasers review and acceptance. Separate prices shall be included for all which are not standard.

The following standard tests shall be performed on the main electric motor driver:

a. Resistance measurement of armature and field windings.
b. Polarity of fields.
c. Di-electric test of windings.
d. check air gap (by gauge.)
e. No load field current check at normal voltage and frequency.
f. No load saturation curve determination (at vendor's option.)

TITLE

MAIN AIR COMPRESSOR CP-11

4.0 TESTING AND GUARANTEES

4.2 Testing continued

4.2.1 Shop Tests

In addition to standard motor tests, vendor shall offer an option for tests required to guarantee motor efficiency.

If a stream turbine driver is specified, vendor shall perform tests required by API 612. In additions, vendor shall include an option for a turbine performance test. Complete details of the proposed tests must be included.

4.2.2 Field Tests

If desired by Purchaser, a field test will be performed at the job site by Purchaser. Vendor shall be given advance notice so that representatives may witness the test. The test shall demonstrate the ability of all equipment to operate at the specified conditions and within the guaranteed power limitions.

The instrumentation installed with the unit will be used for this test. No other special instrumentation will be used or required. Purchaser's standard flow measurement instruments shall be used to determine the air flow through the compressor system.

In addition to abtaining design point data, the test run will be utilized to determine the following:

a. Calculate each stage adiabatic efficiency by temperature rise method.
b. Check intercooler pressure drops with respect to design values.
c. Determine motor input power from measurement of volts, ampere, and power factor.
d. Determine turndown capability and surge line data for proper calibration of the anti-surge controls.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

4.0 TESTING AND GUARANTEES

4.3 Guarantees

Vendor's proposal shall include guarantee and tolerances for the following:

a. Capacity as defined in Section 3.2.3
b. Compressor shaft BHP
c. Kilowatt input to motor

Vendor's proposal shall include a statement that the proposal is in complete accordance with these specifications.

Compressor manufacturer shall have overall responsibility for the mechanical and electrical performance of the unit meeting guaranteed values and for the complete compressor-drive system being free of any adverse mechanical or electrical torsional characteristics at operating conditions.

The vendor shall guarantee against incorrect design, defective materials, poor workmanship and failure from normal usage. During the guarantee period, he shall repair or replace the defective equipment at his expense. He shall also state the terms and conditons of his guarantee. This guarantee shall be for a minimum of one year from the date of start-up or 18 months from date received at site, whichever is first.

The vendor shall guarantee all equipment to be suitable for all possible operating conditions including possible upset conditions up to safety device set points. Vendor shall define any safety valve setting and any other safety trip parameter required to protect the equipment.

TITLE MAIN AIR COMPRESSOR CP-11

5.0 DELIVERY

5.1 Schedule

Delivery schedule shall be specified starting from the date of receipt of order.

Vendor shall state time required to submit drawings for approval and time alloted for drawing approval in order that he meet his specified delivery.

5.2 Preparation for Shipment

All gas, water, and oil piping shall be cleaned and pickled before shipment. Any piping components that are disassembled before shipment are to be sealed from any contaminating elements after cleaning.

All open connections in the "as shipped" condition shall be blanked with metal or wooden covers bolted to the flanges. Threaded openings shall be closed with threaded plugs.

All water shall be drained from the unit and accessories before shipment.

If waxes or other protective coatings are used, they shall be of a type not requiring removal or easily removable without dismantling the unit.

Vendor to label all disassembled parts, valves, instruments, piping, etc., for ease of assembly at site and to furnish a list of such parts. It shall be the vendor's responsibility to insure that the packages are sized to allow delivery to the job site.

The vendor shall adequately support or crate the unit to withstand all shipping loads without damage. The vendor shall adequately tie down to the shipping vehicle the unit to prevent damage en route.

It shall be the vendors's responsibility to repair or replace any items damaged during shipment. All insurance claims shall be processed by the vendor.

Vendor shall notify Airco Cryoplants of all shipping dates which shall include all pertinent shipping information, including but not limited to: name of carrier, way -bill number, estimated time of arrival at the job site.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE MAIN AIR COMPRESSOR CP-11

5.0 Delivery

5.3 Shipment

Vendor shall clearly state in his proposal the terms and conditions of shipment. Charges, if any, are to be established in the proposal.

5.4 Acceptance

Final acceptance of this unit shall be reserved until installed, operated and continuous performance for a minimum of 24 hours shows that design requirements are met. Operation and continuous performance shall be witnessed by the accepting Airco Cryoplants' representative.

WRITTEN BY L.P. Larsen DATE 2/81 APPROVED

Airco Cryoplants

☐ STANDARDS
☐ INSTRUCTIONS
☐ SPECIFICATIONS
☐ DATA

No. 0-251-1Z-8	15-E-23 A,B,C		
WRITTEN BY	A.E.	DATE	10-31-80
APPROVED BY	BM	DATE	10-31-80
APPROVED BY		DATE	3/11/81
APPROVED BY	HNH	DATE	3/11/81

REVISION																
PAGE																
DATE																
WRITTEN BY																
APPROVED BY																

ASU COLD BOX SPECIFICATION

BRECKINRIDGE KENTUCKY PLANT

15E-23 A/B/C

TITLE COLD BOX SPECIFICATION

INDEX

TITLE

COLD BOX SPECIFICATION

SCOPE

1.1 General

The Edmonton Works will supply prefabricated cold box structures containing all required equipment and piping for the column section and pure argon section of an air separation unit to be installed in the Breckinridge, Kentucky area.

This specification lists requirements for design, fabrication, testing, and preparation for shipment, that pertain to Edmonton supplied equipment.

1.2 Scope of Edmonton Supply

Edmonton will furnish three (3) shop fabricated cold boxes to house the following major prepiped components:

Quantity	Item No.	Description
3	SP-32	Flash Separator
3	C-30	Low Pressure Column
3	RB-31	ASU Reboiler
3	RB-31A	ASU Auxiliary Reboiler
3	C-25	High Pressure Column
3	HE-36 A&B	Reflux Nitrogen Subcooler
3	HE-26 A&B	Rich Liquid Subcooler
3	HE-23	Oxygen Product Heater
3	HE-24 A&B	Waste Nitrogen Heater
3	D-27 A,B&C	Rich Liquid Adsorbers and Filters
3	D-37 A&B	Guard Adsorbers and Filter
3	RB-28	Crude Argon Condenser
3	C-29	Crude Argon Column
3	HE-33	Product Oxygen Subcooler
1	HE-40	Argon Heat Exchanger
1	SP-48	Hydrogen Separator
1	C-49	Pure Argon Column
1	SP-492	Crude Argon Surge Tank
1	RB-493	Pure Argon Column Reboiler
1	HE-494	Pure Argon Column Condenser
—	—	Process Piping

Drawings 0-251-4Y-14, 0-251-4Y-15, and 0-251-4Y-23 fully define Edmonton's scope of supply. Cryogenic equipment associated with pure argon system to be located in one coldbox. This equipment includes HE-40, SP-48, C-49, SP-492, RB-493, and HE-494.

TITLE

COLD BOX SPECIFICATION

1. SCOPE (continued)

1.3 Definition of Terms

Throughout this specification, "Murray"Hill refers to Airco Cryoplants, Murray Hill, New Jersey, and "Edmonton" refers to Cryoplants Limited, Angel Road, Edmonton. "AIG" refers to Airco Industrial Gases Division.

2. APPLICABLE DOCUMENTS

The following publications form a part of this specification to the extent indicated under Section 3.

Drawings

0-251-4Q-38	Air Separation Section Process Flowsheet
0-251-4Q-34	Argon Purification Process Flowsheet
0-251-4Y-14	Guard and R.L. Adsorber P & I Diagram
0-251-4Y-15	Air Separation Unit P & I Diagram
0-251-4Y-23	Argon Purification Coldend P & I Diagram

Codes
ASME Section VIII (Division 1)
ANSI B31.3

3. CONTRACT REQUIREMENTS

This specification establishes design parameters for Edmonton. Murray Hill will proceed with overall plant design on the assumption that deviations from these provisions will be cleared with Murray Hill.

The specification under 3.1 and 3.5 are Edmonton's guarantee numbers. They represent the basic design case for which the plant shall operate at best efficiency.

TITLE **COLD BOX SPECIFICATION**

3. CONTRACT REQUIREMENTS

3.1 Product Requirements

Oxygen, nitrogen, crude argon, and pure argon products will conform to the following:

3.1.1 Product Specifications

Liquid and Gaseous Oxygen

Design Oxygen Content	99.5% (v/v)

Liquid and Gaseous Nitrogen

Design Nitrogen Content (including inerts)	99.9998% (v/v)
Design Oxygen Content	2 ppm (v/v)

Crude Liquid Argon

Design Argon Content	96.5% (v/v)
Design Oxygen Content	2.0% (v/v)
Design Nitrogen Content	1.5% (v/v)

Pure Liquid Argon

Design Argon Content	99.999% (v/v)
Design Oxygen Content	2 ppm (v/v)

3.1.2 Air Separation Unit - Performance

Production capacity of each air separation unit will be as follows:

Stream	Flow Rate (SCFM)*	Purity % V/V
Liquid Oxygen	1678	99.6%
Gaseous Oxygen	26,473	99.6%
Net Crude Liquid Argon	808	96.5%
Liquid Nitrogen	189	<2 ppm O_2
Gaseous Nitrogen	17,774	<2 ppm O_2

The Edmonton equipment shall meet these production rates when the interface flow conditions are as specified in Sect. 3.5.1. Interface Flow Conditions - ASU, of this specification. Edmonton will be allowed a 3% tolerance on air flow.

*SCFM measured at 70°F and 1 ATM ABS

TITLE **COLD BOX SPECIFICATION**

3. CONTRACT REQUIREMENTS

3.1 Product Requirements (continued)

3.13 Pure Argon Section - Performance

Production capacity of the pure argon section will be as follows:

Pure Liquid Argon	SCFM*
Turndown Capacity	774
Design Capacity	2554

The turndown capacity applies when processing crude argon from only one ASU.

The design capacity applies when processing crude argon from all three ASU's, plus 10% added for contingency.

Edmonton shall guarantee a flow of 2322 SCFM of pure liquid argon to Murray Hill storage based on the interface flow conditions of section 3.5.2 of this specification. Except for turndown cases, no additional tolerance than the 3% air flowrate to the main ASU will be allowed.

*SCFM measured at 70 °F and 1 ATM absolute

3.2 General Design Requirements

Drawing no.	Title of P & I Drawings
0-251-4Y-14	Guard and R,L, Adsorber P & I
0-251-4Y-15	Air Separation Unit P & I
0-251-4Y-23	Argon Purification - Cold End P & I

Changes in cold box supply, piping, or equipment fittings must be effected by changes to these flowsheets (when such items are normally defined on the P & I drawings).

TITLE

COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS (continued)

3.3 General Design Data

Flow Measurement

The base for measurement of scf is 14.7 psia and 70°F.

Climatic Conditions

Dry bulb temperature	96°F
Wet bulb temperature	78°F
Barometric pressure	14.5 psia

Design pressure ratings

High pressure system	125 psig
Low pressure system	25 psig

Earthquake

Zone No. 2 (UBC 1976)

Roof loads

Live load - 20 lbs/sq ft

Wind loading

To meet Kentucky area requirements, use:

0-30 ft	20 lbs/sq ft
30-50 ft	25 lbs/sq ft
50-100 ft	30 lbs/sq ft
Over 100 ft	40 lbs/sq ft

Cold box datum

The top of the cold box foundation is assumed to be at the base elevation of 100 ft.

3.4 Operating Requirements

The following provisions are consistent with Airco Cryoplants commitments.

TITLE COLD BOX SPECIFICATIONS

3. CONTRACT REQUIREMENTS

3.4 Operating Requirements (continued)

3.4.1 Derime

Process air saturated with water at 85 psig and 90°F, will be warmed to 150°F, reduced in pressure to 20 psig and used for plant derime.

Rich liquid and guard adsorbers will be bypassed during plant derime; then reactivated after startup with medium pressure nitrogen taken from the warm end of the reversing heat exchanger.

3.4.2 Cool Down

Saturated air from the direct cooler will be used for cool down from ambient to normal operating temperatures. Adsorbers will be bypassed.

Cool down may be speeded by pumping LQN into the top of the low pressure column.

3.4.3 Turn Down

The ASU columns shall operate at 70% design air flow without loss of either oxygen, nitrogen or crude argon purity.

The pure argon column shall operate at 30.0% of the design crude argon feed rate without loss of pure argon purity.

3.4.4 Adsorber Reactivation

Adsorber reactivation and cool down must be completed within two eight hour shifts. Reactivation will be done with medium pressure nitrogen from the warm end of the reversing exchanger.

Adsorbers will operate a minimum of two weeks between reactivation.

3.5 Process Design Requirements

Process Flow Diagrams 0-251-4Y-33 and 0-251-4Y-34 will be used for process definition of Edmonton equipment.

TITLE COLD BOX SPECIFICATIONS

3. CONTRACT REQUIREMENTS

3.5 Process Design Requirements (continued)

Changes to these issues will require acceptance by both Edmonton and Murray Hill. Purchase specifications for all equipment must be submitted to Murray Hill for review.

3.5.1 Interface Flow Conditions - ASU

The three air separation units will be designed to operate under the interface conditions shown below. Edmonton will be allowed 3% tolerance on air flow.

Air Feed to Column	143,826	SCFM
		psia
		°F
High Pressure Liquid Nitrogen to Column (Subcooled Liquid)	2,693	SCFM
		psia
		°F
Waste Nitrogen to RHE	96,799	SCFM
		psia
		°F
Medium Pressure Nitrogen into RHE	20,600	SCFM
		psia
		°F
Liquid Oxygen Product	1,678	SCFM
	49	psia
	-300	°F
Liquid Nitrogen Product	189	SCFM
	20.3	psia
	-316	°F
Crude Argon Gas from Pure Argon System	281	SCFM
	20.1	psia
	-297	°F
Oxygen Gas into RHE	26,473	SCFM
		psia
		°F
Air to Pure Argon Column Reboiler	370	SCFM
	96	psia
	-275.4	°F
Liquid Air from Pure Argon Column Reboiler	370	SCFM
	95	psia
	-279.7	°F
Crude Argon to Pure Argon System	1,089	SCFM
	20.3	psia
	-297	°F

TITLE **COLD BOX SPECIFICATION**

3. CONTRACT REQUIREMENTS

3.5 Process Design Requirements

3.5.1 Interface Flow Conditions - ASU (continued)

Low Pressure NItrogen to Reversing Exchanger	17,774	SCFM
		psia
		°F
Liquid Oxygen into and out of Guard Adsorber	30,140	SCFM
		psia
		°F

3.5.2 Interface Flow Conditions - Pure Argon Section

The pure argon section will be designed to operate under the interface conditions shown below.

Liquid Air to L.P. Column	1110	SCFM
	95	psia
	-279.7	°F
Waste Argon from Pure Argon Column	51.6	SCFM
		psia
		°F
Warm Argon from Argon Heat Exchanger HE-40	2778.5	SCFM
		psia
		°F
Warm Argon into Argon Heat Exchanger HE-40	2728.9	SCFM
		psia
		°F
Pure Liquid Argon to Storage	2524.6	SCFM
	44.0	psia
	-281.8	°F
Pure Argon Vent Gas from Storage Tank and Trailer Flash	201.8	SCFM
	20.3	psia
	-297	°F
Crude Argon Gas to ASU	843	SCFM
	20.1	psia
	-297	°F
Air from HP Column	1110	SCFM
	96	psia
	-275.4	°F

TITLE COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.5.2 Interface Flow Conditions - Pure Argon Section (continued)

Crude Liquid Argon from ASU	3267	SCFM
	20.1	psia
	-297	°F

3.5.3 Column Design

Anticipated tray stacking for the ASU columns is shown in Figure 2. Edmonton will confirm Airco's tray stacking or recommend changes.

3.5.4 Rich Liquid Subcooler (HE-26)

Oversize by 50% as an allowance for fouling.

3.5.5 Waste Nitrogen and Pure Nitrogen Subcooler

To insure that adequate waste flow can be achieved on off design conditions, the waste nitrogen piping and subcoolers should be designed to meet design pressure drop at 105.% of the design flow indicated on flowsheet.

3.5.6 Insulation

Mineral wool (provided by Murray Hill) will be used for cold equipment insulation. Insulation will be done in field by Murray Hill.

Thermal conductivity will be 0.25 BTU/hr sq ft °F (at -200°F).

A layer of "cellular glass" insulation will be installed on the low pressure colulmn - from the rich liquid feed to the top - and on lines operating at temperatures lower than the dewpoint of air. Edmonton will supply an external column ring for insulation support.

3. CONTRACT REQUIREMENTS

3.5 Process Design Requirements

3.5.6 Insulation (continued)

An insulation depth of 24" will be provided between the bottom of the high pressure column (on the rich liquid line) and the cold box floor.

Eighteen inches is required between vessels and the nearest outside steel member, and between the waste nitrogen line and nearest steel. Twelve inch clearance may be used for other lines if necessary. Deviations are subject to approval.

3.6 Mechanical Design Requirements

Design should allow for maximum utilization of Edmonton's shop facility to minimize field costs.

Loose shipment of cold process piping should be avoided, except for interconnecting piping between cold boxes.

3.6.1 Code Requirements

a. ASME Section VIII (Division 1) latest addition and addenda.

b. ANSI (USAS) B31.3

3.6.2 Materials of Construction

Normal Edmonton practice will be followed unless modified by the following items.

Adsorbers

Stainless Steel.

All new materials are to be used unless cleared with Murray Hill.

TITLE COLD BOX SPECIFICATIONS

3. CONTRACT REQUIREMENTS

3.6 Mechanical Design Requirements (continued)

3.6.3 Cold Box Requirements

3.6.3.1 Structural Requirements

The cold boxes will be panel type, rectangular all welded carbon steel casings designed for outdoor installation. Panel brakes are not required. The boxes should be shipped as completed packages.

3.6.3.2 Cold Box Access

Bolted, gasketed manways are required in elevation increments of approximately 24 ft to facilitate insulation. Nuts are to be tack welded inside the cold box, and final arrangement is subject to approval from Murray Hill.

3.6.3.3 Platforms and Ladders

Platform and ladder locations are set by Edmonton, allowing access to all valves and controls on the cold box. Murray Hill will do final platform design. Edmonton piping layouts should be directed toward minimizing the number of platforms required. Railings are required on all platforms and additional ladders are required to top of cold box roof. All platform, ladder, and railing material will be supplied by Murray Hill.

3.6.3.4 Data Plates

Duplicate pressure vessel data plates shall be positioned on the outer wall of the cold box.

3.6.3.5 Supports

Temporary pipe and vessel supports, painted yellow will be bolted in place for ease of removal.

Permanent supports are to be shop installed.

Permanent supports will be bare or painted with an inorganic zinc primer not of yellow color depending upon the need for protection against corrosion.

TITLE **COLD BOX REQUIREMENTS**

3. CONTRACT REQUIREMENTS

3.6 Mechanical Design Requirements

3.6.3 Cold Box Requirements

3.6.3.6 Cold Box Purge

Provisions are to be made for purging dry nitrogen through perforated headers within the cold box. These headers are to be arranged to ensure even distribution through the cold box; a single distributor at the base of the cold box will not be acceptable.

If box columns are used for corner supports these can be drilled and used for distribution.

3.6.3.7 Cold Box Relief

Pressure relief devices are required for each cold box. No special requirements have been established but final selection and location of devices is subject to review.

3.6.3.8 Cold Box Dimensions

The maximum allowable dimensions of the main column box for transport in the U.S.A. are to be furnished by Murray Hill.

3.6.4 Vessel Requirements

All pressure vessels including columns must be designed, fabricated and inspected in accordance with the latest edition and addenda of ASME Section VIII, Div. 1. The vessels will be code stamped by a National Board Commissioned Inspector.

All drawings and calculations must include the information stated in Section 3.9.1.2.

The manufacturer shall furnish in addition to any code requirements, six (6) copies of the Manufacturer's Data Report, ASME form U-1, within one week of the code approval date of the vessel.

All drawings, etc. shall be sent to Airco Cryoplants ATTN: Central Files, 460 Mountain Avenue, Murray Hill, New Jersey, 07974, unless otherwise specified.

3.6.4.1 Access

Vessels with internals that can be reasonably expected to require maintenance (such as adsorbers) shall have manways or handholes suitable for inspection and replacement of parts.

TITLE COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.6 Mechanical Design Requirements

3.6.5 Exchanger Requirements

All exchangers must be designed, fabricated, and inspected in accordance with the latest edition and agenda of the ASME Section VIII, Div. 1. The exchangers will be code stamped by a National Board Commissioned Inspector.

3.6.5.1 Relevant Information

The manufacturer must include in his supply two reproducible print velographs of all drawings and calculations used in the design. Bursting test data to support the calculations must also be supplied.

All drawings and calculations must include the information stated in Section 3.9.1.2 and be submitted to Murray Hill for approval before the final reproducibles are made.

These details must be available to Murray Hill within six weeks of placing the order on the subcontractor.

3.6.6 Adsorber Requirements

Each adsorber shall have provision for draining and refilling the adsorbant with a minimum of insulation removal.

The adsorbers will be filled with silica gel in the field by Murray Hill.

The specification for the adsorbant - including the size and depth of bed required - will be specified by Edmonton, and reviewed by Murray Hill (before final release for fabrication).

Adsorbers will be designed to incorporate after filters within the adsorber vessel.

3.6.7 Piping

All Piping requirements within each of the cold boxes will be met by Edmonton.

All cold piping systems will be fabricated of aluminum or stainless steel and in accordance with ANSI (USAS) Code for Pressure Piping B31.3 latest edition and addenda.

All piping external to the cold boxes will be supplied by Murray Hill. All warm piping external to the cold boxes will be carbon steel and in accordance with ANSI (USAS) Code for Pressure Piping B31.3.

