DOE/OR/20717--3 Vol. 2

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The BRECKINRIDGE PROJECT

Initial Effort

REPORT III

SPECIFICATIONS

VOLUME 2

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

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

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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.

Volume Introduction
and Table of Contents

REPORT III
VOLUME 2

INTRODUCTION

Report III, Volume 2 contains those specifications numbered K through Y, as follows:

- Specifications for Compressors (K)
- Specifications for Piping (L)
- Specifications for Structures (M)
- Specifications for Insulation (N)
- Specifications for Electrical (P)
- Specifications for Concrete (Q)
- Specifications for Civil (S)
- Specifications for Welding (W)
- Specifications for Painting (X)
- Specifications for Special (Y)

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 for the Initial Effort (Phase Zero) work performed by all contractors and subcontractors.

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

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Volume 3 - Critical Design Areas

Volume 4 - Critical Review of the Design Basis

Volume 5 - Critical Review of the Design Basis

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SPECIFICATIONS

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BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL SPECIFICATION
CENTRIFUGAL COMPRESSORS

JOB NO. 14222
SPECIFICATION 14222-K-1 REV 2

1.0 GENERAL

1.1 Scope

1.1.1 Except as modified by this specification, centrifugal compressors shall be in accordance with the API Standard 617 (Fourth Edition, November, 1979), "Centrifugal Compressors for General Refinery Services." An exception to API-617 deletes only the portion of the paragraph specifically noted in the parentheses herein.

1.1.2 (Refer to Paragraph 1.1 of API-617 - Addition).

This specification covers the minimum requirements for centrifugal compressors in petroleum refinery and chemical plant services.

1.1.3 Data sheets defining the Buyer's requirements and service conditions form a part of this specification. Copies of these data sheets shall be completed by the Seller and returned to the Buyer.

1.2 Conflicting Requirements

(Refer to Paragraph 1.3 of API-617 - Exception).

In case of conflict between this specification and the accompanying documents, the order of precedence is as follows:

1.2.1 Inquiry or Purchase Order.

1.2.2 Data Sheets.

1.2.3 This Specification.

1.2.4 API-617.

1.2.5 Other Standards.

1.3 (Refer to Paragraph 1.4.1 of API-617 - Addition).

"Pressure Rise to Surge" is the absolute discharge pressure at the flow corresponding to the surge point for the rated operating speed and inlet conditions minus the absolute discharge pressure at the rated operating point.

1.4 (Refer to Paragraph 1.5 of API-617 - Addition).

The publications referenced in this paragraph are subject to the modifications contained in the Buyer's specifications accompanying this specification.

1.5 (Refer to Paragraph 1.5.2 of API-617 - Exception).

The Seller shall comply with Paragraph 2.1.13 of API-617.

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2.0 BASIC DESIGN

2.1 General

2.1.1 (Refer to Paragraph 2.1.2 of API-617 - Addition).

The surge capacity for the overall compression train (at constant speed) shall be at least 20 percent below the capacity required for the normal operating condition.

2.1.2 (Refer to Paragraph 2.1.11 of API-617 - Exception).

2 All equipment shall meet the noise level requirements of Specification 14222-A-12, "Noise Levels of Equipment."

2.1.3 (Refer to Paragraph 2.1.14 of API-617 - Addition).

The Seller shall accept full (unit) responsibility for the engineering coordination of compressor and driver, including gear unit, if needed, and for the avoidance of the critical speeds or resonances of component parts which might adversely affect the operation of the combined unit.

2.1.4 Prior to issuing the Purchase Order, the Buyer and the Seller shall agree on a plan to satisfy the quality assurance requirements of the equipment furnished.

2.2 Casing Connections

2.2.1 (Refer to Paragraph 2.4.3 of API-617 - Addition).

Compressors with all inlet and outlet connections in the lower half of the casing shall be provided with valved vent connections. Valved drains shall be provided on each stage of horizontally split casings.

2.2.2 (Refer to Paragraph 2.4.4 of API-617 - Addition).

All casing drains shall be valved.

2.3 External Forces and Moments

(Refer to Paragraph 2.5.1 of API-617 - Exception).

Compressors shall be designed to withstand the following external loadings:

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 compressor at the support point.

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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 compressor at the support point.

Axial Component - Combined axial forces of all piping connections or axial force of any one piping connection resulting in an axial force on the compressor casing of at least one-sixth the compressor weight.