Thaw, drain, and sample connections are to be run inside the box to near ground level.

TITLE COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.6 Mechanical Design Requirements

3.6.7 Piping (continued)

Internal Piping

Welded connections will be used throughout except for certain valves which will be flanged (see paragraph 3.6.8). Low point piping drains must be provided particularly around cold adsorbers.

External Piping

Thawing and drain manifolds external to the cold box will be supplied by Edmonton for single point connection to Airco piping.

Boundary Terminations

Pipe terminations at cold boxes will be to ASA B36.10 sizes and wall thicknesses.

Lines connecting to the Murray Hill heat exchanger duct shall terminate within the cold box six inches from the cold box wall. Adequate clearance for field welding is to be provided. The lines connecting to the heat exchanger duct should exit the cold box at the proper elevation for stacked exchangers.

The connections for the high pressure nitrogen feed from the liquefier and the exit connections for the liquid products shall be near the bottom of the cold box and through a thermal break panel.

The final location for all cold box connections must be approved by Murray Hill.

3.6.8 Valves

All internal automatic and manual valves that are to be installed in cold lines shall have external bonnets projecting to the outside through flexible sealing diaphragms.

Cryogenic valves in liquid service shall be inclined upward a minimum of 15° from the horizontal.

Piping transition pieces are to be avoided where possible. Valves joining stainless to aluminum piping will be flanged connection.

All valves internal to the cold box will be purchased by Murray Hill and shipped from the United States for installation in the Edmonton shop, carriage paid. Three copies of invoice stating "Free issue material" to be sent to Edmonton prior to dispatch. All valves shipped from U.S. to be certified as clean for oxygen service. All valves shipped from U.S. to be certified as pressure tested.

TITLE COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.6 Mechanical Design Requirements

3.6.8 Valves (continued)

Control Valves

Control valves will be purchased by Murray Hill to Edmonton specifications. Edmonton specifications must include the following:

Body size
Type of valve (Globe, Butterfly, etc.)
Valve CV
Trim characteristic
Shaft extension

Control valves will have flanged connections. Control valves shall be supported so as not to induce excessive pipe stress.

Hand Valves

Manual valves in aluminum piping will be aluminum body for weld connections where possible. If not obtainable, valves will either be stainless or brass with flanged connections.

If damage to manual valves during shipment of the assembled cold box cannot reasonably be precluded, then the applicable valves will be shipped to the site and a spool piece provided by Edmonton in place of the valves.

When manual gate valve stems are removed for shipping clearance, the valve stem shall be tagged for identification and direction flow.

Safety Valves

Safety valves are to be specified by Edmonton. Supply to be Murray Hill responsibility. Safety valves will not be shipped to Edmonton.

Valves Exterior to Cold Box

All exterior valves will be added at job site by Murray Hill. Edmonton to clearly define connecting line, position, and size on cold box penetration drawings.

All exterior valves may have threaded connections where size permits.

TITLE

COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.7 Instrumentation Requirements

Edmonton will supply flow elements, temperature elements, and sample connections within the cold box limits. Murray Hill shall supply transmitters, pressure gauges or any other instrumentation installed outside the cold box limits.

3.7.1 Instrument Connections

All process sample lines and measuring connections originating within the cold box must be protected against damage and terminated at permanent weatherproof connections in a junction box or on a common panel on the cold box shell. Each box must have its own panel. Tubes shall not be welded between boxes. All sample taps shall be located on the side of equipment facing the platforms and ladders for easier access.

Level Connections

Backup taps are required for critical level indicators. As a minimum, a second set of low-pressure connections are required for the two column levels. If no usable backup connection is available for the high pressure taps (such as a drain) then duplicate vessel taps are to be provided.

Proper routing of level lines within the cold box must be shown by drawing and not left for shop determination.

All level taps shall be located on the side of equipment facing the platforms and ladders for easier access.

Line Size

Mimumun size of lines to be used - 3/8" O.D. x 0.49" wall tubing.

3.7.2 Temperature Elements

Thermocouple wiring is to be attached to process piping in the manner indicated in Figure 1 of this specification.

All wires are to be properly tagged in a way that makes identification simple.

Thermocouple pairs are to be mechanically bound to each other at the cold junction. Wiring to be supported by piping, conduit or structural members and terminate at one junction box located at ground elevation on each shipping unit.

Edmonton supplied thermocouple wire is to copperconstantan 20 gauge, solid wire, TFE tape, teflon impregnated glass braid over each conductor, teflon impregnated glass braid overall; Claude S. Gordon catalogue No. T-20-1-207 or approved equal.

TITLE COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.8 Erection Requirements

Erection of Edmonton supplied items is the responsibility of Murray Hill.

3.8.1 Column Leveling

Edmonton should provide the same type of column scribe mark used at Fairfield for leveling.

In addition, three pads are to be provided at the top of the column for level checks.

3.8.2 Rigging

Spreader beams and chokers for unloading and site use will be supplied by Murray Hill. Edmonton to provide drawing showing method to be used in lifting off transport vehicle and to the vertically installed position.

3.8.3 Baseplates

Baseplates will be provided by Murray Hill, but will be designed by Edmonton. Edmonton will specify the required size and number of anchor bolts.

3.9 Administrative Requirements

3.9.1 Data and Drawings

3.9.1.1 General

The following documents and drawings are required for Murray Hill approval. One reproducible will be required for each drawing.

a) Anchor bolt locations
b) Foundation loading
c) Vessel and exchanger layout
d) External cold box drawings
e) Piping arrangement and tie-in drawings
f) Vessel and heat exchanger drawings and calculations
g) Shipping weights
h) Cold box panel diagram showing penetrations
i) Structural steel erection diagrams
j) Monthly progress reports
k) Contract schedule
l) Spool piece and line material summary
m) Drawing list

A record set of all calculations and drawings is required.

TITLE COLD BOX SPECIFICATION

3. CONTRACT REQUIREMENTS

3.9 Administrative Requirements (continued)

3.9.1 Data and Drawings

3.9.1.2 Vessel Drawings

Vessel drawings are to include plan and elevation drawings of adsorbers, columns, and separators showing all nozzle and internal details. Column drawings to specifically show tray distribution and tray details.

Vessel drawings will contain the following information. One reproducible will be sent in each case.

a) Code to which vessel is constructed
b) Requirements for stamping and inspection. Include in the ASME nameplate the following information:
    a) Shell and head thickness
    b) Dished radius of heads
c) Materials (to American specs. for pressure parts, non-pressure parts to B.S. specifications with nearest American equivalent alongside)
d) Radiographed (require or not required)
e) Stress relieved (required or not required)
f) Corrosion allowance (if any)
g) Joint efficiency
h) Operating pressure
i) Operating temperature
j) Maximum working pressure
k) Hydrostatic test pressure or air test pressure or both
l) Water capacity
m) Weight empty (approx.)
n) Weight filled with water (approx.)
o) Orientation of nozzles and elevation
p) Diagrammatic view of interior of vessels
q) Dimensions

3.9.1.3 Numbering of Equipment Items

All numbering of equipment, instrumentation, and process piping to be in complete accordance with the Murray Hill process and engineering flowsheets included as part of this specification (Section 2).

TITLE **COLD BOX SPECIFICATION**

3. CONTRACT REQUIREMENTS

3.9 Administrative Requirements

3.9.2 Reports

A Critical Path Diagram showing the design. planning, procurement, and fabrication activities will be employed. This diagram is to be reviewed and corrected every two months or earlier at the Contract Manager's discretion until the equipment is dispatched. from Edmonton.

One copy of each revised schedule will be sent to the Project Manager at Murray Hill through the Contract Manager.

3.9.3 Miscellaneous Manuals and Data

A minimum of six (6) sets of manuals and date for all equipment purchased is required. This includes, but is not limited to, the following:

a). Data reports and code stamp rubbings
b) Control valve specifications and manuals including drawings
c) Inspection documentation

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality Assurance - ASME Pressure Vessels and Piping

The fabricator shall document and maintain a quality control program that complies with the requirements of ASME Pressure Vessel Code Section VIII, Div. 1.

All welding procedures, welder and welding operator qualifications shall meet the requirements of ASME Section IX and one reproducible copy shall be submitted to Airco Central Files.

The fabricator shall submit to Airco Central Files one reproducible copy of each mill test data report and material certification as required by the ASME code.

The fabricator shall submit to Airco Central Files one reproducible copy of all certified inspection and test results.

All ASME and National Board stamped pressure vessels shall be hydrostatically tested, except for distillation columns which shall be pneumatically tested. All piping systems shall be pneumatically tested as specified in the ANSI B31.3 piping code.

TITLE

COLD BOX SPECIFICATION

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality Assurance - ASME Pressure Vessels and Piping (continued)

All pressure vessels and piping shall be cleaned internally free of all scale, slag, rust, foreign material, and hydrocarbons if in oxygen service. The exterior shall be clean of all scale, slag, rust, and foreign material.

4.2 Quality Assurance - Equipment Performance Tests

A performance test will be carried out on site by AIG under Murray Hill supervision to ensure that the requirements of Section 4.5.1 are met.

4.3 Acceptance

Final acceptance will be reserved until all components have been proven.

4.3.1 Mechanical Acceptance

Airco may conditionally accept the cold boxes upon delivery to site, and before the acceptance tests. The units will be accepted - in the sense that fabrication is complete. This will not imply that Airco Cryoplants - and therefore Edmonton - is relieved of responsibilities listed under warranties.

4.4 Warranty Restriction and Guarantee

Edmonton is reponsible for the replacement or repair of items supplied by them that are either defective or do not meet guarantee conditions.

4.4.1 Performance Warranty

One operating case has been chosen to serve as a basis for the performance warranty. The proposed facility is guaranteed to meet these capabilities listed under the temperature, pressure and purity specifications of Section 3.

The standard base for flow is 14.7 psia and 70°F.

Production rates are measured at the cold box battery limits. No measuring tolerances are allowed.

5. DELIVERY

5.1 Shipping Charges

Edmonton is responsible for liaison with Murray Hill and as necessary with Airco's transport manager for placing the freight order. Final choice of shipping company is Murray Hill or their nomination's responsibility. These are to be charged at cost to Murray Hill and will be only to port of entry.

Edmonton is responsible for all insurance charges to F.O.B. London Docks only. Insurances from F.O.B. to site is Murray Hill's responisibility and its confirmation prior to shipment by name of company, etc., to be conveyed to Edmonton.

5.2 Packaging

Maximum allowable dimensions for package to be transported in U.S.A. are to be furnished by Murray Hill.

Edmonton to supply weight and shipping dimensions for packages.

Adequate precautions to be taken for sealing each cold box against the ingress of sea water. It should be assumed that each package will be shipped as deck cargo.

5.3 Preparation for Shipment

5.3.1 Painting

All exposed carbon steel surfaces shall be prepared in shop with a "Commercial Blast" and painted with a 1 1/2 mil coat of Amercoat Dimetcote 2 steel primer or approved equal. See attached paint specification sheets, pages 25 and 26 Stainless steel or aluminum pipes and vessels shall not be painted.

5.3.2 Corrosion Protection

Equipment subject to corrosion shall be suitably protected during shipping and storage.

5.3.3 Connections

All piping, pressure taps, etc., to be shipped with suitable blanks, caps, or other closures to prevent entrance of dirt and other foreign matter.

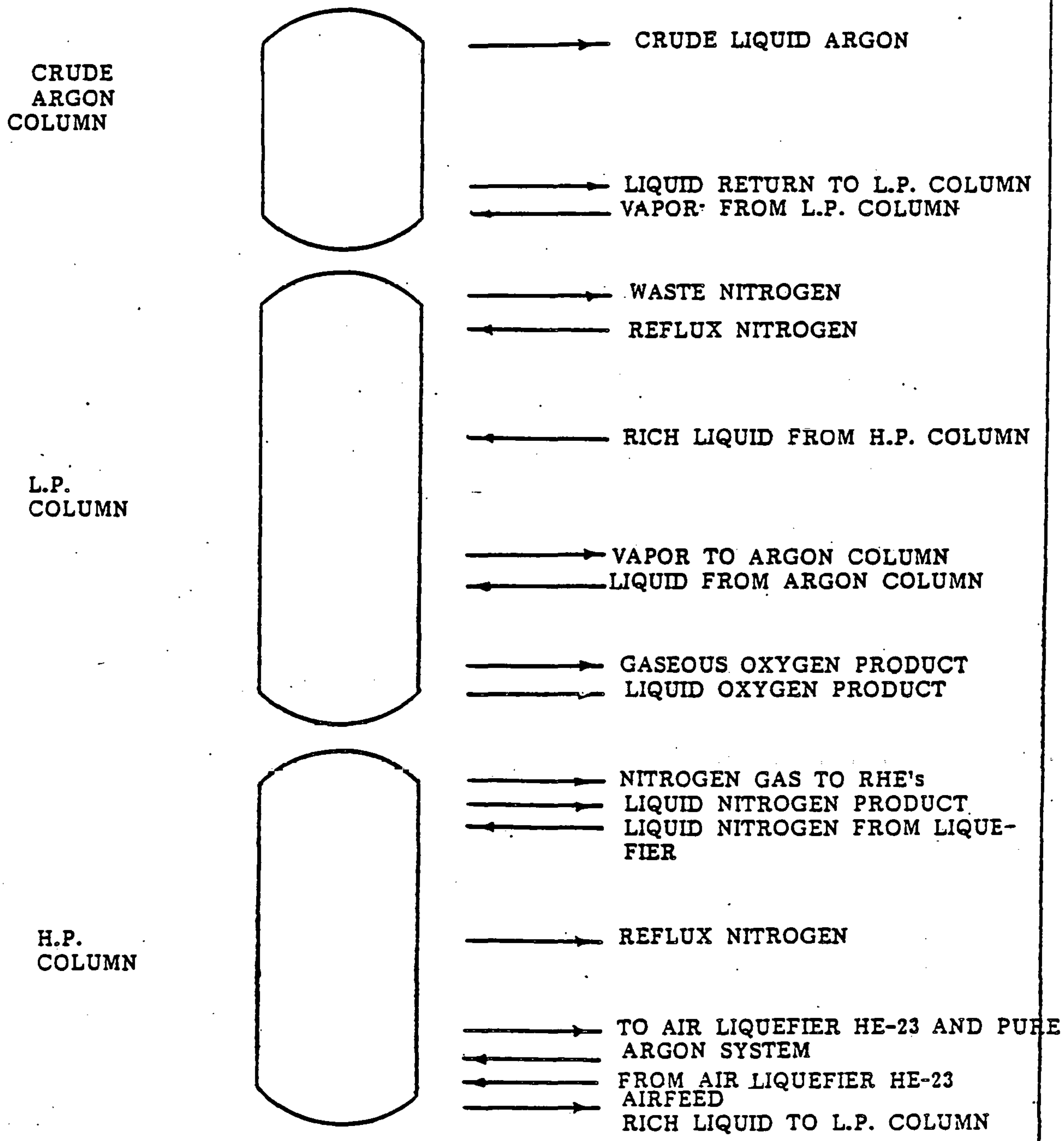
5.3.4 Markings

All separately packaged equipment or parts shall be marked as agreed with the Contract Manager.

TITLE

COLD BOX SPECIFICATION

FIGURE 2 - ANTICIPATED TRAY STACKING



REBOILERS AND CONDENSERS ARE NOT COUNTED AS TRAYS

SPEC No 0-251-1Z-8

Amercoat® DIMETCOTE STEEL PRIMER

PROTECTIVE COATING

TYPE: Self-Curing Inorganic Zinc Primer

USE: Preconstruction Primer; Shop or Field-Applied Primer

SUITABLE FOR: Steel

☐ INORGANIC ZINC PROTECTION AT SHOP PRIMER COST

☐ SPECIALLY FORMULATED FOR PRIMING STEEL

☐ USE AS WELDABLE PRECONSTRUCTION PRIMER OR FIELD OR SHOP-APPLIED PRIMER

☐ PREVENTS CORROSION OVER 1 YEAR AT ¾ MIL; "PERMANENT" PRIMING AT 1½ MILS WITH SUITABLE TOPCOAT

☐ DRIES HARD; PERMITS ALMOST IMMEDIATE HANDLING, WELDING, CUTTING AND FABRICATING

☐ NO BURNBACK—BURNS ONLY WHERE TORCH OR ARC TOUCHES; WILL NOT UNDERCUT, REDUCES REPREPARATION

☐ WATER BASED—NO SPECIAL SAFETY REQUIREMENTS

As A Weldable Preconstruction Primer—

- Far More Abrasion-Resistant Than Organic Primers; Minimizes Damage During Handling and Fabricating
- Bonds With Steel for High Degree of Adhesion ....Many Bending and Shaping Operations Can Be Performed Without Rupturing Primer
- Fabricators Can Enjoy Savings Gained With Automatic Welding Equipment and Other Production-Line Techniques

As A Field or Shop-Applied Primer—

- Far Greater Protection Than By Conventional Inhibitive Primers Based on Red Lead or Chromate Pigments
- Even More Protection Than Full Coat of Conventional Zinc-Rich Coatings
- Compatible With Almost All Types of Organic and Inorganic Topcoats

PRINCIPAL USES:

As a weldable preconstruction primer, protects against weathering and abrasion on:

■ Flat Steel Plates ■ Structural Steel Shapes

Apply a single coat at ¾-mil dry film thickness. After fabricating, overcoat with suitable inorganic zinc for "permanent" priming, then with recommended organic topcoat.

As a field or shop-applied primer, protects against weathering, water, abrasion or chemical atmospheres on:

■ Ships ■ Barges ■ Tank Interiors and Exteriors ■ Marine and Industrial Structures

Apply a single coat at 1½ mils dry film thickness, and overcoat with suitable organic topcoat.

NOTE: When topcoating Dimetcote Steel Primer 2 with vinyls, a tie coat may be required. Obtain a specific recommendation from the Amercoat Representative before topcoating.

FINISH	Matte
COLOR	Zinc Gray
RECOMMENDED DRY FILM THICKNESS PER COAT	¾ Mil (Preconstruction) 1½ Mils (Shop or Field)
NO. OF COATS RE'D	1
TOTAL DRY FILM THICKNESS, STEEL PRIMER	¾ Mil (Preconstruction) 1½ Mils (Shop or Field)
TOTAL VOLUME SOLIDS†	35.0%
THEORETICAL COVERAGE* @ 1 MIL	560 Sq. Ft. per Gal.
THEORETICAL COVERAGE* PER COAT @	¾ Mil: 750 Sq. Ft. per Gal. 1½ Mils: 375 Sq. Ft. per Gal.

*When computing working coverages, allow for application losses, surface irregularities, anchor pattern depth, etc.

NO. OF COMPONENTS	2
MIXING RATIO	14 Lbs. Powder to ¾ Gal. Liquid
POT LIFE	8 hrs. @ 70°F
APPLY OVER	Blasted Steel
APPLY BY	Conventional Spray
DRYING TIME	Water Insoluble: At least 15-30 min. @ 50-95°F, 50-95% humidity To Handle: 15 minutes or less on warm (above 50°F) steel
TOPCOAT REQUIRED	Inorganic Zinc, Vinyl or Epoxy
THINNER	None
CLEANER	Fresh Water

TEMPERATURE RESISTANCE	Up to 800°F (dry)
FLASH POINT	Nonflammable
COMBUSTIBILITY	Nonflammable
WT. PER MIL/SQ. FT. OF DRY FILM	Approx. 0.50 oz.
ELECTRICAL CONDUCTIVITY	Weak Conductor

PACKAGING	1 Gal. Liquid 1 Gal. Powder
SHIPPING WEIGHT	6.1 lbs. Liquid, 15.1 lbs. Powder
GUARANTEED SHELF LIFE FROM SHIPMENT DATE	1 Year

†Volatiles Measurement Method

Amercoat® DIMETCOTE STEEL PRIMER 2

APPLICATION INSTRUCTIONS Spec No - 0-25I-1Z-

SURFACE PREPARATION

☐ Immersion Services—

- ■ As a weldable preconstruction primer or as a shop or field-applied primer, dry-abrasive blast, including all pits and depressions, remove all mill scale, rust, rust scale, grease, paint or foreign matter. Surface profiles from abrasive blasting should be similar to those obtained with fresh steel grit (G-40 size), steel shot (S-230 size), graded flint or silica sand (30-60 mesh). Use nozzle pressure of 100 psi with air volume at 200 CFM minimum. If reusing blasting abrasives, clean them of contamination before reusing; do not reuse sand or flint abrasives.

  Where an automatic blasting unit is used, its manufacturer should be consulted for "working" abrasive mixtures and line speeds.

☐ Nonimmersion Services—

- ■ As a weldable preconstruction primer or shop or field-applied primer, dry-abrasive blast new steel in accordance with Steel Structures Painting Council Specification SP-6-63 for "Commercial Blast."
- ■ As a field-applied primer for old steel, dry-abrasive blast in accordance with Steel Structures Painting Council Specification SP-10-63T for "Near White Metal."

EQUIPMENT REQUIRED

- ■ Pressure material pot with mechanical agitator.
- ■ Separate atomizing air and fluid pressure regulators.
- ■ Air supply: continuous volume of 20 CFM at 35-50 psi minimum to each gun nozzle (with DeVilbiss equipment).
- ■ Air hose for gun, 5/16" ID.
- ■ Material hose, ½" ID.
- ■ Industrial spray gun, such as DeVilbiss MBC 704FF or 24FF with leather or Teflon needle packing and heavy mastic spring.
- ■ 30-60 mesh metal screen.

SAFETY EQUIPMENT REQUIRED

(In Tanks or Confined Areas Only)

- ■ Air mask, such as DeVilbiss P-MPH 527 and MPH 529, connected by ¼" ID hose directly to air source.

APPLICATION PROCEDURE

1. Clean all equipment with fresh water.
2. Discard desiccant bag from powder can.
3. Thoroughly mix total contents of each powder can slowly into total contents of each liquid can until well dispersed. Use power mixer. Do not reverse order. Do not vary proportions.
4. Do not thin for any reason.
5. Strain mixture through 30-60 mesh screen to remove large particles.
6. Remove all dust from surfaces to be coated.
7. Regulate air pressure: 30-50 psi to gun (with DeVilbiss) and 10-15 psi to pot. Note: pressure requirements may vary with temperature and hose length.
8. Keep pressure pot at approximately same elevation as spray gun.
9. Hold spray gun at right angle to work, and make even, parallel passes. Overlap each pass 50%; do not leave bare spots, pinholes, or holidays.
10. Apply a heavy, wet coat. Double-lap spray all welds, corners, edges, etc.
11. Clean all equipment immediately after use with fresh water.
12. Allow Dimetcote Steel Primer 2 to dry at least 15-30 minutes @ 50-95°F, 50-95% humidity to resist intermittent contact with water, rain or condensation.
13. Before handling Dimetcote Steel Primer 2, allow to dry 15 minutes or less on warm (above 50°F) steel.
14. If additional thickness is desired, recoat when 1st coat is dry to touch.
15. Before topcoating, allow to dry 24 hours at 75°F.

TO TOPCOAT DIMETCOTE STEEL PRIMER 2

1. When used as a field primer, topcoat with vinyl or epoxy. For epoxy, apply full coat at recommended coverage for epoxy topcoat. For vinyls, see note below.
2. When used as an after-blast primer to be topcoated with an inorganic zinc: (a) roughen and clean surface with dry brush-off blast. Tightly-adhering Dimetcote Steel Primer may remain. (b) apply inorganic zinc topcoat according to that product's application instructions.
3. When used as an after-blast primer to be topcoated with epoxy or vinyl: (a) dry surface and remove oil, grease, or other contaminants with Amercoat No. 57 Oil Cleaner. (b) apply epoxy full coat at recommended coverage. For vinyls, see note below.

NOTE: If topcoating with vinyls, apply tie-coat where required, then topcoat. For best results with high-build topcoats, apply light "mist" of topcoat material to avoid solvent bubbling. When mist coat is tack-free (a few minutes), apply full topcoat.

WARNING: Dimetcote Steel Primer 2 Powder is a harmful dust. Avoid breathing dust. Wash thoroughly before eating or smoking. Keep away from feed or food products.

WARNING: Dimetcote Steel Primer 2 Liquid may cause burns to skin and eyes. Avoid contact with skin, eyes, and clothing. Do not take internally. When handling, wear goggles or face shield. In case of contact, immediately flush skin with plenty of water; for eyes, flush with plenty of water for at least 15 minutes and get medical attention.

If welding is to be performed in confined spaces on steel coated with Dimetcote Steel Primer 2, do so in accordance with instructions in U.S.A. Standard Z 49.1—1967, "Safety in Welding and Cutting."

Ameron
CORROSION CONTROL DIVISION
Home Office BREA CALIFORNIA 92621

R 3/70

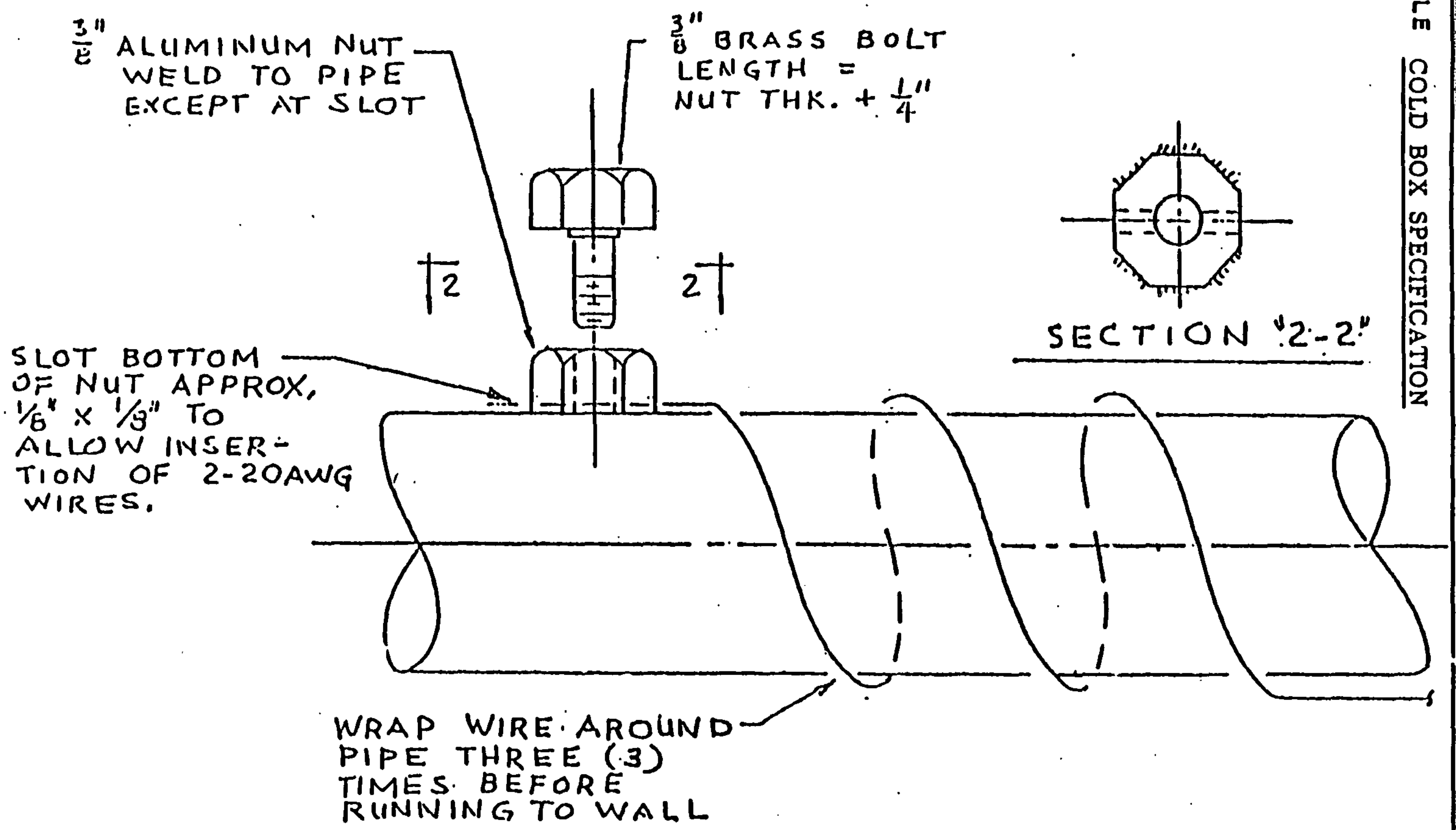


FIGURE 1 - THERMOCOUPLE ATTACHMENT

CR 171A - 3/76 PRTD. IN USA

Airco Cryoplants	☐ STANDARDS ☐ INSTRUCTIONS ☒ SPECIFICATIONS ☐ DATA	NO. 0-251-12-10			
		WRITTEN BY	LPL	DATE	2-25-80
		APPROVED BY		DATE	3/10/81
		APPROVED BY		DATE	3/11/81
		APPROVED BY	HuH	DATE	3/11/81

REVISION																
PAGE																
DATE																
WRITTEN BY																
APPROVED BY																

OXYGEN COMPRESSORS

CP-50 A, B, C

BRECKINRIDGE PROJECT

AIRCO Cryoplants

☐ STANDARDS
☐ INSTRUCTIONS
☒ SPECIFICATIONS
☐ DATA

NO. 0-251-1Z-10

REV.

TITLE OXYGEN COMPRESSOR CP-50

INDEX

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

AIRCO Cryoplants

☐ STANDARDS
☐ INSTRUCTIONS
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☐ DATA

NO. 0-251-12-10
REV.

TITLE OXYGEN COMPRESSOR CP-50

1.0 SCOPE

1.1 General

This specification defines the requirements for a centrifugal oxygen compressor to compress high purity product oxygen to pipeline pressure. The compressor shall be a multi stage intercooled centrifugal type. Intercoolers are required to achieve operating efficiency and to maintain low operating temperatures. When multiple units are specified in Section 3, this specification will apply to each unit.

All equipment furnished shall be suitable installation and operation as defined in this specification and shall be designed for the site conditions outlined in Section 3.

1.2 Destination

Breckinridge, Kentucky

1.3 Changes in Scope of Supply

The vendor shall clearly define, in writing, all areas where his scope of supply deviates from the scope of supply of this specification.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent indicated under Section 3.

2.1 Codes

ASME Code for Unfired Pressure Vessels, Section VIII, Division 1, latest edition, revision or supplements to.

Code for Pressure Piping ANSI B31.3, latest edition, revision, or supplement to.

Federal, State and local codes, and ordinances including OSHA, where applicable.

National Electric Code

2.2 Standards

NEMA
ANSI - Standards For Motors
IEEE - Standards For Motors

TEMA
API-612

AGMA-421
Compressed Gas Association Pamphlet G-4.4

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

AIRCO Cryoplants

☐ STANDARDS
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NO. 0-251-1Z-10

REV.

TITLE OXYGEN COMPRESSOR CP-50

3.0 REQUIREMENTS

3.1 General Requirements

3.1.1 Design

The compressor is required to compress product oxygen from an air separation plant. All equipment shall be suitable for the entire range of operating conditions defined in this specification without danger to personnel or equipment. Vendor shall clearly define any operating limitations of his equipment. All equipment offered shall be rated heavy duty for continuous service. Equipment shall be designed for economy of operation, ease of installation, and rapid and economical maintenance.

Vendor shall define and furnish any additional device not covered by this specification but required for proper operation of the equipment, or protection of the equipment or personnel.

3.1.2 Alternate Design

Vendors proposal shall clearly define all areas where his design deviates from this specification.

Proposals for equipment of a different type than intended by this specification will be considered only if a clear and definite advantage to the purchaser is indicated.

Purchaser reserves the right to reject any proposal not in compliance with this specification.

WRITTEN BY L. D. Larsen DATE 2/81 APPROVED ____________

AIRCO Cryoplants

☐ STANDARDS
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NO. 0-251-1Z-10

REV.

TITLE OXYGEN COMPRESSOR CP-50

3.0 REQUIREMENTS (continued)

3.2 Process Requirements

3.2.1 General

Number Required: 3 each as specified herein

Driver Type: 1 electric motor

2 steam turbine

3.2.2 Design Ambient Conditions

Altitude	420	ft. above sea level
Barometric Pressure	14.5	psia
Rated Dry Bulb Temperature	96	°F
Rated Wet Bulb Temperature	78	°F
Summer Maximum Temperature	110	°F
Winter Minimum Temperature	-10	°F

Equipment Installation:

Outdoors Unprotected

Site Environmental Conditions:

Coal Processing Facility

The ambient conditions specified are design point conditions. The compressor must be capable of operation at ambient and cooling water extremes without adverse effects on the compressors' or drivers' mechanical integrity.

Vendors proposal shall include performance curves defining operation at suction pressure, ambient, and cooling water extremes defined herein, in addition to specified design conditions.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

AIRCO Cryoplants

☐ STANDARDS
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NO. 0-251-12-10

REV.

TITLE OXYGEN COMPRESSOR CP-50

3.0 REQUIREMENTS

3.2 Process Requirements (continued)

3.2.3 Design Operating Conditions

	Case A (Normal)	Case B (Rated)
Delivered Capacity - SCFM	26,473	28,000
Discharge Pressure at discharge flange - PSIA	950	950
Inlet Pressure, psia	19.8	19.8
Inlet Temperature, °F	84	84
Discharge Temperature, °F (at compressor discharge flange)	Vendor to define in proposal	
Cooling water supply temperature, °F	85	
Cooling water supply pressure, psig	50	
Max. Cooling water temperature, rise °F	20	
Max. Cooling water Δp, psi	10	

The compressor must be capable of meeting the specified conditions for Case A (Normal) with a guaranteed horsepower at the motor shaft. The compressor must be capable of meeting the conditions specified as Case B (Rated) with a guarantee of no negative tolerance on capacity and pressure.

The capacity specified is for the net dry basis gas delivered at the compressor outlet flange. Compressor seal losses must be allowed for in the inlet capacity by the compressor vendor.

The base for measurement of scf is dry gas at 14.7 psia and 70°F.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

TITLE OXYGEN COMPRESSOR CP-50

3.0 REQUIREMENTS

3.2 Process Requirements

3.2.3 Design Operating Conditions (continued)

The inlet pressure specified is a design condition. Purchasers control system will be arranged to control the inlet pressure between 15 psia and 21 psia. All equipment shall be suitable for operation within this range of inlet pressures.

The unit shall be capable of a turndown to * % of normal flow at design pressure without blow-off or by-pass. The unit shall be capable of operation at Case A conditions during winter ambients without by-pass or blow-off. Specified ambient conditions and cooling water data are design point data only. The compressor must by capable of operation at ambient extremes and with cooling water temperature variations caused by seasonal and weather changes at the site. The compressor and all components must be capable of operating anywhere within an envelope bounded on the left by a line 5% away from surge and bounded on the right by motor winding temperature limitation. Any other operating limitations must be defined in the proposal by the vendor.

*Vendor shall advise maximum turndown with inlet butterfly valve before bypass is required. In addition, vendor shall define minimum throttled inlet pressure to insure that no air will enter through the seals. Specified control pressure range is process pressure controlled before the inlet throttle valve.

WRITTEN BY L. P. Larsen DATE 2/81 APPROVED

3.0 REQUIREMENTS (continued)

3.3 Design Requirements

3.3.1 Compressor (3 required)

The compressor shall be a multistage centrifugal type with intercooling to obtain horsepower efficiency and low operating temperatures.

Compressor design must insure that no oil can enter the compressor casing. An open air space must be provided between the casing and bearing housing at each end of each compressor unit. Provision shall be made to prevent oil or oil vapor from escaping from the bearing housing or gear housings contained within the oxygen compressor area. Vendors quotation shall describe eductor and/or seal system hardware included for this purpose.

Tilting pad type journal and thrust bearings shall be furnished. Bearing design shall allow for the possibility of backward rotation. Shaft seals shall be provided to minimize loss of oxygen to the atmosphere and prevent intrusion of air or seal gas into the oxygen stream. All necessary seal gas pipingand control shall be included. Vendor shall completely describe the seal system operation proposed. Purchaser will provide clean, dry, oil free nitrogen as seal gas.

All materials of construction including gaskets, sealing and anti galling compounds shall be conpatable with oxygen.

Rotating parts of steel or steel alloy shall be arranged to first contact or rub on bronze or copper surfaces in the event of thrust bearing failure.

Bushes for shaft seals and interstage seals shall be copper, silver lined.

Shaft grounding brushes shall be provided to insure that the rotating and stationary parts are of the same electrical potential.

AIRCO Cryoplants

☐ STANDARDS
☐ INSTRUCTIONS
☒ SPECIFICATIONS
☐ DATA

NO. 0-251-1Z-10
REV.

TITLE OXYGEN COMPRESSOR CP-50

3.0 REQUIREMENTS

3.3 Design Requirements

3.3.1 Compressor (3 required) (continued)

Compressor case design pressure shall be not less than the surge limit pressure when operating at the maximum specified suction pressure.

All components which require shrink fit shall be thoroughly degreased prior to assembly.

Vendors proposal shall thoroughly describe all materials of construction for purchasers approval.

3.3.2 Cooling Water System

Cooling water to the unit will be supplied from a closed system furnished by Purchaser. Cooling water design data is supplied under Section 3.2.3. Vendor shall define water flows, pressure drop, and temperature rise for all coolers.

3.3.3 Coolers and Piping

There shall be an intercooler between each stage. Vendor shall furnish all intercoolers and interstage gas piping. Coolers shall have removable tube bundles and assessibility for bundle removal. In addition, a bypass cooler rated for full compressor flow shall be furnished. On all coolers, where attainable pressure exceeds water design pressure, rupture discs shall be furnished and installed by Vendor to relieve overpressure in the event of water passage failure. Rupture discs shall come with vacuum supports.

All coolers shall be designed to cool the gas stream to not more than 10°F above the water supply temperature. Design pressures of interstage piping and accessories shall be no less

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.3 Coolers and Piping (continued)

than the gas side design pressure of the coolers.

All coolers shall be matched for water pressure drop, for example the oil cooler design water pressure drop shall be the same as the intercoolers.

All cooler tubes shall be 5/8" diameter minimum. Carbon steel tubes are unacceptable.

All water passages to be self draining to prevent freezing damage to coolers and piping in the event of an emergency shutdown in winter.

Each exchanger shall be complete with gas side drain valve and water side vent and drain valves.

All exchangers shall be designed for a water side fouling factor of 0.002 hr.-sq. ft.-°F/BTU.

Sealing between oxygen and water shall be provided by welded or gasketed joints. Packing is unacceptable.

Tube to tube sheet joints shall be made without the use of oil or oil compounds. Tube surfaces and tube sheet holes must be degreased prior to assembly.

All welds on the oxygen side shall be smooth and regular form. No back-up rings shall be used.

All oxygen side components shall be degreased and cleaned for oxygen service.

All coolers shall have stainless steel gas side channels, heads, and nozzles. Coolers shalll conform to TEMA "C".

All coolers with water in the shell shall include non-corrosive baffles.

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.3 Coolers and Piping (continued)

Hot side interstage gas piping shall be stainless steel.

Gas velocity in piping shall conform to CGA Pamphlet G-4.4, latest revision.

All piping shall be in accordance with the latest issue of the Code for Pressure Piping ANSI B31.3.

All coolers shall be fabricated in accordance with the requirements of the latest edition of the ASME Code for Unfired Pressure Vessels, Section VIII, Division I, (Code U Symbol). Stamping is required by the commissioned inspector of the National Board.

Five (5) copies of manufacturer's data reports and nameplate rubbings shall be furnished. Data reports to be signed by a commmissioned inspector of the National Board.

Vendors proposal shall include an option for coolers with a closer approach (CTD) than specified and define expected power savings.

Purchaser will furnish a monel inlet screen.
Vendor shall advise design recommendations.
It is intended to furnish screen over perforated metal for initial service. The perforated metal without screen overlay will be used as a permanent screen. Vendors comments are requested.

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3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.4 Lubrication System

A complete system for bearing and gear lubrication shall be supplied by Vendor. The system shall include a full flow oil cooler, dual full flow filters with transfer valve, pressure relief valves, control valves, interconnecting piping, pressure gauges, temperature indicators, shaft driven main oil pump and electric driven auxiliary oil pump. The system shall be capable of furnishing oil to all bearings and gears during coastdown periods subsequent to complete electrical power failure. The shaft driven oil system shall be designed to provide sufficient oil to all users in the event of reverse rotation of the compressor because of discharge check valve failure. The compressor shall be designed so as not to be damaged in the event of reverse rotation.

An Amot type valve shall be included, which will automatically control oil temperature by bypassing oil around the oil cooler.

Filters to remove all particles of 10 micron and larger.

Oil cooler tubes shall be 5/8" minimum diameter.

Vendor shall also furnish an electric oil heater with thermostat control, sized to heat the oil prior to start-up during cold weather conditions.

The auxiliary oil pump and oil heater shall each be rated for 460 volt, 3 phase, 60H3 service.

The pump motor shall be non overloading with respect to pump charachteristics.

It is intended that the system will furnish lubrication to all users including the main drive motor or turbine, gears, and couplings (if continuously lubricated). In addition, the system may be used to furnish hydraulic power to speed governors or stator vane actuator devices. High pressure pumps, control valves, etc. required for hydraulic power shall be included if required.

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.4 Lubrication System (continued)

Vendor shall furnish all lube oil piping within the confines of his equipment such that purchaser need only connect supply and return lines between the equipment and the lube consol.

The lube consol will be located outside of the compressor hazard area which will be enclosed by four walls. All necessary protective switches and instrumentation shall be located at the consol or arranged for remote indication if it is required to be located near the compressor.

All vendor lube oil piping must be thoroughly cleaned and sealed prior to shipment.

Nitrogen to be used as a buffer seal gas is available at 65 psig. Vendor to state in his proposal buffer seal gas pressure and quantity required.

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3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.5 Gears and Couplings

Speed increasers and reducers shall be in accordance with AGMA Standard 421 and shall be sized for the maximum horsepower and speed of the driver, including all service factors.*

All couplings used shall be selected to satisfy the torsional characteristics of the drive train. Couplings and spacers shall be dynamically balanced and coupling halves mounted by the vendor or supplier of the driver.

Removable coupling guards shall be supplied for all exposed couplings. Guards shall be suitable for all operating conditions and comply with all applicable safety codes including OSHA.

Vendor shall supply complete design characteristics of all gear units including torsional data and critical speeds. AGMA service factors shall be based on the maximum output power of the driver including any driver service factor.

Vendors proposal shall completely define proposed couplings. Bendex type couplings are perferred for high speed couplings.

*Vendor to state normally applied service factors in accordance with A.G.M.A. Airco has a stated preference for a actual service factor which exceeded normal by 0.25 or more.

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3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.6 Electric Motor Drive (one(1) required)

The compressor drive motor shall be designed for operation with three phase, 60 hertz, 13,800 volt power supplied to the motor terminals. The motor shall have the following characteristics:

Type:	Synchronous
Enclosure	TEWAC
Insulation	Class B
Horsepower	12000
Service Factor	1.0
Power Factor	1.0
Type Connection	Wye
Excitation	Brushless
Speed	1200 RPM Max.
Motor Starter	Full Voltage (Furnished by Purchaser)

The nameplate rating of the motor, including all service factors, shall exceed the maximum potential power requirement of the driven equipment. In addition, the motor shall be suitable for voltage variations of ±10% under all load conditions.

The motor nameplate shall show design voltage, phase, cycle, full load amperes, service factor, etc.

The motor shall be furnished with a minimum of six (6) embedded resistance temperature detectors (10 OHM Copper, 2 per phase, in the windings, with leads brought out to a separate terminal box).

The motor shall be furnished with space heaters with leads brought out to a separate terminal box.

The motor is to have brushless excitation. 125 VDC pilot exitation voltage will be furnished by purchaser

Motor shall be supplied with a free standing terminal box.

The terminal box shall be:

4 ft. wide x 4 ft. deep x 6 ft. high and made of #10 gauge sheet steel with both sides and front removable. The stator and neutral leads in the

3.0 REQUIREMENTS

3.3 Design Requirements

3.3.6 Electric Motor Drive (one (1) required) (continued)

box shall be in the form of a bus braced to withstand 750 mva short circuit and taped to an insulation level of 15 kv ungrounded.

Motor vendor shall furnish and install lightning arrestors and surge capacitors. Connection capacitor shall be made with nonshielded cable rated 15kv ungrounded.

Motor vendor shall suplly and install three (3) self-balancing window type differential current transformers. Current transformer ratio shall be 50/5 with wiring terminated at a four (4) point terminal block. These items are to be housed in the motor terminal box.

A rectangular bus duct shall be furnished between the motor stator and the back of the terminal box.

The duct shall contain six (6) copper bars, three (3) for the stator and three (3) for neutral leads, and all shall be braced to withstand 500 mva short circuit. Bolted connections shall be used between the bus bars and stator leads.

Continuous current rating of all bus bars shall be 125% of stator current, both in the duct and in the terminal box.

If a WPII enclosure is specified, inlet air filters shall be furnished and mounted by the motor manufacturer.

If a TEWAC is specified, the water to air cooler(s) shall be side or bottom mounted. Cooling water supply is outlined in Section 3.2.3. A loss of cooling water flow switch shall be included for each cooler furnished.

Two (2) grounding brushes to be provided by vendor to take stray currents off motor shaft, and grounded to bearing pedestal feet.

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.6 Electric Motor Drive (one(1) required) (continued)

The motor shall be designed, manufactured, and tested in accordance with the latest edition of NEMA, IEEE, and ANSI Standards.

Motor starting shall be as follows:

Across the line starting. Purchaser will furnish a 15 KV class circuit breaker.

Motor vendor shall supply a Dynalco proximity pick up device with two contacts (one low speed and one high speed). The low speed contact shall be normally closed and will be utilized as part of a locked rotor protective arrangement. The normally open high speed contact, when directed by Airco, will be utilized as part of the exciter field application control circuit. Exact pick up speeds for both contacts will depend upon motor parameters such as accelerating time, safe cage time, and recommended speed for main motor field application.

Motor vendor shall furnish a monitor package to determine the temperature rise of the motor cage bars, cage end rings, and rotor field windings. A complete system including readout meter shall be furnished. System shall be G.E. Rotector or approved equal. (Quote as option)

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3.3 Design Requirements

3.3.6 Electric Motor Drive (one required) (continued)

A reference mark shall be permanently scribed on the motor shaft so that actual F.L. magnetic center with respect to the motor housing can be easily located for initial field arrangement.

The motor half of the drive coupling shall be mounted on the motor shaft by the motor manufacturer.

If available, an option shall be offered for a low noise level design motor. Complete details for evaluation shall be included.

The motor starter will be furnished by purchaser.

The motor rotor shall be balanced such that vibration will be limited to 1.0 mils peak to peak maximum.

It shall be the compressor vendor's responsibility to perform a complete torsional analysis of the drive system to insure proper operation of all equipment. A torsional analysis report is required.

The motor supplier shall furnish complete engineering details of field pole and stator coil winding and assembly, including dimensioned drawings. Only motor vendors willing to furnish complete design information requested will be considered acceptable bidders.

Airco reserves the right to select the motor which will become part of the purchase order. Vendor quotation must clearly define cost differences, if any, for purchasers evaluation.

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.7 Steam Turbine Drive (two required)

Steam turbine drivers, when specified, shall be in accordance with API Standard 612. The turbine shall be rated to deliver the required horsepower for the Case B Rated Conditions. The steam rate guarantee shall apply to Case A Normal Conditions.

The turbine shall be rated for the following steam conditions:

Steam inlet pressure, psig	900
Steam inlet temperature, °F	750
Steam exhaust pressure, psig	- 13
Steam exhaust temperature, °F	116

The main steam condenser, if required, will be furnished by purchaser.

The turbine vendor shall furnish gland condensers as required to minimize steam loss. Glad condensers shall be TEMA "C".

Labyrinth seals are preferred.

Bearing lubrication shall be supplied from the common lube system specified in paragraph 3.3.4.

A sentinel warning valve shall be furnished.

A separate trip and the valve shall be supplied.

The turbine speed governor shall be NEMA Class D or better. The governor shall be furnished with an actuator arranged to receive an external signal to set the control point of the governor. Purchasers control signal will be 4 to 20 miliamps, 24 VDC.

Vibration probes of the displacement type shall be furnished for X-Y and axial displacement protection. Vendor shall furnish probes, cables and oscillator-demodulators suitable for use with Bently Nevada

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.7 Steam Turbine Drive (two required) (continued)

series 9000 or 7200 or equal monitor. All vibration equipment shall be wired to a common terminal box.

A local panel shall be furnished by the turbine vendor and shall include pressure gauges for steam inlet and exhaust, seal pressure, lube oil pressure, and control oil pressure (if applicable); speed indicator, and necessary local control components required for local starting of the turbine.

In addition, primary control components for the turbine operation and start-up, including a tachometer, shall be furnished for mounting in Purchasers Main Control Room panel.

The turbine vendor shall recommend any additional controls or equipment necessary for proper operation of the turbine.

A key-phasor probe shall be offered as an optional extra to permit a complete and accurate analysis at any time.

3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.8 Capacity Control

A pneumatically operated control system will be furnished by Airco for each unit and will include all equipment necessary to: (1) remotely adjust the inlet butterfly valve (2) prevent unit from surging, (3) prevent unit from starting, unless surge valve and inlet throttle valve are in an unloading position and (4) an atmosphere "dump" valve to pass full flow to atmosphere during "emergency" shutdown. The anti-surge valve should not open in the event of emergency shutdown, due to fire actuated signals.

The inlet butterfly valve will be suitable for use as an isolation valve, and provide tight shut-off. Also, the "dump" valve will be capable of being controlled from local panel through an HIC.

The anti-surge flow controller element will be pressure and temperature compensated. Anti-surge valve is to be sized to pass full design flow at design pressure. The anti-surge valve will provide tight shut-off, and will be piped back to the suction of the compressor.

Vendor shall furnish the bypass cooler rated for full compressor capacity. Cooler connections shall be matched to purchasers by pass pipe system. The cooler shall conform to paragraph 3.3.3 of this specification.

Purchaser will furnish the control panel and all control system components. System details will be furnished to vendor for review and certification that the system is acceptable and in no way conprimises the compressor warranty.

All control valves will be furnished by Airco.

3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.9 Instruments and Protective Devices

The vendor shall provide tapped and capped 1/2" connections for the purchaser to connect to for remote indication of the following:

1. Discharge and inlet pressure of each compression stage or section.
2. Oil pressure to the bearings.
3. 3/4" connection for purchasers themo-well and temperature switch at inlet of each compressor stage or section.

The vendor shall supply and locally mount on the compressor or compressor piping the following instrumentation:

1. Dual element, type T, Copper-Constentan thermocouples in a 3/4" stainless steel thermowell complete with wiring to a terminal strip in a NEMA IV head with screwed conduit connection.
    a. Inlet and discharge each compression stage or section.
    b. Lube oil supply header.
2. Bearing temperature thermocouples, type T, copper-constantan wired to terminal strips in common NEMA IV conduit boxes for the compressor, speed increaser gear, and driver.
3. Dial Thermometers with Thermowells (5" dial)
    a. Lube oil sump
    b. Lube oil supply header
    c. Vendor standard supply

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.9 Instruments and Protective Devices (continued)

4. Pressure Gauges (4-1/2 inch dial size)

   a. After lube oil pump
   b. After lube oil filters
   c. All required seal gas pressure gages (remote)

5. Sight Flow Indicators

   a. Each lube oil return line

6. Pressure Switches

   a. Lube oil system (alarm at decreasing oil pressure)
   b. Lube oil system (start auxiliary lube oil pump)
   c. Lube oil system (shutdown machine if oil pressure continues to fall)
   d. Lube oil system (close interlock to allow starting main drive)
   e. All required seal gas pressure switches

7. Temperature Switches with Therowells

   a. Lube oil temperature

8. Flow Switch - Loss of water flow to motor cooler (if applicable)

9. Level Switches

   a. Oil level - alarm on low oil level

10. Vibration Probes

    Vibration probes of the displacement type shall be furnished for X-Y protection of all shafts including compressors, gears and drivers, and for axial displacement of all high speed shafts. All probes shall include cable and proximeters (oscillator-demodulators) mounted in local NEMA IV conduct boxes. Purchaser will connect all vibration equipment to a Bently-Nevada Series 9000 or equal monitor. Vendor shall quote option for Keyphasor Probe.

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.9 Instruments and Protective Devices (continued)

18. All pressure gauges shall be supplied with isolating valves to allow removal for service during operation.

All alarm, shutdown, and permissive devices shall contain two (2) DPDT switches. Alarm and shutdown devices shall have contacts rated for 120 volts A.C., 10 ampere minimum. Permissive devices shall have contacts rated for 125 volts D.C. with a minimum 10 ampere contact rating. All switches shall be wired by the vendor to terminal strips inside a machine mounted terminal box and clearly marked.

All pneumatic fittings shall be Swagelock.

Dial thermometers to be 5 inch dial, hermetically sealed, external calbration and every angle design. Airco will

Airco will furnish and install a local control panel including vibration monitors, annunciators, etc.

A protective barrier will be provided around the compressor. All local instruments such as seal gas pressure gauges, etc. shall be arranged such that reading or adjustment may be made from outside the hazard area.

3.0 REQUIREMENTS

3.3. Design Requirements (continued)

3.3.10 Vibration Limits (Compressors & Turbines)

Vibration levels including shaft runout during shop test or during operation in the field shall not exceed the following value or 2.0 mils, whichever is less:

$$\text{Double amplitude in mils} = \sqrt{\frac{12{,}000}{\text{shaft rpm}}}$$

Electrical runout or "glich" shall not exceed 0.25 mils. If the vendor can demonstrate that this is present but does not exceed 0.25 mils, he may add this to the above limits.

3.3.11 Noise

All equipment shall be designed for quiet operation. Vendor's quotation shall include expected sound level data for his equipment and optional extras available to reduce noise levels of his standard equipment.

Successful vendor will be required to supply noise level data for his equipment for purchaser's use in evaluating equipment layout and plant noise control.

Sound pressure level data shall be expressed as dB ref. 0.0002 microbars or dBA. Sound power level data shall be shown for octave band center frequencies of 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz, and overall levels.

Vendor shall quote optional extra for noise hoods, logging etc. to reduce noise to 90 dBA at 3 feet from any surface.

3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.12 Special Tools

Special wrenches or tools required for erection or maintenance of the equipment shall be furnished by the vendor.

3.3.13 Spare Parts

Vendor proposal shall include a priced list of spare parts as follows:

1. Compressor Rotor
2. Gear Set
3. High Speed Coupling
4. Turbin Rotor (if applicable)
5. Motor Stator Coils
6. Motor Field Pole
7. Compressor Bearings (Set)
8. Motor or Turbine Bearings (Set)
9. Speed Increaser Bearings (Set)
10. Compressor (and Turbine if applicable) Seals
11. Gaskets, Shims, O-Rings, etc required for start-up and first year operation

3.3.14 Tagging and Marking

Each and every component and accessory shall be identified by name and number if assigned. Metal or plastic tags wired to the item are acceptable. A suitable substitute can be pressure sensitive backed plastic tape with embossed numbers and letters provided that clean, flat and smooth surfaces are available for application.

All wiring terminals in junction boxes and control panels shall be identified with letters and/or numbers corresponding with the wiring schematics. All electrical wiring shall be identified with plastic tube type markers.

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3.0 REQUIREMENTS

3.3 Design Requirements (continued)

3.3.15 OSHA Regulations

All equipment furnished shall conform to all applicable regulations of the Occupational Safety and Health Administration when properly installed and maintained.

3.3.16 Maintenance

The unit shall be designed to minimize required maintenance shutdowns. The ability to run continuous for 365 days without a required maintenance shutdown is required. Any maintenance task that requires a shutdown at intervals less than 365 days shall be specified in the proposal.

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3.0 REQUIREMENTS

3.3 Design Requirements

3.3.17 Painting

All equipment shall be painted in accordance with manufacturers standard for the service intended. Vendors proposal shall describe in detail the extent of painting included.

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3.0 REQUIREMENTS

3.4 Administrative Requirements

3.4.1 Information to be Supplied with Proposal

The Vendor shal supply the following in the Proposal:

1. Completed forms - Bechtel Data Sheets
2. Price and Delivery Definition.
3. List of all exceptions of this specification.
4. Performance guarantee and mechanical warranty.
5. Recommended spare parts list including prices.
6. Description of all tests to be performed including descriptions of test procedures and data to be supplied purchaser to confirm reported test results.
7. Performance Curve
8. Schedule of promised drawing submittal.

3.4.2 Drawings and Manufacturing Schedule

Within twelve (12) weeks from date of purchase order, the Vendor shall submit one (1) reproducible copy of the following drawings for purchaser's review and approval. These shall include, but not be limited to:

1. Gas flor shcematics.
2. Lube system schematic.
3. Electrical schematic - As applicable; defining HP or KW of all pumps, heaters, etc.
4. Bill of materials for all supplied hardware.
5. External Drawing - Giving details on envelopes, instrument locations, connection locations, required accesibility dimension, and installation requirements.

3.0 REQUIREMENTS

3.4 Administrative Requirements

3.4.2 Drawings and Manufacturing Schedule (continued)

6. External drawings of all items that require some sort of connection or installation by Airco.
7. Water schematic.
8. Thermal rating sheets for coolers.
9. Bechtel Data Sheets
10. Motor Winding Information Data Sheet.

The vendor shall supply one (1) reproducible and six (6) copies of certified drawings of the above within six (6) weeks after return of approved drawings by Purchaser.

One (1) complete set of final drawings is to be included in each Operating and Maintenance Manual.

Within three (3) weeks from data of purchase order, Vendor shall prepare and submit a manufacturing schedule showin scheduled dates for completion of engineering, drawings, purchasing, casting, machining and assembly of major components. This schedule shall be revised with actual datas of completion of the above activities and reissued on a monthly basis until the unit is shipped.

Drawings and manufacturing schedules shall be sent to the following:

Airco Cryoplants
460 Mountain Avenue
Murray Hill, New Jersey 07974

Attention: Central Files

3.0 REQUIREMENTS

3.4 Administrative Requirements (continued)

3.4.3 Operating and Maintenance Instructions

Six (6) copies of Operating & Maintenance Instructions Manual with parts list shall be furnished by the Vendor.

This manual shall give full mechanical details of all parts included in the order. The manual shall, for all equipment, cover all conditions of operation including initial run-in and start-up, subsequent start-ups from cold to warm condition and regular inspection and maintenance procedures.

The manual must be specifically written for the purchased machine and its support systems and accessories. It must not be a general booklet containing information not applicable to the purchased machine. Any statements in the supplied material and subvendor material not applicable to the purchased machine shall be crossed out.

All subvendor material shall be marked by an identifying name or number which clearly defines what piece of equipment it is and where it is used.

The manual shall define all required lubricants. It shall specify the type (e.g. oil, grease, etc.) the basic characteristics (e.g. lithium base, viscosity, etc.) and various brand definitions (e.g. Shell #3, etc.), including quantity requirements and service intervals.

The above must be furnished a minimum of two (2) weeks before shipment of the unit.

In addition, vendor shall furnish five (5) copies of all test reports and torsional and lateral analysis reports as soon as available. Performance test reports shall include all test data, sample calculations, test loop diagrams, and certified test performance curves.

4.0 TESTING AND GUARANTEES

4.1 Inspection

All material is subject to inspection in vendor's shop and vendor's supplier's shops. Vendor shall give purchaser at least one (1) week notice prior to hydrostatic tests, mechanical test, and performance test so that a representative of purchaser may be present.

4.2 Testing

4.2.1 Shop Tests

Compressor shall be given a mechanical running test and full performance test at the vendor's shop. Vendor shall furnish a complete performance test report containing the compressor performance curve showing the pressure, thru-put and power relationship plotted from at least five test points, vibration log data, bearing oil temperatures, interstage pressure and temperatures, etc. Sample stage pressures and temperatures, etc. Sample calculations for flow, pressure, and HP shall be provided.

Compressor casings are to be hydrotested at 150% of design pressure.

Vendors proposal shall include a complete description of his test procedures for purchasers review and acceptance. Separate prices shall be included for all which are not standard.

The following standard tests shall be performed on the main electric motor driver:

a. Resistance measurement of armature and field windings.
b. Polarity of fields.
c. Di-electric tests of windings.
d. Check air gap (by gauge).
e. No load field current check at normal voltage and frequency.
f. No load saturation curve determination (at vendor's option).

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4.0 TESTING AND GUARANTEES

4.2 Testing

4.2.1 Shop Tests (continued)

In addition to standard motor tests, Vendor shall offer an option for tests required to guarantee motor efficiency.

If a steam turbine driver is specified, Vendor shall perform tests required by API 612. In addition, vendor shall include an option for a turbine Performance Test. Complete details of the proposed tests must be included.

4.2.2 Field Tests

If desired by Purchaser, a field test will be performed at the job site by Purchaser. Vendor shall be given advance notice so that representatives may witness the test. The test shall demonstrate the ability of all equipment to operate at the specified conditions and within the guaranteed power limitations.

The instrumentation installed with the unit will be used for this test. No other special instrumentation will be used or required. Purchaser's standard flow measurement instruments shall be used to determine the gas flow through the compressor system.

In addition to obtaining design point data, the test run will be utilized to determine the following:

a. Calculate each stage adiabatic efficiency by temperature rise method.
b. Check intercooler pressure drops with respect to design values.
c. Determine motor input power from measurement of volts, amperes, and power factor.
d. Determine turndown capability and surge line data for proper calibration of the anti-surge controls.

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4.0 TESTING AND GUARANTEES

4.2 Testing

4.2.2 Field Tests (continued)

The test gas supplied by Purchaser, shall consist of 75 mole% of N_2 and 25 mole% of CO_2 to simulate a mole wgt. of 32 (O_2).

4.3 Guarantees

Vendor 's proposal shall include guarantee and tolerances for the following:

a. Capacity as defined in Section 3.2.3.
b. Compressor shaft BHP.
c. Kilowatt input to motor.

Vendor's proposal shall include a statement that the proposal is in complete accordance with these specifications.

Compressor manufacturer shall have overall responsibility for the mechanical and electrical performance of the unit meeting guaranteed values and for the complete compressor-drive system being free of any adverse mechanical or electrical torsional characteristics at operating conditions.

The vendor shall guarantee against incorrect design, defective materials, poor workmanship and failure from normal usage. During the guarantee period, he shall repair or replace the defective equipment at his expense. He shall also state the terms and conditions of his guarantee. This guarantee shall be for a minimum of one year from date of start-up or 18 months from date received at site, whichever is first.

The vendor shall guarantee all equipment to be suitable for all possible operating conditions including possible upset conditions up to safety device set points. Vendor shall define any safety valve settings and any other safety trip parameter required to protect the equipment.

5.0 DELIVERY

5.1 Schedule

Delivery schedule shall be specified starting from the date of receipt of order.

Vendor shall state time required to submit drawings for approval and time allotted for drawing approval in order that he meet his specified delivery.

5.2 Preparation for Shipment

All gas, water, and oil piping shall be cleaned and pickled before shipment. Any piping components that are disassembled before shipment are to be sealed from any contaminating elements after cleaning.

All open connections in the "as shipped" condition shall be blanked with metal or wooden covers bolted to the flanges. Threaded openings shall be closed with threaded plugs.

All water shall be drained from the unit and accessories before shipment.

All parts in contact with oxygen gas shall be cleaned to remove all hydrocarbons and other impurities. Black light inspection shall be used to assure complete cleanliness. All parts cleaned for oxygen service shall be protected and sealed from any contaminating elements.

Vendor to label all disassembled parts, valves, instruments, piping, etc., for ease of assembly at site and to furnish a list of such parts. It shall be the vendor's responsibility to insure that the packages are sized to allow delivery to the job site.

The vendor shall adequately support or crate the unit to withstand all shipping loads without damage. The Vendor shall adequately tie down to the shipping vechicle the unit to prevent damage en route.

5.0 DELIVERY

5.2 Preparation for Shipment (continued)

It shall be the vendor's responsibility to repair or replace any items damaged during shipment. All insurance claims shall be processed by the vendor.

Vendor shall notify Airco Cryoplants of all shipping dates which shall include all pertiment shipping information, including but not limited to: name of carrier, way-bill number, estimated time of arrival at the job site.

5.3 Shipment

Vendor shall clearly state in his proposal the terms and conditions of shipment. Charges, if any, are to established in the proposal.

5.4 Acceptance

Final acceptance of this unit shall be reserved until installed, operated and continuous performance for a minimum of 24 hours shows that design requirements are met. Operation and continuous performance shall be witnessed by the accepting Airco Cryoplants' representative.

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Airco Cryoplants

☐ STANDARDS
☐ INSTRUCTIONS
☐ SPECIFICATIONS
☐ DATA

No.

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APPROVED BY	AE	DATE	2/15/81
APPROVED BY		DATE	3/11/
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STANDARD INSULATION SPECIFICATION

3. INSULATION DESCRIPTION

3.1 Perlite - Code I_A

3.1.1 Classification

This specification shall cover bulk or bagged material. It does not cover expanded-on-site material.

3.1.2 Service

Cold Vessels and piping enclosed in cold boxes and/or ducts at atmospheric pressure.

3.1.3 Rating

a. Minus 350°F to 60°F

b. Liquid oxygen compatible

3.1.4 Material

Expanded perlite produced by the application of heat to the natural ore.

a. Density shall be 4.0 ± 1.0 lbs per cu ft.

b. Grading - The grading of the perlite insulation covered by these specifications shall conform to the following:

U.S. Standard Sieve No.	Retained by Weight (Cumulative)
16	10% Maximum
100	80% Minimum

c. Moisture Content - The moisture content shall be less than 0.5% by weight.

d. Combustibility - The perlite insulation shall not spark or burn when in contact with an embedded glowing platinum wire in an oxygen atmosphere.

e. Solvent Solubles - The perlite insulation must not contain more than 0.1% by weight of matter that is soluble in trichlorethane.

f. Thermal conductivity shall be a max. of .23 BTU/in/hr/sq. ft./°F at mean temp. of minus 115.

3.1.5 INSTALLATION

a. Thickness - the perlite shall completely fill the enclosed insulation space.

b. Application - the perlite insulation shall be applied in a manner so as to maintain a compacted density of approximately 4 lbs. per cu. ft.

c. The perlite as installed shall be dry.

3. INSULATION DESCRIPTION

3.1 Perlite - Code I_A

3.1.1 Classification

This specification shall cover bulk or bagged material. It does not cover expanded-on-site material.

3.1.2 Service

Cold Vessels and piping enclosed in cold boxes and/or ducts at atmospheric pressure.

3.1.3 Rating

a. Minus 350°F to 80°F

b. Liquid oxygen compatible

3.1.4 Material

Expanded perlite produced by the application of heat to the natural ore.

a. Density shall be 4.0 ± 1.0 lbs per cu ft.

b. Grading - The grading of the perlite insulation covered by these specifications shall conform to the following:

U.S. Standard Sieve No.	Retained by Weight (Cumulative)
16	10% Maximum
100	80% Minimum

c. Moisture Content - The moisture content shall be less than 0.5% by weight.

d. Combustibility - The perlite insulation shall not spark or burn when in contact with an embedded glowing platinum wire in an oxygen atmosphere.

e. Solvent Solubles - The perlite insulation must not contain more than 0.1% by weight of matter that is soluble in trichlorethane.

3.2 Mineral Wool - Code I_B

3.2.1 Classification

Loose or bagged mineral wool

3.2.2 Services

Cold vessels and piping enclosed in cold boxes and/or ducts at atmospheric pressure.

3.2.3 Rating

Temperature Range - minus 450°F to plus 1400°F.

3.2.4 Material

The mineral wool shall be Eagle-Picher H-4 Special Steam Blown Mineral Wool or equal.

Typical Properties

Bulk Density (75 lbs per sq ft packing pressure)	15.5 lbs per cu ft
Combustible Ingredients	Less than 0.15%
Thermal Conductivity (at packing density of 15.5 lbs/cu ft and mean temp. of -128°F)	$.268 \, BTU/hr.ft^2$ (°F/in)

Moisture content shall be less than 1% by wt.

3.2.5 Installation

a. Mineral wool shall be used for filling all void spaces in the cold box or ducts between the inside equipment and panel structure. It may be applied by the use of machinery or by hand labor. The Contractor shall submit his procedure for Airco approval.

b. The Vendor shall exercise extreme precaution to prevent damaging the process components, piping and instrumentation elements. Any damage caused directly or indirectly by the Vendor's labor, tools or equipment shall be repaired and/or replaced at no extra cost to Airco Cryoplants Corporation. Airco Cryoplants will maintain a pressure of 10 psig on all piping. Any leaks created by the

3.2 Mineral Wool - Code I_B (Cont.)

3.2.5 Installation (Cont.)

workmen will show up as a loss in the pressure of the unit at which time the packing operation shall be stopped, the unit shall be depressurized, and the leaks shall be repaired by the Vendor at no additional expense to Airco. After the leaks have been satisfactorily repaired and pressure tested, the unit shall again be pressurized and the packing operation shall be resumed.

Thermocouple leads at the terminal junction box shall be checked frequently during the installation with Simpson meter for damaged wiring, and to insure that the hot junction is still grounded. Any breakage shall be repaired by the Vendor at no additional expense to Airco before packing operation is resumed.

c. The Vendor shall clean the interior of the cold box jacket before starting to place any mineral wool in cold box, and shall exercise precaution to prevent entrance of any foreign material including but not limited to wood, paper, rags, oily waste, metal scraps, weld slag, etc.

d. The Contractor shall not proceed with the packing of mineral wool in the cold box jacket until all piping and equipment has been pressure tested and approval to proceed has been given by Airco inspector.

e. The Vendor shall pack the mineral wool in successive layers and compact to a density of not less than fifteen pounds per cubic foot. Airco will periodically check the packing procedures and density. The Contractor shall correct any deficiencies pointed out by Airco. No voids will be tolerated. Any frost, ice spots, or heat leak after start-up and as a result of insulation deficiencies shall be corrected by repacking the areas and at no cost to Airco. The packed height of the layers shall be approximately two feet. Care shall be taken that temporary pipe supports are removed as packing progresses.

3.2 Mineral Wool - Code I_B (Cont.)

3.2.5 Installation (Cont.)

f. The Vendor shall keep the mineral wool dry and clean at all times. Should this material become wet or contaminated, it shall be removed and replaced by the Vendor. Once mineral wool becomes wet, it can not be reused.

Any additional access openings required for insulation or for correcting deficiencies shall be provided by Airco Cryoplants and charged to the insulating contractor.

g. Insulation shall be installed by competent workmen, experienced in this type of work.

h. Contractor shall supply all the labor, tools, handling equipment, insulation material and supervision.

i. The Contractor shall contain any and all paper and debris in the immediate working area during the insulation period and prior to removing same from the jobsite. Paper will not be permitted to fly around due to the probability of landing on the exposed high voltage equipment or damage other equipment.

j. After completion of the insulation work, the Vendor shall arrange for the removal and the disposal of all excess insulation, paper waste, and debris from the plant area.

3.3 Cellular Glass - Code I_C

3.3.1 Classification

Rigid preformed cellular glass sections

3.3.2 Service

a. Pipe

b. Use for oxygen service at the top section of low pressure distillation columns and waste nitrogen piping between column and heat exchanger.

3.3.3 Rating

Temperature Range - minus 450°F to 800°F

3.3.4 Material

Density - 6$^{\#}$/ft^3
Thermal Conductivity, BTU/hr. ft^2(°F/in)-0.35 @ 0°F
Compressive strength (Ult.) - 100 psi
Combustibility - will not burn

3.3.5

Item & Material (Manufacturer or Equal)	Description of Application
	Service "a"
Insulation Foamglas (Pittsburgh -Corning Corp.)	Use sectional foamglas pipe covering. Apply to piping with butt joints staggered and all joints tightly butted.
	Service "b"
	Use single layer min. 1" thick sectional foamglas block. Apply with butt joints staggered and all joints tightly butted. At top head, block to be cut to conform to contour of knuckle radius.

TITLE STANDARD INSULATION SPECIFICATIONS

3.3.5 Item & Material - Cont. (Manufacturer or Equal)	Description of Application
Joint Sealer (Benjamin Foster Co. 82-10)	On single layer construction, seal all edges with sealing compound in such a manner that each segment of insulation is sealed at all joints. On Multilayer construction joints are to be staggered and only outer layer sealed.
	Service "a"
Insulation Ties Up to 12" Diam.	1/2" by .020" stainless steel bands on 9" centers.
Over 12" Diam. up to 48"	3/4" by .020" stainless steel bands on 9" centers.
	Service "b"
Over 48"	Cylindrical walls, 1" wide, 14 gage min. thk. aluminum bands. tightly drawn. At least two bands per course of block. On dished head, cement blocks to surface.
	Service "a"
Contraction Joint ---	Provide joint in accordance to SK #1.A.
	Service "b"
	None
	Service "a"
Jacket 0.016 Aluminum corrugated with factory applied vapor barrier (Childers Alloy 5005-H14, 3003-H14)	The weatherproof jacket shall be applied with a 3 inch end and side lap. Wrap snugly around the pipe insulation securing with tie bands. All end laps and longitudinal joints and seams shall receive a coating of vapor barrier mastic to assure vapor barrier.

3.3.5

Item & Material - Cont. (Manufacturer or Equal)	Description of Application
	Service "b"
	None
Vapor Barrier Mastic (Benjamin Foster Co.) Fire, Resistive) 60-30 dark brown-Trowel 60-35 Aluminum - " 60-60 Dark Brown-Spray 60-65 Aluminum "	All end laps and longitudinal joints.
Jacket Ties Less than 48"inch OD	3/4 inch by .020" inch stainless steel bands spaced on 9 inch centers.

3.3.6 Service - Elbows, Flanges and Valves All Sizes

Item & Material (Manufacturer & Equal)	Description of Application
Insulation Molded Foamglass or fabricated from foamglass pipe covering (Pittsburgh Corning Corp.)	Elbows, bends, flanges and valves shall be covered with two piece factory fabricated covers. If not available fabricate from pipe covering trim for good fit and force tightly together. Use same thickness as the pipe insulation. Control valves and flanges shall be insulated in such a manner to permit easy removal and replacement of insulation.

TITLE STANDARD INSULATION SPECIFICATIONS

3.3.6 Item & Material - Cont.

(Manufacturer or Equal)	Description of Application
Joint Sealer Adhesive (Benjamin Foster Co. 82-10	All joints shall be joined and sealed to provide a tight construction.
Insulation Ties 1/2 by 0.020 inch type 304 stainless steel bands with	Band all flanges and control valve covers used on all molded fittings.
Wire #16 gauge (Any)stainless steel	On irregular surfaces, where use of insulation straps is impractical., insulation shall be secured with wire.
Vapor Barrier Mastic (Benjamin Foster Co. Fire Resistive) 60-30 Dark brown-Trowel 60-35 Aluminum - " 60-60 Dark Brown-Spray 60-65 Aluminum "	Cover top layer of insulation with minimum 1/32 inch continuous coat.
Reinforcement Glass cloth, white, 10 by 10 mesh open weave (Twinburg-Miller Glasfab.)	While vapor seal coat is still tacky glass cloth shall be laid smooth and thoroughly embedded in coating. Lap the edges 3 inches. At corners, overlap edges 6 inches. Before surface becomes dry to touch a second coating of aluminum colored vapor barrier mastic thickness 1/8 inch shall be applied. Heavy fillets of mastic shall be applied at all points of flashing.

3.3.7 See Section 4 for details of application.

3.4 Polyurethane - Code I_D

3.4.1 Classification

Rigid preformed polyurethane sections

3.4.2 Service

Pipe, vessels; except in liquid oxygen service.

3.4.3 Rating Temperature Range: -423°F to +350°F

3.4.4 Material

Density - 1.8 to 2.2 #/ft^3
Thermal conductivity - K=0.15 @ 40°F mean temperature BTU/hr. sq. ft. (°F/in)
Compresive strength - 25 psi @ 10% deflection
Combustibility - self extinguishing

Item & Material (Manufacturer or Equal)	Description of Application
Insulation Rigid Polyurethane (National Gypsum Co. Gold Bond "Zer-O-Cel") (Armstrong Cork Co.- "Armalok")	Use sectional polyurethane pipe covering. Apply to piping with butt joints staggered and all joints tightly butted.
Adhesive and Joint Sealer (Benjamin Foster Co. 81-33 Fire Resistive) (Armstrong #520 Adhesive for Armalok)	On single layer construction seal all edges with sealing compound in such a manner that each segment of insulation is sealed at all joints. On multi-layer construction joints are to be staggered and only outer layer sealed.

3.4.4 Material - Cont.

Item & Material (Manufacturer or Equal)	Description of Application
Insulation Ties Banding Tape (Permade P-691	Insulation shall be secured by spiral wrapping the banding tape tightly around the insulation.
NOTE: In lieu of banding tape, we suggest the use of factory or field applied jackets:	
Contraction Joint On the single or outer insulation dyers	Provide joint in accordance with SK#1.
Jacket 0.016 Aluminum Corrugated with Factory Applied Vapor Barrier (Childers Alloy 5005-H14, 3003-H14)	The weatherproof jacket shall be applied with a 3 inch end and side lap. Wrap snugly around the pipe insulation securing with tie bands.
Vapor Barrier Mastic (Benjamin Foster Co. Fire Resistive) 60-30 dark brown-trowel 60-35 aluminum 60-60 dark brown-spray 60-65 aluminum - "	All end laps and longitudinal joints and seams shall receive a coating of vapor barrier mastic to assure vapor barrier.
Jacket Ties Less than 48-inch OD	3/4" by .020" stainless steel bands spaced on 9 inch centers

TITLE STANDARD INSULATION SPECIFICATIONS

3.4.5 Service: Elbows, Flanges and Valves All Sizes

Item & Material (Manufacturer or Equal)	Description of Application
Insulation Preformed Rigid Polyurethane or fabricated from pipe covering. (National Gypsum Co. Gold Bond "Zer-O-Cell") (Armstrong Cork Co. - Armalok) (Dow Chemical Co. PZ2020)	Elbows, bends, flanges and valves shall be covered with two-piece factory fabricated from pipe covering. Trim for good fit and force tightly together. Use the same thickness as the pipe insulation. Control valves and flanges shall be insulated in such a manner to permit easy removal and replacement of insulation.
Joint Sealer Adhesive (Benjamin Foster Co. 81-33 Fire Resistive)	All joints shall be joined and sealed to provide a tight construction.
Insulation Ties 1/2" by 0.020" type 304 stainless steel bonds with banding tape (Permade P-691)	Band all flanges and control valve covers. Use on all molded fittings. On irregular surfaces, where use of insulation shall be secured with spirally wrapped banding tape. NOTE: In lieu of band tape we suggest the use of either factory or field applied jackets.
Vapor Seal Mastic (Benjamin Foster Co. Fire Resistive) 60-30 Dark brown-Trowel 60-35 Aluminum " 60-60 dark brown spray 60-65 aluminum "	Cover top layer of insulation with minimum 1/32 inch continuous coat.

3.4 Polyurethane - Code I_D (Cont.)

3.4.5 (Cont.)

Item & Material (Manufacturer or Equal)	Description of Application
Reinforcement Glass cloth white 10 by 10 mesh open weave. (Twinburg-Miller Glassfab.)	While vapor seal coat is still tacky glass cloth shall be laid smooth and thoroughly embedded in coating. Lap the edges 6 inches. Before surface becomes dry to touch a second coating of aluminum colored vapor barrier mastic minimum thickness 1/8 inch shall be applied. Heavy fillets of mastic shall be applied all points of flashing.

3.4.6 See Section 4 for details of application.

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☐ INSTRUCTIONS
☒ SPECIFICATIONS
☐ DATA

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PIPING MATERIAL SPECIFICATION

TITLE

- AS Service: Cold Gases & Liquids - General Purpose
304SS (Do not use for oxygen)
Rating: 150 #
Pressure Temp. Range: 275 psig @ +100°F
20 psig @ +1000°F
Min. Temp. -325°F

- ASO Service: O2 Piping Above 200 °F, O2 Outlet Line from Discharge of Base Load O2 Compressor, Cold O2 Gas & Liquid Oxygen. Oxygen Service - 304SS
Rating: 150#
Pressure Temp. Range: 275 psig @ +100 °F
170 psig @ +500 °F
Min. Temp. -325 °F

- BS Service: General Purpose - 304SS (Do not use for oxygen)
Rating: 300#
Pressure Temp. Range: 720 psig @ 100 °F
25 psig @ 1500 °F
Min. Temp. -325 °F

- BSO Service: Oxygen Service - 304SS - Discharge Piping from LQO Vaporizer & H.P. LQO Vaporizer Pumps
Rating: 300#
Pressure Temp. Range: 720 psig @ +100 °F
470 psig @ +400 °F
Min. Temp. -325 °F

- AA Service: General Purpose - Aluminum - For Use Inside and Outside of Cold Box (Do not use for oxygen)
Rating: 150#
Pressure Temp. Range: 150 psig @ +100 °F
150 psig @ +200 °F
Min. Temp. -325 °F

- AAL Service: Low Pressure Service such as Oxygen Comp. Suction Lines 12" and above - Aluminum.
Rating: 150#
Pressure Temp. Range: 30 psig @ +100 °F
25 psig @ +200 °F
Min. Temp. -20 °F

- AAO Service: Cold Oxygen Gas & Liquid - Aluminum
Rating: 150#
Pressure Temp. Range: 150 psig @ 100 °F
150 psig @ 200 °F
Min. Temp. -325 °F

- AAS Service: Liquid Nitrogen - General Purpose Aluminum
(Do not use for oxygen)

Rating: 150#
Pressure Temp. Range: 275 psig @ +100 °F
100 psig @ +400 °F
Min. Temp. -325 °F

- BA **Service:** Liquid Nitrogen - General Purpose Aluminum
(Do not use for oxygen)
Rating: 300#
Pressure Temp. Range: 720 psig @ +100 °F
265 psig @ +400 °F
Min. Temp. -325 °F

- BAO **Service:** Oxygen, Moderate Pressure Range Inside & Outside
Cold Box - Aluminum
Rating: 300#
Pressure Temp. Range: 720 psig @ +100 °F
265 psig @ +400 °F
Min. Temp. -325 °F

- DCO **Service:** Oxygen (Product O_2 Pipeline) - Carbon steel
Rating: 600#

- DSO **Service:** Liquid Oxygen - 304 SS - Product O_2 to
steam vaporizer
Rating: 600#

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Airco Cryoplants
ENGINEERING STANDARD

PROJ. ISSUE DATE

AS 35.45.00
PROJ. NO.

SERVICE - Cold Gases & Liquids - General Purpose 304SS (Do not use for oxygen)

RATING - 150#

PRESSURE TEMPERATURE RANGE: 275 psig @ +100°F
20 psig @ +1000°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTE
PIPE				
2" & smaller	Seamless	SCH 80S	SST, ASTM A312 TP 304, P.E.	1
2" & smaller	Seamless	SCH 10S	SST, ASTM A312 TP 304, P.E.	
2-1/2" through 12"	Seamless	SCH 10S	SST, ASTM A312 TP 304, P.E.	
14" through 24"	EWR	.375" wall	SST, ASTM A312 TP 304 P.E.	
FITTINGS				
2" & smaller	Socketweld	3000#	Fgd. SST, ASTM A182, F 304	2
2-1/2" through 24"	Buttweld	To Match Pipe	SST, ASTM A403 WP 304	
FLANGES				
2" & smaller	Socketweld	150 RF	Fgd. SST, ASTM A182, F304	3,4
2-1/2" through 24"	Weldneck	150 R.F.	Fgd. SST, ASTM A182, F304 bore to suit pipe	4
GASKETS				
All Sizes	1/16" Ring	150 RF	JM-61 Graphite Free	3
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M, Class 1, full threaded stainless steel bolt-stud, with (2 ea) ASTM A194, 8 American Standard Heavy Series Hexagon nuts	

NOTES:

1. Use only where threading is required.
2. For Branch Reinforcement see chart AS-R1
3. Use 150 flat face flanges with full face gaskets when mating to flat faced equipment or components below 750°F.
4. Above 750°F use 150 ring type joint flanges together with JM-951 V-Tite, type 304, octagonal ring gaskets.

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Airco Cryoplants SERVICE ENGINEERING STANDARD	PROJ. ISSUE DATE	ASO PROJ. NO. 35.45.00

SERVICE - O_2 Piping Above 200°F, O_2 Outlet Line from Discharge of Base Load O_2 Compressor, Cold O_2 Compressor, Cold O_2 Gas & Liquid Oxygen. Oxygen Service - 304SS (See Note 4)

RATING - 150#

PRESSURE TEMP. RATING: 275 psig @ +100°F
170 psig @ +500°F Max.
Min. Temp. -325°F

CORROSIVE ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 80S	SST, ASTM A312 TP 304, P.E.	1
2" & smaller	Seamless	SCH 10S	SST, ASTM A312 TP 304, P.E.	
2-1/2" through 12"	Seamless	SCH 10S	SST, ASTM A312 TP 304, P.E.	
14" through 24"	ERW	375" wall	SST, ASTM A312' TP 304 P.E.	
FITTINGS				
2" & smaller	Socketweld	3000#	Fgd. SST, ASTM A182, F 304	4
2-1/2" through 24"	Buttweld	To Match Pipe	SST, ASTM A403 WP 304	
FLANGES				
2" & smaller	Socketweld	150# RF	Fgd. SST, ASTM A182, F304	3
2-1/2 through 24"	Weldneck	150# RF	Fgd. SST, ASTM A182, F304 bore to suit pipe	
GASKETS				
All Sizes	1/16" Ring	150# RF	JM-61 Graphite Free	3
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M class 1, full threaded stainless steel bolt-stud, with (2ea.) ASTM A194,8 American Standard Heavy Series Hexagon nuts.	

NOTES:

1. Use only where threading is required.
2. For Branch Reinforcement see chart ASO-RI.
3. Use 150# flat face flanges with full face gaskets when mating to flat faced equipment or components.
4. Cleaning Std. DM-35.45.03, Class "A", is required.

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Airco Cryoplants

ENGINEERING STANDARD

PROJ. ISSUE DATE

BS 35..45..00

PROJ. NO.

SERVICE - General Purpose - 304 SS (Do not use for oxygen)

RATING - 300#

PRESSURE TEMP. RANGE: 720 psig @ 100°F
25 psig @ 1500°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTE
PIPE				
2" & smaller	Seamless	SCH 80S	SST, ASTM A312 TP 304 P.E.	1
2" & smaller	Seamless	SCH 40S	SST, ASTM A312 TP 304 P.E.	
2-1/2" through 12"	ERW	SCH 40S	SST, ASTM A312 TP 304 P.E.	
14" through 24"	ERW	Cal.wall	SST ASTM A312 TP 304 P.E.	
FITTINGS				
2" & smaller	Socketweld	3000#	Fgd. SST, ASTM A182, F 304	2
2-1/2" through 24"	Buttweld	To Match Pipe	SST, ASTM A403 WP 304	
FLANGES				
2" or smaller	Socketweld	300# RF	Fgd. SST, ASTM A182, F 304	3
2-1/2" to 24"	Weld Neck	300# RF	Fgd. SST, ASTM A 182, F 304 bore to suit pipe	3
GASKETS				
All Sizes	1/16" Ring	300# RF	JM-61 Graphite Free	1
BOLTING	Stud Bolts		ASTM A320,B8M, Class 1, full threaded stainless steel bolt-stud, with (2ea.) ASTM A194,8 American Standard Heavy Series Hexagon nuts	

NOTES:

1. Use only where threading is required. Backweld all thd. conns.
2. For Branch Reinforcement see chart BS-R1.
3. Use 300# flat face flanges with full face gaskets when mating to flat faced equipment or components for temperatures below 750°F.
4. For temperatures above 750°F use: (a-1) New construction w/raised face flanges. Preferred. Flexitallic, or equal, style CG, 316 L & Canadian asbestos paper. (a-2) Replacement for API ring joint flanges. Flexitallic, or equal, style CG-RJ, 316 L & Canadian asbestos paper. (b) New construction to match vendor furnished R-J flange equipment, Johns-Manville style #951, V-type 316, octagonal shape
5. For operating temperatures above 1000°F carbon content is to be certified .04 percent minimum. Purchase order to require carbon content certification

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Airco Cryoplants

ENGINEERING STANDARD

PROJ. ISSUE DATE

BSO

PROJ. NO.

35.45.00

SERVICE - Oxygen Service - 304SS - Discharge Piping from LQO Vaporizer & H.P. LQO Vaporizer Pumps (See Note 4)

RATING - 300#

PRESSURE TEMP. RANGE: 720 psig @ +100°F
470 psig @ +400°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTE
PIPE				
2" & smaller	Seamless	SCH 80S	SST, ASTM A312 TP 304 P.E.	1
2" & smaller	Seamless	SCH 40S	SST, ASTM A312 TP 304 P.E.	
2-1/2" through 12"	ERW	SCH 40S	SST, ASTM A312 TP 304 P.E.	
14" through 24"	ERW	Cal. wall	SST, ASTM A312 TP 304 P.E.	
FITTINGS				
2" & smaller	Socket weld	3000#	Fgd. SST, ASTM A182, F 304	2
2-1/2" through 24"	Buttweld	To Match Pipe	SST, ASTM A403 WP 304	
FLANGES				
2" or smaller	Socketweld	300# RF	Fgd. SST, ASTM A182, F 304	3
2-1/2" to 24"	Weld Neck	300# RF	Fgd. SST, ASTM A182, F 304 bore to suit pipe	3
GASKETS				
All Sizes	1/16" Ring	300# RF	JM-61 Graphite Free	3
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M, Class 1, full threaded stainless steel bolt-stud, with (2ea.) ASTM A194, 8 American Standard Heavy Series Hexagon nuts	

NOTES:

1. Use only where threading is required. Backweld all thd. conns.
2. For Branch Reinforcement see chart BSO-R1.
3. Use 300# flat face flanges with full face gaskets when mating to flat faced equipment or components.
4. Cleaning std. DM-35.45.03, Class "A", is required.

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Airco Cryoplants
ENGINEERING STANDARD

	AA	35.45.00
PROJ. ISSUE DATE	PROJ. NO.	

SERVICE - General Purpose - Aluminum - For Use Inside & Outside of Cold Box
(Do not use for oxygen)

RATING - 150#

PRESSURE TEMP. RANGE: 150 psig @ +100°F
150 psig @ +200°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 80	Alum, ASTM B 241 6061-T6*	1
2" & smaller	Seamless	SCH 40	Alum, ASTM B 241 6061-T6*	
2-1/2" through 12"	Seamless	STD WT	Alum, ASTM B 241 6061-T6*	
14" through 24"	Welded	STD WT (0.375"wall)	Alum, ASTM B 209 6061-T6*	4
FITTINGS				
2" & smaller	Socketweld	3000#	Alum, ASTM B247 6051-T6	
2-1/2" through 24"	Buttweld	Std. Wt.	Alum, ASTM B361 WP6061-T6*	2
FLANGES				
All Sizes	Weld Neck	150# RF	Fgd. Alum, ASTM B247 6061-T6 Bore to Match Pipe	5
UNIONS Use Flanges				
GASKETS				
All Sizes	1/16" ring	150#RF	JM-61 Graphite Free	3,5
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M, Class 1, full threaded stainless steel bolt-stud, with (2ea) ASTM A194,8 American Standard Heavy Series Hexagon nuts	

*Purchase order must specify that mechanical properties are verified by a tensile test at Mill.

NOTES:

1. Use only where threading is reuqired.
2. For branch reinforcement see "Branch Reinforcement Chart AA-R1".
3. Gasket dimensions are to conform to ANSI B16.21, Table 1.
4. Longitudinal joints in welded pipe shall be single butt welded with joints in accordance with Table 302.3.4, (3e) of the pressure piping code ANSI B31.3 latest edition.
5. Use 150# flat face flanges with full face gaskets when mating to flat faced equipment or components.

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Airco Cryoplants
ENGINEERING STANDARD

PROJ. ISSUE DATE

AAL
PROJ. NO.

35.45.00

SERVICE - Low Pressure Service Such as Oxygen Compressor Suction Lines 12" and above (Aluminum)

RATING - 150#

PRESSURE TEMP. RANGE: 30 psig @ +100°F
25 psig @ +200°F
Min. Temp. -20°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE 12" through 24"	Welded	.375 Wall	Alum, ASTM B 209 6061-T6*	1,3
FITTINGS				
All Sizes	Miter Ell Type "A"	To Match Pipe	Alum, ASTM B209 6061-T6*	4
FLANGES 12" to 24"	Lap Joint	150# RF	Fgd. Steel ASTM A181	
UNIONS				
Use Flanges				
GASKETS				
All Sizes	1/16" ring	150# RF	JM-61 Graphite Free	2
BOLTING				
All Sizes	Stud Bolts		ASTM A193, B7 full threaded bolt-stud, with (2ea.) ASTM A194, 2H American Standard Heavy Series Hexagon nuts.	

VALVES

See Note 8

*Purchase Order must specify that mechanical properties are verified by a tensile test at Mill.

NOTES:

1. For branch reinforcement see "Branch Reinforcement Chart AAL".
2. Gasket dimensions are to conform to ANSI B16.21.
3. All weld joints shall be butt welded and inspected in accordance with Table 302.3.4 (3d) of the pressure piping code ANSI B313 latest edition.
4. See Miter detail chart AAL-EL
5. All welds on interior surface of pipe shall be wirebrushed prior to solvent cleaning.
6. Solvent cleaning of all pipe to be done in accordance with Airco's standard DM-35.45.03, Class A.
7. No back rings are to be used when making pipe welds.
8. Valves to be individually selected to suit application.

CR 8501

Airco Cryoplants

ENGINEERING STANDARD

PROJ. ISSUE DATE

AAO 35.45.00

PROJ. NO.

SERVICE - Cold Oxygen Gas & Liquid -- Aluminum

RATING - 150# (See Note 6)

PRESSURE TEMP. RANGE: 150 psig @ 100°F
150 psig @ 200°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 80	Alum. ASTM B 241 6061-T6*	1
2" & smaller	Seamless	SCH 40	Alum. ASTM B 241 6061-T6*	
2-1/2" through 12"	Seamless	STD WT	Alum. ASTM B241 6061-T6*	
14" through 24"	Welded	STD WT (0.375"wall)	Alum. ASTM B 209 6061-T6*	4
FITTINGS				
2" & smaller	Socketweld	3000#	Alum. ASTM B247 6061-T6	
2-1/2" through 24"	Buttweld	Std. Wt.	Alum. ASTM B361 WP-6061-T6*	2
FLANGES				
All Sizes	Weld Neck	150# RF	Fgd. Alum. ASTM B247 6061-T6 Bore to Match Pipe	5
UNIONS				
Use Flanges				
GASKETS				
All Sizes	1/16" ring	150# RF	JM-61 Graphite Free	3,5
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M Class 1 full threaded stainless steel bolt-stud with (2ea) ASTM A194.8 American Standard Heavy Series Hexagon nuts.	

*Purchase order must specify that mechanical properties are verified by a Tensile test at Mill.

NOTES:

1. Use only where threading is required.
2. For branch reinforcement see "Branch Reinforcement Chart AAO-R1.
3. Gasket dimensions are to conform to ANSI B16.21 Table 1.
4. Longitudinal joints in welded pipe shall be single butt welded with joints in accordance with Table 302.3.4. (3e) of the pressure piping code ANSI B31.3 latest edition.
5. Use 150# flat face flanges with full face gaskets when mating to flat faced equipment or components.
6. Cleaning Std. DM-35.45.03. Class "A". is required.

CR 8501

Airco Cryoplants ENGINEERING STANDARD	PROJ. ISSUE DATE	AAS PROJ. NO.	35.45.00

SERVICE - Liquid Nitrogen - General Purpose Aluminum (Do not use for oxygen)

RATING - 150#

PRESSURE TEMP. RANGE: 275 psig @ +100°F
100 psig @ +400°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 80	Aluml, ASTM B 241 6061-T6*	1
2" & smaller	Seamless	SCH 40	Alum, ASTM B 241 6061-T6*	
2-1/2" through 12"	Seamless	Std. Wt.	Alum, ASTM B 241 6061-T6*	
14" through 16"	Welded	X-Stg.	Alum, ASTM B 209 6061-T6*	4
FITTINGS				
2" & smaller	Socketweld	3000#	Alum, ASTM B247 6061-T6	
2-1/2" through 16"	Buttweld	Wall to MatchPipe	Alum, ASTM _RPYB361 WP6061-T6*	2
FLANGES				
All Sizes	Weld Neck	150 RF	Fgd. Alum, ASTM B247 6061-T6 Bore to Match Pipe	5
UNIONS				
Use Flanges				
GASKETS				
All Sizes	1/16" ring	150 RF	JM-61 Graphite Free	3,5
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M, Class 1, full threaded stainless steel bolt-stud, with (2 ea) ASTM A194,8 American Standard Heavy Series Hexagon nuts.	

*Purchase order must specify that mechanical properties are verified by a tensile test at Mill.

NOTES:

1. Use only where threading is required.
2. For branch reinforcement see "Branch Reinforcement Chart AAS-R1".
3. Gasket dimensions are to conform to ANSI B16.21 Table 1.
4. Longitudinal joints in welded pipe shall be single butt welded with joints in accordance with Table 302.3.4, (3e) of the pressure piping code ANSI B31, latest edition.
5. Use 150# flat face flanges with full face gaskets when mating to flat faced equipment or components.

SERVICE - Liquid Nitrogen - General Purpose Aluminum (Do not use for oxygen)

RATING - 300#

PRESSURE TEMP. RANGE: 720 psig @ +100°F
265 psig @ +400°F
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 80	Alum, ASTM B 241 6061-T6*	1
2-1/2" through 4"	Seamless	SCH 80	Alum, ASTM B 241 6061-T6*	
6" through 12"	Welded	Calculate Wall	Alum, ASTM B 209 6061-T6*	4
FITTINGS				
2" & smaller	Socketweld	3000#	Alum, ASTM B 247 6061-T6	
2-1/2" through 4"	Buttweld	SCH 80	Alum, ASTM B 361 WP 6061-T6*	2
6" through 12	Buttweld	Wall to Match Pipe	Alum, ASTM B 361 WP 6061-T6*	2
FLANGES				
All Sizes	Weld Neck	300 RF	Fgd. Alum, ASTM B 247 6061-T6 Bore to Match Pipe	3,5
UNIONS				
Use Flanges				
GASKETS				
All Sizes	1/16" ring	300 RF	JM-61 Graphite Free	3,5
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M Class 1, full threaded stainless steel bolt-stud, with (2ea) ASTM A194,8 American Standard Heavy Series Hexagon nuts.	

*Purchase order must specify that mechanical properties are verified by a Tensile test at Mill.

NOTES:

1. Use only where threading is required.
2. For branch reinforcement see "Branch Reinforcement Chart BA-R1."
3. Gasket dimensions are to conform to ANSI B16.21 Table 1.
4. Longitudinal joints in welded pipe shall be single butt welded with joints in accordance with Table 302.3.4, (3e) of the pressure piping code ANSI B31.3.
5. Use 300# flat face flanges with full face gaskets when mating to flat faced equipment or components.

CR 8501

SERVICE - Oxygen, Moderate Pressure Range Inside & Outsisde Cold Box - Aluminum

RATING - 300# (See Note 6)

PRESSURE TEMP. RANGE: 720 psig @ +100°F, Min Temp. -327°F
265 psig @ +400°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 80	Alum, ASTM B241 6061-T6*	1
2-1/2" through 4"	Seamless	SCH 80	Alum, ASTM B241 6061-T6*	
6" through 12"	Welded	Calculate Wall	Alum, ASTM B 209 6061-T6*	4
FITTINGS				
2" & smaller	Socketweld	3000#	Alum, ASTM B 247 6061-T6* 2-1/2"	
2-1/2" through 4"	Buttweld	SCH 80	Alum, ASTM B361 WP6061-T6*	2
6" through 12"	Buttweld	Wall to Match Pipe	Alum, ASTM B361 WP6061-T6*	2
FLANGES				
All sizes	Weld Neck	300 RF	Fgd. Alum, ASTM B247 6061-T6 Bore to Match Pipe	3,5
UNIONS				
Use Flanges				
GASKETS				
All Sizes	1/16" ring	300 RF	JM-61 Graphite Free	3,5
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M Class 1, full threaded stainless steel bolt-stud, with (2 ea) ASTM A194,8 American Standard Heavy Series Hexagon nuts.	

*Purchase order must specify that mechanical properties are verified by a tensile test at Mill.

NOTES:
1. Use only where threading is required. Welded in field.
2. For branch reinforcement see "Branch Reinforcement Chart BAO-R1".
3. Gasket dimensions are to conform to ANSI B16.21, Table 1.
4. Longitudinal joints in welded pipe shall be single butt welded with joints in accordance with Table 302.3.4, (3e) of the pressure piping code ANSI B31.3.
5. Use 300# flat face flanges with full face gaskets when mating to flat face equipment or component.
6. Cleaning Std. DM 35.45.03, Calss "A", is required.

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Airco Cryoplants
ENGINEERING STANDARD

PROJ. ISSUE DATE

DCO 35.45.00
PROJ. NO.

SERVICE - Oxygen (Product O_2 Pipeline) - Carbon Steel (See Note 4).

RATING - 600#

PRESSURE TEMP. RANGE: 1480 psig @ 100°F
1350 psig @ 200°F Max.
Min. Temp. -20°F

CORROSION ALLOWANCE: 0.05"

ITEM	TYPE	RATING	MATERIAL	NOTES
PIPE				
2" & smaller	Seamless	SCH 160	C. Stl, ASTM A106 GR B.P.E.	1
2" & smaller	Seamless	SCH 80	C. Stl, ASTM A106 GR B.P.E.	
2-1/2" through 24"	Seamless	SCH 80	C. Stl, ASTM A106 GR B.P.E.	
FITTINGS				
2" & smaller	Socketweld	3000#	Fgd. Stl, ASTM A181-II	2
2" & smaller	Socketweld	3000#	Fgd. Monel, ASTM B164 GR A	3
2-1/2" & larger	Buttweld	SCH 80	C.Stl, ASTM A234, GR WPB BP	2
2-1/2" & larger	Buttweld	SCH 80	Monel, ASTM B366,#11, GR WPNC	3
FLANGES				
2" & smaller	Socketweld	600# RTJ	Fgd. St. ASTM A 105	
2-1/2" through 24"	Weld Neck	600# RTJ	Fgd. St. ASTM A 105 bore to match pipe	
UNIONS				
2" & smaller	Socketweld	3000#	Fgd. Stl, Integral Seat ASTM A181-II	
GASKETS				
All Sizes	Ring Joint	600# RTJ	JM-951 V-Tite, Soft Iron octagonal ring gasket	
BOLTING				
All Sizes	Stud Bolts		ASTM A-193, GR B7 full threaded bolt-stud with (2 ea) ASTM A-194, 2H American Standard Heavy Series Hexagon Nuts.	

NOTES:

1. Use only where threading is required.
2. For branch reinforcement see "Branch Reinforcement Chart DC-R1".
3. Use only where specified on Airco piping drawings.
4. Cleaning Std. DM 35.45.03 Class "A" is required.

CR 0501

SERVICE - Liquid Oxygen - 304 SS - Product O2
to Steam Vaporizer (See Note 2)

RATING - 600#

PRESSURE TEMP. RANGE: 1440 psig @ +100°F
1200 psig @ +200°F (max.)
Min. Temp. -325°F

CORROSION ALLOWANCE: None

ITEM	TYPE	RATING	MATERIAL	NOTE
PIPE				
2" & smaller	Seamless	SCH 80S	SST, ASTM A312 TP304 PE	1
2" & smaller	Seamless	SCH 40S	SST, ASTM A312 TP304 PE	
2 1/2" through 24"	ERW	SCH 80S	SST, ASTM A312 TP304 PE	
FITTING				
2" & smaller	Socketweld	3000#	Fgd. SST, ASTM A182 F304	
2 1/2" through 24"	Buttweld	To Match Pipe	SST, ASTM A403 WP304	
FLANGES				
2" & smaller	Socketweld	600# RTJ	Fgd. SST, ASTM A182 F304	
2 1/2" through 24"	Weld Neck	600# RTJ	Fgd. SST, ASTM A182 F304 Bore to suit pipe	
GASKETS				
All Sizes	Ring Joint	600# RTJ	JM-951, V-Tite, 304 SS octagonal ring gasket	
BOLTING				
All Sizes	Stud Bolts		ASTM A320, B8M, Class 1 full threaded SS bolt-stud with (2 each) ASTM A194, 8 American Standard Heavy Series Hexagon nuts	

NOTES:
1. Use only where threading is required. Backweld all thd. conns.
2. Cleaning Std. EM 35.45.03, Class "A" is required.

Airco Cryoplants Corp.	☒ STANDARDS ☐ INSTRUCTIONS ☐ SPECIFICATIONS ☐ DATA	DM 35.45.03			
		WRITTEN BY	K.W.	DATE	3/6/75
		APPROVED BY		DATE	3/6/75
		APPROVED BY	R M	DATE	3/11/81
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PAGE	4															
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WRITTEN BY																
APPROVED BY																

PIPING STANDARD

CLEANING

AIRCO CRYOPLANTS CORPORATION

☒ STANDARDS
☐ INSTRUCTIONS
☐ SPECIFICATIONS
☐ DATA

NO. DM-35.45.03

TITLE
PIPING STANDARD - CLEANING

INDEX

Written by: K. Williams

Date: 2/75

AIRCO CRYOPLANTS CORPORATION

☒ STANDARDS
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NO. DM- 35.45.03

TITLE PIPING STANDARD - CLEANING

1.0 Scope

This section defines the various cleaning levels and methods used to clean vessels, pipe, fittings, valves, and machine components.

Several categories of cleaning, their application and their implementation are specified herein.

2.0 Categories and Application

The following paragraphs define the various levels or classes of cleaning and give typical applicability data for each. The line index and valve list shall specify which level of cleaning is required.

2.1 Class A Cleaning - This is the highest level of cleaning and shall be performed by the Contractor for all vessels, pipe, fittings, valves, and machine components in oxygen or cryogenic service.

2.2 Class B Cleaning - This level of cleaning is not so stringent as Class A and shall be performed by the Contractor for all other process piping or equipment.

2.3 Class C Cleaning - This level of cleaning is commercial and shall be performed by the Contractor for utility piping such as plant air, instrument air, water, steam and condensate.

2.4 Class D Cleaning - This level of cleaning and treating shall be performed by the Contractor for lube oil piping only.

3.0 Cleaning Requirements

The following paragraphs give the acceptance standards for the various classes of cleaning and the methods which shall be used for obtaining the desired result. Detailed procedures for using the cleaners called for are described in 4.0.

3.1 Class A - Class A cleaning requires the interior and exterior of vessels, pipe, fittings, fabricated pipespools, valves and machine components to show no visible dirt, scale, rust, weld splatter, oil, grease and crayon marking of any kind and the interior surfaces, when wiped clean with white filter paper, shall show no dirt under sunlight and no fluorescence under blacklight. Cleaning methods follow:

Written by: K. Williams Date: 2/75

TITLE PIPING STANDARD - CLEANING

△1 a. Carbon Steel Pipe and Fittings:

Oakite #77 (4.1) then Oakite #33 (4.3) or
Oakite #77 (4.1) then Chlorothene NU (4.6) or
Sandblasting (4.7) then Oakite #33 (4.3) or
Sandblasting (4.7) then Chlorothene NU (4.6)

b. Stainless steel, copper, brass pipe and fittings:

Oakite #33 (4.3) or if pipe is scale and dirt free, Chlorothene NU (4.6)

c. Aluminum Pipe and fittings:

Oakite aluminum cleaner NST (4.4) or
Chlorothene NU (4.6)

d. Valves:

Valves shall be purchased degreased for oxygen service and wrapped and tagged as such by the valve vendor. Care must be taken in the field to see that these valves are stored and protected carefully until final installation. If the valve wrapper should become damaged or if a valve is required to be degreased in the field, the following field cleaning procedure shall be followed: Disassemble the valve completely and match mark parts for reassembly. Place the parts in Chlorothene NU and scrub each part individually to remove all traces of grease and oil. Parts shall show no fluorescence when inspected under blacklight. Valves shall be reassembled by workmen wearing clean white gloves taking care to preserve the cleanliness. Repack the valve with packing specified by Airco Cryoplants, seal all openings, and wrap in an airtight plastic container. Tag each valve - "Degreased for Oxygen Service".

e. Machine Components:

All machine components in contact with the process fluid shall be degreased by swabbing with Chlorothene NU.

f. Vessels:

The interior and exterior of all vessels and any internal circuits shall be degreased by swabbing or flushing with Chlorothene NU.

3.2 Class B - Class B cleaning requires that the interior of vessels, pipe, fittings and fabricated pipespools shall be free of loose foreign material such as scale, sand, weld spatter particles, cutting chips, etc., as determined by a visual inspection. Valves shall be commercially cleaned. Cleaning methods follow:

a. Carbon steel pipe and fittings:

Oakite "Rustripper" (4.2) or sandblasting (4.7).

b. Stainless Steel, copper, brass pipe and fittings:

Oakite #33 (4.3)

c. Aluminum Pipe and Fittings:

Oakite aluminum cleaner #164 (4.5)

3.3 Class C - Class C cleaning is only applicable to carbon steel utility piping and simply requires that all fabricated and erected piping systems shall be blown out with compressed air until essentially free of foreign material.

3.4 Class D - Class D is only applicable to carbon steel lube oil piping. All shop and field fabricated lube oil piping shall be pickled and then flushed with a turbine oil containing no additives. All pipe ends shall be capped or plugged with metal or plastic protectors and flanges blinded with plywood discs until ready for final installation.

4.0 Methods for Cleaning and Treating

Cleaning with the various Oakite compounds requires that the items to be cleaned shall be completely immersed in the solution and that some agitation take place. Agitation may be accomplished by (1) placing small assemblies in a basket and pushing back and forth in the solution, (2) rocking pipe lengths or larger assemblies up and down in the solution, or (3) by pumping the solution through the assembly. Oakite cleaning shall be followed by thorough rinsing in clean water and then drained and allowed to dry. If more than one rinse is required, it is stipulated in the following paragraphs.

After cleaning, all pipe, fittings and fabricated pipespools shall be carefully protected until final installation. All pipe ends shall be capped or plugged with metal or plastic protectors. All flanges shall be blinded with fiberboard or plywood blinds.

TITLE

PIPING STANDARD - CLEANING

4.1 Oakite #77 - Oakite #77 shall be used for carbon steel prior to final degreasing. For immersion cleaning use 4 to 10 ounces per gallon of water and maintain the solution at 180° to 200°F. Minimum cleaning time shall be five minutes. If the solution is circulated; use 1 pound per gallon of water and maintain at 170°F.

4.2 Oakite Rustripper - Oakite Rustripper shall be used for removal of rust, scale and dirt from carbon steel. Use 8 to 16 ounces per gallon of water and maintain the solution at 180°F to 200°F. Minimum cleaning time shall be five minutes.

4.3 Oakite #33 - Oakite #33 is both a cleaning and degreasing agent. It shall be used alone for stainless steel, copper and brass.

If used alone, a concentration of 25% by volume and solution temperature of 140°F is recommended. If used after Oakite #77 a concentration of 10% by volume and solution temperature of 140°F is recommended. Minimum cleaning time shall be ten minutes. Two cold rinses circulating and overflowing until neutralized shall be used after Oakite #33. If any white powdery residue is left after rinsing and drying, the cleaning sequence shall be repeated.

4.4 Oakite Aluminum Cleaner NST - Oakite NST is both a cleaner and degreasing agent. It is used at a concentration of 5 to 10% volume. Solution temperature shall be maintained at 120°F to 130°F. Minimum cleaning time shall be five minutes.

4.5 Oakite Aluminum Cleaner #164 - Oakite #164 is used in a solution of 6 to 8 ounces per gallon of water at a temperature of 160° to 180°F. Minimum cleaning time shall be five minutes and adequate agitation shall be maintained. Cleaning shall be followed by two clear water rinses.

4.6 Chlorothene NU - Cleaning shall be by pumping the solvent through an assembly or by immersion and swabbing or by swabbing. For immersion, fabricate a trough large enough to completely immerse item to be cleaned. Fill the trough with solvent and allow pipe, fittings or pipespool to remain in the solution until all grease and oil is dissolved. After this, swab the interior with a clean, white lintless cloth soaked in the solvent. Swab until no signs of grease and oil are evident on the cloth. Surfaces shall show no fluorescence when inspected under blacklight. After cleaning, drain completely and blow out with oil-free dry nitrogen. Care shall be taken to be sure all items to be cleaned are dry prior to cleaning. Chlorothene NU is not effective on a wet surface. For vessels too large for immersion cleaning the exterior and interior shall be swabbed clean as noted above.

4.7 Sandblasting and Shotblasting - Sandblasting may be used for cleaning carbon steel. Prior to fabrication each fitting and length of pipe shall be sandblasted clean of rust, scale, dirt and foreign material. After fabrication, shop pipespools shall be shotblasted. All shot and sand from the cleaning operations shall be thoroughly removed from the pipe spools before installation of the protective covers.

5.0 Inspection - All cleaning is subject to inspection and rejection by the Buyer, either at the point of delivery or in the manufacturer's shop. If the cleaning work is rejected due to non-compliance with this specification, the rework shall be at Seller's expense.

Plant—27 Unique
Specifications

GENERAL

100.1 - WATER & PROCESS PIPING

This item includes pipe, fittings, valves, hangers, insulation and materials to, from, and between the items of equipment being furnished under this Specification.

The Contractor shall supply and install piping systems required to insure the proper operation of the Preparation Plant.

1. A process piping system including heavy medium piping, dilute medium piping, slurry piping, clarified water and vacuum piping as required for the proper operation of all the equipment. This will include all pump suction and discharge lines, pipe launders from screen pans to collecting sumps, sump emergency overflows and drains, and spray nozzles, rinse boxes and manifolds at screens where rinsing water is required.

2. Compressed air piping, washdown piping, fire protection piping, oxygen and acetylene piping, reagent piping, flocculation piping and any other piping required to insure the proper operation of all the equipment.

Materials:

1. Pipe

a. Pipe handling heavy medium and/or slurries shall be extra strong black steel pipe up to and including 8" diameter, 10" diameter pipe and above will have 1/2" minimum wall thickness.

100.2 - PLATEWORK

This item includes all chutes, hoppers, round and rectangular sumps and sluices to and from the items of equipment being furnished under this specification.

Platework, including sumps, shall be of 1/4" thick mild steel and adequately supported and reinforced with stiffeners as required.

Sumps shall have the lower one-half of the bottom lined with 1" thick Duraline. Sluices and screen pans shall have 1" thick Duraline bottom liners and 3" high side liners in areas of material flow.

Conveyor skirt plates shall be 1/4" thick mild steel with skirtboard rubber attached on the bottom for sealing at the belt. Covers, where required, shall be constructed of 10 gauge mild steel, adequately stiffened, with spring clip fasteners.

Steel liners specified for chutes shall be installed on the bottom and 6" up the sides in areas of material flow.

The vacuum filter discharge chutes shall be constructed of 1/8" thick Armadillo rubber suitably supported and reinforced with stiffeners.

Steel liners shall be held in place with countersunk bolts or weld studs.

Rubber liners shall be "Trellex" with abrasion-resistant qualities exceeding those of normal steel liners.

The liners shall be as follows:

<u>AR-235 Steel</u>

Raw Coal Feeder Chutes	1/2" thick
Coarse Refuse Chutes	1/2" thick
Boiler Fuel Chutes	3/8" thick
Clean Coal Chutes	3/8" thick

Sieve Bend Discharge Chutes 1/4" thick

1" Duraline with Hexmetal

Screen Pans
Sumps
Cyclone Overflow and Underflow Launders
Thickener Feed Sluices
Sieve Bend Underflow Pans

Stainless Steel

Small and Fine Coal Centrifuge Discharge Hoppers 1/4" thick
Boiler Fuel Sampling System Chutes
Clean Coal Sampling System Chutes

2" Smooth Rubber

Plant Feed Conveyor Discharge Chutes
Raw Coal Screen Chutes
Prewet Screen Chutes
Coarse Clean Coal Screen Chutes
Coarse Middlings Screen Chutes
Middlings Crusher Chutes
Coarse Refuse Screen Chutes

1" Smooth Rubber

Desliming Screen Chutes
Primary Small Refuse Screen Chutes
Small Clean Coal Screen Chutes
Secondary Small Refuse Screen Chutes
Small Middlings Screen Chutes

POWER CENTERS

100.3 - ELECTRICAL

Primary power supply provided by the Owner to be 13,800 volts delta, 3 phase, 60 hertz. Secondary of transformer to be 4160/2400 and 480/277 volts.

Each power center unit substation will consist of the following:

1 - Free standing incoming line section, for bolting to transformer, containing clamp type terminals for 15,000 volt cable and manually operated 15 KV air interrupting load switch with current limiting fuses and 9 KV station type lighting arresters.

1 - Transformer 35 KV BIL, 3 phase, 60 hertz, resistance grounded secondary for continuous 15A duty, open dry type transformer, 115 degree C. rise, standard impedance for 4160 volts and 8 percent impendance for 480 volts and two 2-1/2% (approximately) full capacity taps above and below primary voltage. A 25:5 CT for ground trip, and standard accessories will be included. Provisions to be made for future fan cooling of transformer.

1 - Low voltage compartment for cable connecting to the 4160 volt motor starter line-up or motor control centers.

A diversity factor of approximately 95% will be applied to all motors up to and including 300 HP as the basic selection of transformer capacity.

MOTOR CONTROLS

4160 Volt Motor Starters

The full-voltage across-the-line squirrel cage motor starter to consist of the following basic components:

High-voltage compartments containing:

1 - Drawout Contactor and fuse assembly consisting of:

- 1 - Set of current limiting fuses and supports.
- 1 - Isolating mechanism, externally operated. Mechanism operates in sequence to (1) open secondary of control transformer, (2) withdraw stabs, (3) close shutters over power connectors.
- 1 - 3-pole air-break contactor with 500,000 KVA interrupting rating.
- 1 - Set of mechanical interlocks to prevent withdrawal of stabs while contactor is closed.
- 1 - Control power transformer, 120 volt secondary.
- 3 - Current transformers.
- \- Terminals for motor cable connection.
- 1 - Set of mechanical door interlocks to prevent opening of door to high-voltage compartment until panel is isolated and to prevent energizing panel until door to high-voltage compartment is closed.
- \- Incoming line terminals.

Low-voltage compartment containing:

- 3 - Temperature-compensate thermal-overload relays, hand-reset.
- \- Ground fault protection with indication.
- 1 - Instantaneous under voltage release.
- 1 - Control-circuit fuse.

Location

Motor Control Centers for the Preparation Plant to be located in the Service Wing.

INTERLOCKING

All units to be interlocked to provide proper starting order and automatic shutdown of all the feeding units due to motor overload or power failure. Crushers and centrifuges will not be stopped but units feeding them will. All units that are in interlock to have selector switches, mounted on operator's panel to by-pass interlock contacts, for maintenance purposes.

OPERATOR'S PANEL

Operator's Panel for Preparation Plant

A custom-made, vertical type, operator's panel, gasketed construction, containing push button groups for centrally controlling the Preparation Plant, Refuse Handling and Clean Coal Belts, to be furnished. The panel to be designed to hold operating personnel to a minimum consistent with modern operating practice and safety.

The operator's panel to have the following oil-tight units mounted on the front and wired to terminal blocks:

1. Green push button for starting all units that are interlock, with integral green light indicating unit is in interlock.
2. Extended green push button for starting all units that are not interlocked.

3. Red push button for stopping with integral red light indicating motor running.

4. Selector switch for each unit in sequence interlocking and removal from sequence operation.

5. Indicating ammeters, where load current will be an aid to operation, to be provided for main process pumps, vacuum pumps, crushers, centrifuges (rotation only), heavy medium vessels elevators, belt conveyors, units are listed by the following item numbers:

   1.2, 2.4, 2.5, 3.1, 3.2, 4.4, 5.1, 5.5, 5.8,
   6.1, 6.3, 6.6, 6.8, 6.12, 7.3, 7.6, 7.8, 7.9,
   8.3, 8.4, 11.1, 12.1, 12.5, 12.7, 12.10,
   12.12, 13.1, 13.5, 13.7, 13.10, 13.11

6. Engraved plastic group nameplates, 1" x 2-3/4" black letters on white background, as required by above listed push button and lights.

7. Electric clock.

8. A solid state Panalarm, or approved equal, annunciator panel with signal lights and audible alarm to be furnished for indicating abnormal conditions such as oil pressure failure, thickener overload, bins full, belt conveyor chute plug, emergency stop-misalignment-underspeed switches and sumps high-low level warning. Common master lights, only, to be provided for all belt conveyor switches.

   A common audible alarm with silence push button to be included.

The arrangement of the push buttons and selector switches on the operator's panel to be located in the order of plant starting, vertically aligned for each individual unit.

The panel to have a steel front and steel hinged access doors on the rear. Front and rear panel mounted equipment to be arranged so that all are readily accessible for inspection, trouble shooting and maintenance. Electrical terminal blocks will not impede access to other devices and will be compression type.

The control panel to be complete and ready for field installation, including instruments, accessories and interconnecting wiring. Panel to be shop tested and "checked out" prior to shipment.

Mimic Flow Diagram

A pictorial coal flow panel containing graphic shapes, flow lines, pilot lights (mounted in the graphic shapes, one light per shape) arranged to illustrate the flow of material (solid and liquid) in the Preparation Plant and associated facilities to be furnished. The graphic shapes and flow lines will be color coded and identified.

The pictorial panel to be mounted on top of the operator's panel and inclined, slightly, downward for comfort viewing by the operator. The overall height of both panels not to exceed ten (10) feet exclusive of the shock absorbing pad.

The clear piece of acrylic or harder scratch resistant plastic (one piece if possible) to be placed overall as a cover.

Operator's Panel for Coal Storage

A vertical type operator's panel containing push button groups and indicating lights to be furnished for controlling the coal storage and reclaim facilities. A pictorial coal flow panel to be included.

Plant Refuse Truck Operator's Station

An "open-close" push button station to be furnished for controlling the bin loadout gate. The push button station to be mounted on a pendant cord and located within reach of the truck operator.

MISCELLANEOUS CONTROLS

1. One (1) "Jog-Stop" push button in NEMA 4 or 7-9 enclosure, with lockout provision in stop, to be furnished and located in sight of each motor starter from the operator's panel.

2. Push buttons, in NEMA 4 or 7-9 enclosure, with lockout provisions on stop, to be provided for all units that require local starting.

3. Level controls, electrode type to be furnished for the floor sump pumps.

4. Conveyor belt slippage switch, belt misalignment switches and pull cord operated emergency stop switch, to be provided only for the belt conveyors furnished.

   One (1) Ensign Bulletin 1100 Series, flat wheel type belt slippage switch to be furnished and located under the top side of the belt at the head end.

   Four (4) belt misalignment switches, Dension Loxswitch Model L-525 to be furnished, two (2) will be located near the head pulley and two (2) will be located at the tail pulley, for all belt conveyors over, 100 feet long, center-to-center of pulleys. Belt conveyors over 400 feet in length to have intermediate misalignment switches spaced at 400 foot intervals.

   One (1) Crouse-Hinds Type AFU safety stop switch operated by a 3/32" stranded wire core, plastic coated, pull cord, suspended along the inspection walkway side only of the belt conveyor and spaced at 200 feet on centers maximum.

5. Belt conveyor discharge chute plugged switch, Ensign Electric Catalog NO. 1350 Wobble Switch, to be provided.

6. The Refuse Bin to be provided with a high level warning device wired to the annunciator panel and full bin shutoff switch wired into the belt stop circuit.

7. Gates, power-operated, to be provided with limit switches to limit the gate travel. Gate position lights to be provided on the operator's panel from which the gates are controlled.

8. A raise-lower push button station to be provided on each floor at the machinery well for controlling the machinery well hoist.

9. Zero speed switches to be provided on the drag conveyors and screw conveyors tail shaft or drive chain.

10. Limit switches for manually operated by-pass gates for sequential inter-locking.

11. High and low level controls to be furnished with the process sumps.

The control circuits for the belt misalignment switches, discharge chute plugged switches and bin full switches to include a timer to prevent shut-down by momentary operation. The time interval to be adjustable from 0 to 3 seconds.

MAGNET POWER CONVERSION UNIT

A 5 KW Silicon AC-DC power conversion unit to be furnished for the Raw Coal Magnet for supplying 250 volts DC power. A DC Series relay will be included in the magnet power supply for sequential interlocking.

SIGNAL SYSTEM

Plant starting horns, or equal, 120 volts, to be provided and spaced throughout the Preparation Plant.

A push button to be provided, for the operator, for sounding the horns located at the facilities that are started from the respective operator's push button panel. A time delay to be provided before the equipment can be started after the horns have been sounded.

LIGHTNING PROTECTION

A lightning protection system for the structures to be furnished in accordance with the requirements of the Underwriter's Laboratories and complying with NFDA No. 78. Air terminals to be spaced around the outside perimeter of the structures and longitudinally along the roof ridges. The air terminals to be connected to a continuous heavy duty lightning conductor with ground leads terminating to ground rod assemblies. The lightning protection ground rods to be interconnected into the main structures grounding system.

PREPARATION PLANT HEATING

A steam heating system to be provided for the Preparation Plant, including the motor control room and transformer room to maintain a minimum temperature at 40^{o}F. inside with a minus 10^{o}F. outside temperature. The heating furnished to be based on the building siding being sandwich construction with fiberglass insulation. The system to be sized for infiltration of 1-1/2 air changes per hour.

The Preparation Plant operator's room, and foreman's office will be heated to maintain 70^{o}-75^{o}F. with outside temperature of 0^{o}F.

Additional unit heaters to be furnished for the following locations:

Service Wing
Static Thickener Pump Hose
Boiler Fuel Sampling Station
Boiler Fuel Transfer Stations
Clean Coal Sampling Station
Clean Coal Transfer Station

HEATING FOR REFUSE BIN

Heating to be provided for the bottom of the Refuse Bin, near the discharge gate, to prevent freeze-up of the refuse material to the bin sides. Heating units furnished to be Aitken Model OH204, 2000 watt, 480 volts, single phase, metal sheath heaters mounted in heavy gauge aluminum housings of weatherproof construction. The bin bottom to be heated by nine (9) infared units.

The Refuse Belt discharge chute to be heated by three (3) 2000 watt metal sheath heaters.

The 480 volt power supply for the bin heaters to be supplied by combination circuit breaker type contactors mounted in motor control centers. Heaters to be controlled by its own capillary, tube type, thermostat.

HEATING FOR CHUTES

The storage belts discharge chutes to be heated to prevent freeze-up of coal to sides.

AIR HANDLING

Air Handling Motor Control Room

American Air Filter ventilating air handling units to ventilate and pressurize against a .25 external static, to be furnished. The units to include a mixing box with return air and fresh air dampers to allow up to 25 percent outside air, throw away filters in a standard angle box, fan section and vibration isolators. An outside louver with bird screen to be included.

Cabinet Unit Heaters/Air Handlers

American Air Filter heating and ventilating electric cabinet heaters to heat, ventilate and pressurize against a .15 external static with manual damper set to allow up to 25 percent outside air to be furnished. The units to include throwaway filters, manual outside air damper, duct collar for the outside air, wall louver, and overheat switch to de-energize the heating coil should the air be restricted across the heating element, a circuit breaker disconnect, single speed continuous fan, sheated electric heating elements, all necessary controls and including a unit mounted thermostat. The cabinet heaters/air handlers to be furnished.

Air Conditioners Thru-Wall Type

Thru-wall type Comfort Aire air conditioning units to maintain a 15°F temperature differential with outside ambient air to be provided.

Lighting for Hazardous Areas

Lighting in Hazardous areas to be by Crouse-Hinds EVMA43151 Hazard-Gard, 150 watt high pressure sodium fixtures with factory sealed integral high power factor ballast.

WELDING CIRCUITS

Four (4) 300 ampere dual operator, constant current welders for the Preparation Plant, to be furnished by Owner. The electrode side of each welder to be carried through the Preparation Plant by two separate circuits, over 2-350 MCM cable installed in conduit, to carry the positive and negative welding current. Two (2) receptacles to be provided for each module for each floor or a total of eight (8) receptacles for each main floor. Welding machine receptacles furnished to be 300 ampere, two pole, with flip cover. 300 ampere, double pole plugs, for the above receptacles, to be furnished.

POWER SUPPLY

Power supply shall be 13,800 volts Delta, 3 phase, 60 hertz, high resistance grounded power supply, with suitable short circuit protection and disconnect devices, fed underground to a service box provided on the ground floor of the Service Wing.

The primary power supplies, from the service box to the distribution switchgear located in the Service Wing Transformer Room, are furnished.

Utilization Power Requirements

The estimated utilization power requirements is as follows:

5,350 HP - 4000 Volt Motors
15,712 HP - 460 Volt Motors
90 HP - Preparation Plant Ventilation
2,462 HP - Heating
585 KVA - Transformers for Lighting & Convenience Receptacles
1,000 KVA - Estimated Power for Service Wing
200 KVA at 460 volts - Welders

Note: Service Wing power requirements not included at this time.

ELECTRICAL

SERVICE WING

Heating, Ventilation, and Air-Conditioning Systems General

Service and office wing to be provided with heating, ventilation and air conditioning.

Stair wells to be provided with heating and ventilation.

Features for the equipment in the above areas include the following:

1. Air Handling or ductwork systems.
2. Packaged air-conditioning unit system.
3. Electric heating.
4. Insulated ductwork.
5. Centralized automatic control system. Adjusted for both summer and winter operation.

Design

Service and office wing provided with centralized heating, ventilation and air conditioning, designed to maintain environmental conditions per general specifications.

Data To Be Furnished

The following data shall be furnished:

Airflow Diagrams

Showing schematic layout of ductwork and quantity of airflow provided in each duct system (CFM).

Showing location of fans, air-conditioning units, dampers, and supply and return outlets.

Computations

Heat loss and heat gain calculations for sizing HVAC equipment.

Pressure calculations for determining pump and fan pressure capabilities.

Air Testing Air Balancing

General

The heating, ventilating, and air-conditioning system balanced with ± 10 percent of the flow rates shown on the airflow diagram.

100.4 - STRUCTURES

The structures shall consist of the following items shown on the general arrangement drawings.

Raw Coal Facilities

1.2	42" Plant Feed Conveyors A,B,C,& D (4)

Preparation Plant Facilities

	Preparation Plant
2.8	48" 3 x 0 Clean Coal Conveyors (4)
3.6	30" Middlings Conveyors (4)
4.12	48" 3/8 x 100M Clean Coal Conveyors (4)
	Service Wing Building
8.1	Static Thickeners (4)
8.6	Pond Return Pump House

Coarse Refuse Facilities

11.1	36" Coarse Refuse Conveyors (2)
11.2	Coarse Refuse Bin 500T.

Boiler Fuel Facilities

12.1	30" Boiler Fuel Conveyor 1A & 1B (2)
	Boiler Fuel Sampling Building
12.5	30" Boiler Fuel Conveyor 2A & 2B (2)
	Boiler Fuel Transfer Building
12.7	30" Boiler Fuel Stacker Conveyor
12.10	30" Boiler Fuel Reclaim Conveyor
12.11	30" Boiler Fuel By-Pass Conveyor #1
	Boiler Fuel By-Pass Transfer Building
12.12	30" Boiler Fuel By-Pass Conveyor #2
	Boiler Fuel Storage Stacking and Reclaim Trackwork

Clean Coal Facilities

13.1	60" Clean Coal Conveyor 1A & 1B (2)
	Clean Coal Sampling Building
13.5	60" Clean Coal Conveyor 2A & 2B (2)
	Clean Coal Transfer Building
13.7	60" Clean Coal Stacker Conveyor
13.10	54" Clean Coal Reclaim Conveyor
13.11	54" Emergency Clean Coal Reclaim Conveyor
	Clean Coal Loading Building
	Electrical MCC Buildings (3)
	Clean Coal Storage Stacking and Reclaim Trackwork

1. Belt Conveyors

A #14 gauge deck plate on all conveyor deck sections shall be furnished at loading points, terminals and over vertical take-ups only.

A 10 gauge flat stainless steel drip pan shall be furnished for the full length of all belts within the Preparation Plant. On the exterior all inclined belts without turnover sections shall be furnished with #20 gauge stainless steel V-beam type drip pans. Pans will be interrupted at vertical gravity take-ups where material flow shall be directed laterally to by-pass piping to down slope pan.

Belts where exposed to weather except for Stacker and Recalaim Conveyors shall be covered with curved standard corrugated, 22 gauge galvanized steel sheets, with corrugations paralleling the belt and a service opening on one side. Sheets shall be finished, exterior only, with PVF2 as described in Section D.

Stacker and reclaimer belts shall have a curved cover as described only in areas not affecting equipment operation. For the remainder of their exterior length they shall have a vertical wind guard of standard corrugated, 22 gauge galvanized steel sheets with a PVF2 finish on both surfaces which shall extend 6" above the carrying run of belt to 6" below the return run of belt on one side only.

Conveyor walkways shall be of 1-1/4" x 1/8 serrated bar type grating. All conveyor walkways shall be 3'-0 wide.

Counterweights shall be guarded with a cage of 3/4" x 9 mesh for 7'-0 above floors in buildings only. Exterior counterweight tower shall be surrounded with a cyclone fence.

2. Preparation Plant

The Preparation Plant shall be constructed as described in sections A through E.

The interior partition for the Preparation Plant side of the common core wall with the Service Wing Building shall consist of 8" lightweight concrete block.

The interior partition for the vacuum pump rooms are to be 8" concrete block. The block shall be given two coats of paint on the Preparation Plant side.

A 6" thick slab on grade shall be furnished sloped to drainage trenches and waste sumps. A 12" thick slab shall be furnished in the monorail machinery well areas.

Two enclosed stairwells shall be provided with exterior walls as described in Section D and interior partition of "8" concrete block. Concrete floors and doors shall be provided at each floor level. Stair treads and handrail shall be as described in Section C.

In the machinery well areas motorized overhead rolling doors shall be furnished.

Floor trenches shall be covered with 1-1/4" x 1/8" grating.

Internal vertical bracing shall be used in the Preparation Plant and so located, where possible, to provide maximum walkway and machinery access room. However, structural integrity shall be given first consideration.

Four (4) 30 ton capacity magnetite bins shall be provided and constructed of 1/4" thick A36 steel plate sides and conical bottom. No liners shall be furnished. The bin top shall be 1/4" thick checkered plate.

The reagent tanks shall be buried.

3. Service Wing Building

The Service Wing Building shall be constructed as described in Sections A through E. Except as described below.

The Service Wing and Preparation Plant shall be separated by a 8'-0 wide totally enclosed aisle for the full building height. The purpose of this aisle is to prevent noise pollution and vibration from the preparation equipment from encroaching upon the Service Wing Building. The partition on the Preparation Plant side shall be as described in Section 2. The Service Wing partition shall be an acoustical, fire rated wall.

Both stairwells, elevator shafts and duct spaces in the Service Wing Building shall be enclosed in an acoustic fire rated wall. Stairs shall be provided with closed risers and treads.

The vestibules between the two buildings shall be provided with two sets of doors each. Doors will be of an acoustical type and fire rated.

The following floor area has been allocated for the Service Wing Building:

Areas:

Ground Floor	12,600 s.f.
Second Floor	5,400 s.f.
Third Floor	5,400 s.f.
Fourth Floor	5,400 s.f.
Fifth Floor	3,600 s.f.
Sixth Floor	5,400 s.f.
Seventh Floor	5,400 s.f.
	43,200 s.f.

Architectural Appurtenances

Window Wall: Window wall shall be bronzed anodized aluminum, equal to Kawneer Series 550. Doors shall be equal to Kawneer extra duty 350.

Aluminum Windows: Reversible aluminum windows and accessories shall be Fentron series 2000 TB or equal.

Interior Partitions: Shall be masonry, or steel stud with firerated gypsum board. Acoustical treatment furnished at separation between Plant Building and Service Wing.

Doors and Hardware:

Overhead doors shall be power operated industrical quality, 16 guage steel, insulated.

Metal swinging doors except in window walls shall be flush, hollow metal, acoustical type and fire rated.

All door frames except in window walls shall be pressed steel, double rabbetted, insulated.

Locksets shall be heavy duty type, equal to Russwin "Uniloc".

Glass: All exterior glass shall be 1" insulating glass composed of 1/4" clear tempered solar bronze glass outside. All glass shall meet Federal Specification DD-G0451.

Ceramic Tile: Ceramic tile to conform to ANSI A137.1 and U.S. Department of Commerce Simplified Practice Recommendation R61-61 with sizes as follows:

Floor tile, 2 x 2 x 1/4 inch
Wall tile, 4 x 4 x 1/4 inch

Resilient Floor Tile: Vinyl asbestos shall be grease and acid resistant, 9 x 9 or 12 x 12 inches square, 1/8" thick. Vinyl base 1/8" thick, top set.

Metal Toilet Partitions: Metal toilet partitions to be floor supported with doors, Henry Weis, or equal.

Suspended Ceilings:

Luminous ceiling panels in operator's room shall be metal egg crate louver panels with 45° shielding and supported on T-shape grid system.

Accoustical tile shall be equal to Armstrong "Fire Guard" tile, 12 x 12 x 5/8", supported on concealed grid system.

Moisture-resistant tile shall be equal to Armstrong "Ceramaguard" tile, 12 x 12 x 5/8", supported on a exposed grid system

4. 135' Diameter Static Thickeners and Pump Houses

Four (4) 135'-0 diameter Static Thickeners constructed of reinforced concrete side walls with a 5" concrete bottom slab reinforced with wire mesh shall be furnished. Underflow tunnels shall be provided.

Two (2) Clarified Water Sumps of reinforced concrete construction shall be constructed one between each pair of thickeners.

Launders shall be constructed of 1/4" thick A36 steel.

A 36" diameter C.M.P. emergency escape tunnel shall be provided from each of the underflow tunnels.

Two (2) pump houses shall be provided, one for each pair of thickeners. Three walls of the pump house shall be formed by the thickener walls and clarified water sump wall. The fourth wall shall be of 8" concrete block. The roofs shall be as described in Section D.

Two foot bridges shall be furnished to the Preparation Plant, one from each pump house roof.

5. Coarse Refuse Bin

The refuse bin structure shall be constructed as described in Sections A through E. Only the head house above the bins shall be enclosed. The Contractor shall furnish the stairs to grade along with the foundations and a slab on ground.

The 500-ton capacity bin shall be constructed of 3/8" thick A36 steel side walls and hopper bottom both suitably stiffened with structural shapes. The hopper bottom of the coarse refuse bin is to be lined with a 3/8" thick abrasive resistant liner.

6. Sampling Stations and Transfer Buildings

The structures shall be constructed as described in Section A through E, completely enclosed with insulated siding and with concrete floors. The Contractor shall furnish the stairs to grade along with the foundations and a slab on ground.

7. Pond Return Pump House

A pump house shall be furnished with concrete block walls, a flat roof and a 6" thick concrete slab on ground.

A 72" diameter C.M.P. wet well with a 36" diameter CMP inlet to the pond shall also be furnished.

8. Electrical Motor Control Center Building

The Structures shall be constructed as described in Section A through E completely enclosed with insulated siding and slab on ground.

9. Coal Storage Stacking & Reclaim System

The trackwork shall be supported on precast concrete ties placed on an 18 inch thick crushed roll trackwork.

10. Site Preparation

The Owner shall furnish a cleared, levelled and graded site as shown on the general arrangment drawings.

Surface or subsurface drainage and sewage facilities are not included in this specification.

On-site roads, parking and walks are to be provided by the Owner.

100.7 - NOISE CONTROL

A comprehensive noise control program in compliance with all State and Federal laws, regulations and codes shall be a design feature. The following is an outline of the specific items included for noise control in the Preparation Facility:

1. The entire Service Wing shall be structurally divorced from the main Preparation Plant structure to reduce the transmission of noise and vibration.

2. An air space and an acoustically designed buffer wall shall be furnished between the main Preparation Plant and Service Wing. In addition, two (2) double doors shall be provided at all passage ways from the main plant to the Service Wing to provide additional noise barrier.

3. The plant design and selection of process equipment shall be made with due consideration given to the noise requirements. The following is a listing of specific items:

   a. Rubber lined chutes for handling plus 28M material.

   b. Trelleborg rubber screen surface for the top deck of the vessel refuse, raw coal and vessel clean coal screens.

   c. Rubber lined feed boxes for raw coal screens.

   d. Rubber lined discharge chutes for raw coal, prewet, vessel refuse and vessel clean coal screens.

   e. Marshmallow isolators for all horizontal vibrating screens.

   f. Vibration isolation rubber for large chute section handling coarse material.

   g. Rubber feed closure for CMI centrifuges.

h. Vacuum pumps and filter blowers shall be located in a separate concrete block enclosure. In addition, the vacuum pumps shall be furnished with high efficiency silencer units and the filter blowers shall be furnished with inlet and outlet mufflers.

i. The electric motors shall be selected with due consideration given to the noise requirements.

4. Sound absorbing ceiling hung noise baffles will be furnished in the main plant area. Noise baffles will be of a water-resistant design.

5. The services of a qualified noise and vibration consultant shall be provided to aid in the initial design, make all necessary studies and reports, and recommend any required remedial work.

100.9 - FIRE PROTECTION

The fire protection system shall be as follows:

Preparation Plant

Two (2) 6" diameter steel pipe fire protections headers having 2-1/2" diameter branch lines shall be provided on each floor located, so that the entire floor area can be reached with a 100'-0 length of hose.

15 - 1-1/2" diameter rubber lined, synthetic fiber covered hose with coupling and combination steam/fog nozzle complete with open fire hose rack. (Located at header branch lines).

12 - 1-1/2" diameter rubber lined, synthetic fiber covered hose with coupling and combination steam/fog nozzle complete with open fire hose rack, complete with recessed fire hose cabinet. (Located to service office, service, change and electrical rooms.)

60 - Seco Model 20, 20 lb. capacity dry type chemical fire extinguisher,.. Located adjacent to each open fire hose rack and with balance located throughout plant.

14 - Seco Model 20, 20 lb. capacity dry type chemical fire extinguisher, mounted in recessed cabinet and located at each recessed fire hose cabinet. Balance to be located throughout office, service, change and electrical rooms.

1 - Automatic sprinkler system for the electrical spreading room. The system shall be wet pipe type with heat sensitive melt plugs located above the cable trays. The system shall be in accordance with a NFPA Standards.

In addition, a Mueller Style 59S simplex cast iron strainer shall be included to filter the raw water source to guard against plugging of the sprinkler nozzles.

100.10 - AUTOMATIC LUBRICATION

Automatic lubrication shall be provided. System as follows:

One (1)—complete Riggs Auto Lube System per module consisting of approximately 126 lubrication points to minimize the equipment maintenance by automatically lubricating bearings at pre-determined intervals for the following equipment in the Preparation Plant.

Plant Feed Conveyor, head and snub
Raw Coal Screens
Primary and Secondary Vessel
Middlings Crusher
Vacuum Filter
Flotation Cells
Product Conveyors and Storage Conveyors, tail
Magnetic Separators
Magnetite Thickener
Sumps

The system shall consist of the following:

Lincoln electric drive drum pump
2-way N/O high pressure solenoid valve system vent
Riggs Model MCP-3 control panel with visual and audio signals
SL-1 series injectors
Pipe and pipe fittings
Tube and pipe fittings
Tube and tube fittings
Braid hose and hose to pipe connectors
Clamps and supports

Note: No automatic lubrication to be provided for remote grease points.

GENERAL DESCRIPTION OF BELT CONVEYORS

The following standards shall be common to the Belt Conveyors listed in this Specification:

1. Shafts

Shafting shall be AISI 1045. In sizes to and including 5-15/16" diameter shafts shall be cold finished. Sizes from 6" to 10" shall be hot rolled AISI 4140, machined to size. Shafts larger than 10" diameter shall be forged and machined to size.

Shear stress for shafts keyseated - 6,000 PSI.
Shear stress for shafts not keyseated - 8,000 PSI.
Service factor for bending - 1.5
Services factor for torsion - 1.0

Deflection shall be measured from centerline of bearing to nearest pulley end disc and the slope angle of deflection curve at point under end discs shall be limited to a maximum of 0.0859 degrees (TAN 0.0859 degrees = .0015).

Shaft size is determined by either strength or deflection, whichever is larger.

Shaft tolerances, finishes and keyway sizes shall be in accordance with the recommendations of manufacturers of components mounted on the shafts. Finish bores of coupling halves and backstops shall be based on actual micrometer measurement of each conveyor drive shaft with cold finished shafts.

In instances where shafting is necked down, the maximum difference in diameter in the necked portion shall be no more then one (1) inch. the fillet radius will be equal to 1/2 the difference of the two diameters with 125 micro inch finish.

2. Bearings

Shaft shall be supported on pillow blocks incorporating spherical roller type, self-aligning, adapter mounted, anti-friction bearings. The housings shall be gray iron split with labyrinth seals or end caps where feasible. Each shaft shall have one fixed, and one expansion type bearing mounted thereto.

Pillow block housing shall have four bolt bases for all bearings two and seven-sixteenth inches and larger. All lube points shall be equipped with standard button head grease fittings. (5/8" dia. head).

Grease fittings shall have extended lube lines where fittings are obstructed. All lube points shall be accessible for convenient manual lubrication, no more than four feet above a floor, platform or walkway.

Lubrication points shall be accessible from outside of guards, and lubrication shall be possible without removal of guards or portion of guards.

3. Pulleys

All pulleys shall be welded steel constructed with a tapered lock bushing and hub attachment to shaft. Hubs shall be welded to end discs.

Pulley diameters shall comply with belting manufacturer's recommendations.

Design and construction will comply with MPTA Specification 301-1974 which is also ANSI Specification B-105.1 - 1976.

Drive pulleys shall be keyed on both sides, no keys required on other pulleys.

Pulley face shall be belt width plus 2" for belt widths up to 42" inclusive. 48" and wider belts shall have belt width plus 3".

Drive pulleys shall have 1/2" thick fire resistant resistant herringbone rubber vulcanized lagging of 50 to 60 durometer reading. Pulleys in contact with carrying side of belt shall have 3/8" plain rubber vulcanized lagging of 40 to 50 durometer reading.

Tail and take-up pulleys shall be crowned.

Pulley identification shall include conveyor number, mark number and drawing number.

Identification tag shall be metal, permanently attached to end disc.

Pulley assemblies shall be removable, tail and snub pulleys shall have a minimum distance of twelve inches between floor and pulley.

4. Belt Cleaners

Belt Cleaner's shall be Martin Engineering Company heavy-duty, CM/Torsion Arm Type, track mounted, with tungsten, carbide blades or equal. One (1) belt cleaner shall be provided at the head pulley of each conveyor.

Adequate room shall be provided for wipers between drive and snub pulleys. Dribble from wipers shall be handled by the main discharge chute or an individual chute.

Return belt plows shall be furnished for all belt conveyors.

5. Conveyor Idlers

Conveyors handling up to and including 700 TPH to have medium duty CEMA classification C5 or C6 (Former Series III of IV) standard base idlers. Conveyors handling more than 700 TPH to have heavy duty CEMA classification E6 (Former Series V) standard base idlers.

Idler Types as Follows:

Carrying - Three (3) equal length 5" or 6" dia. steel rolls with roller bearings and grease fittings. 35° through.

Return - On conveyors using turnover system - 5" or 6" dia., flat single roll with roller bearings and grease fittings.

All other conveyors to have 6" dia. (minimum) rubber disc massed end return idlers.

Self-Aligning Carrying and Return - On conveyors 150 feet long and longer spaced 50 feet from each end terminal and 100 feet thereafter. S.A. idler no closer than 15 feet from end of skirt board.

Carrying - Transition - Three (3) equal length 5" or 6" dia. steel rolls with roller bearings and grease fittings. 20° trough one at each terminal with transition distance to pulley per belting manufactures recommendation.

Idler spacing to be as indicated under individual conveyor specification Item No. The spacing is selected to allow a maximum of 2% sag between carrying idlers.

Idlers to be equipped with one side, one point greasing, button head type fitting (5/8 inch dia. head). Fitting and lube line to terminate at outside of idler support bracket. Lube points to be accessible for convenient manual lubrication and be no more than four feet above a floor or platform.

6. Take-Ups

a. Automatic vertical or horizontal gravity type take-ups on all conveyors with single or double cable connections from take-up carriage to counterweight.

b. Horizontal carriages shall have "V"-groove type wheels on inverted angle track with a hold-down arrangement.

c. Supports, cables, sheaves and hardware shall be designed for design load plus 25 percent minimum.

d. Lube points shall be extended to a location convenient for lubrication and flexible for moving parts.

e. Counterweights shall be sectional and designed for a plus-minus 25 percent adustment in field.

f. Protection around and under counterweights shall be provided on all four sides with fence type guards six feet high above grade and floors with removable front section.

7. <u>Backstops</u>

Inclined conveyors where required shall have over-running sprag or roller-ramp type backstops mounted on the drive pulley shafts or integral backstops furnished with motorducers, and shaft mounted reducers.

Backstops shall be sized for torque developed from loading material to a 25 degree surcharge maximum belt loading on the lift portion of the conveyor and multiplying said torque by a factor of safety of 1.5 or sized on breakdown torque rating of motor which ever is greater.

Backstop to have shaft collars or other suitable device to prevent backstop from traveling along drive shaft.

Manufacturer - Backstops shall be Formsprag LLH or Owner approved equal.

8. Conveyor Drives

Under 60 HP - Pulley shaft direct connected to the low speed shaft of a motorducer by a flexible shaft coupling.

Under 25 HP - Where clearance is a problem. Shaft mounted reducer with V-belt drive to motor.

Over 60 HP - Pulley shaft direct connected to the low speed shaft of a parallel shaft reducer by a flexible shaft coupling.

Speed Reducers - Parallel shaft type to be Falk or equal with service factor of 1.5 based on brake horsepower or 1.25 based on motor horsepower whichever is greater. Motoreducers to be Falk all-motor type or equal with Class II gearing. Thermal rating to exceed motor rating without additional cooling. Lubrication shall be internal splash lubrication.

All drives units to be AGMA rated units. Integral bases shall be furnished for parallel shafts reducers.

Shaft Couplings - Falk Steelflex T20 or equal.

9. Conveyor Belting

All conveyor belting shall be Goodrich Flexseal H, M or XH (USBM) approved. Belting shall be multiple ply, sealed cut edge type, to conform to manufacturer's recommendation for operation over 20° and 35° idlers.* Construction and cover thickness shall be as shown in individual conveyor specification and Belt Conveyor Schedule.

Belt carcass shall be as recommended by belt manufacturer to meet maximum operating tensions (starting under full load), minimum plies for load support, maximum plies for troughing and minimum plies for impact.

Belting shall be designed for operating in ambient temperatures from minus 20 degrees F to plus 100 degrees F. Belts shall be suitable for open weather exposed operation.

All splice connections of belting shall be by hot vulcanized method.

*Covers shall be Longlife Brand Rubber (RMA Grade II).

Splicing shall be subcontracted to the belt manufacturer's service representative.

10. Walkways

All conveyors inaccessible from floor or grade shall be provided with 27" wide clear walkways on one side of belt.

11. Drip Pans

Drip pans shall be installed as outlined and specified under item entitled "Structures", Item 100.4, except for turnovers which do not require drip pans.

12. Safety Pull Cables

All conveyors shall be provided with stop pull cables for entire length.