2.4 Rotating Elements

(Refer to Paragraph 2.6.13 of API-617 - Addition).

Balance piston return lines shall comply with this paragraph of API-617, but other equalizing lines and passages on the compressor (such as the reference gas line) shall be sized to limit velocity to 25 fps at the most demanding transient condition. These requirements shall apply when the labyrinth-to-rotor clearances are up to 150 percent of the normal clearances. The gas reference line shall be 2" diameter minimum.

2.5 Shaft Seals

2.5.1 (Refer to Paragraph 2.7.3.1 of API-617 - Addition).

Labyrinth type shaft seals shall be designed to prevent the possibility of any oil leakage into the compressor gas flow under any operating condition.

2.5.2 The suction end labyrinths of any air compressor which draws from atmosphere shall be pressurized with air from the discharge. A connection shall be provided to pressurize the suction end labyrinths temporarily with air from an external source during startup.

2.6 Critical Speed

2.6.1 (Refer to Paragraph 2.8.1.6 of API-617 - Exception).

No actual torsional resonant speed shall be within 10 percent of the first or second harmonic of the rotational frequency in the operating speed range, including up to trip speed, nor shall it be within 10 percent of gear tooth-passing frequencies within the operating speed range.

2.6.2 (Refer to Paragraph 2.8.1.11 of API-617 - Exception).

The Seller shall perform a composite torsional-vibration analysis of the compressor-driver unit (and speed changing gear, if used), and shall be responsible for the unit's satisfactory performance. Other manufacturers providing components in the system shall provide the necessary data to the Seller and shall identify sources or torsional excitation. The Seller shall submit a torsional analysis report to the Buyer for approval.

2.6.3 The Seller shall, when requested, supply all necessary information to enable the Buyer to check the lateral and torsional critical speeds.

2.7 Vibration and Balance

(Refer to Paragraph 2.8.2.1 of API-617 - Addition).

Shafts shall be dynamically balanced before assembling the impellers and other rotating components.

2.8 Thrust Bearings

2.8.1 (Refer to Paragraph 2.9.2.1 of API-617 - Addition).

Thrust collars shall be replaceable.

2.8.2 (Refer to Paragraph 2.9.2.8 of API-617 - Clarification).

When specified, a minimum of two pads on both the active and inactive side of the thrust bearing shall be fitted with embedded thermocouples to sense pad surface temperature.

2.9 Materials

2.9.1 General

2.9.1.1 (Refer to Paragraph 2.11 of API-617 - Addition).

When specified by the Buyer, alloy steel, stainless steel, or carbon steel castings shall be x-ray inspected. The requirements for x-ray inspection including the extent of radiography, technique, and standards for acceptance will be covered by separate specifications.

2.9.1.2 (Refer to Paragraph 2.11 of API-617 - Addition).

The Buyer shall be informed in writing whenever a proposed steel casting is to be the first one cast from a new set of patterns. Such castings shall be x-ray inspected as defined by separate specifications.

2.9.2 Welding

2.9.2.1 (Refer to Paragraph 2.11.2.2(6) of API-617 - Exception).

All welds on cast, forged, or fabricated parts containing process gas under pressure shall be radiographed. Radiographs shall be made and judged according to Paragraph UW-51 of the ASME Unfired Pressure Vessel Code. Defects which exceed these requirements shall be repaired and the part reradiographed.

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2.9.2.2 (Refer to Paragraph 2.11.5.2 of API-617 - Addition).

Repairs to castings by welding or by other means may be made only on approval of the Buyer's representative. The 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.

2.9.3 After completion of machine work, cast or forged parts subject to process gas pressure shall be inspected over their entire surface by the magnetic particle method. Tears and cracks located by magnetic particle inspection shall be repaired or the part replaced.

2.9.4 Shafts shall be ultrasonically examined in accordance with Section VIII, Division I, UF-55 of the ASME Code.

2.9.5 (Refer to Paragraph 2.11.2.4, 2.11.6.1, and 2.11.6.2 of API-617 - Addition).

Refer to Paragraph 4.2.7 of API-617.

3.0 ACCESSORIES

3.1 Drivers

3.1.1 (Refer to Paragraph 3.1.1 of API-617 - Addition).

Unless otherwise noted, drivers and drive equipment shall be furnished by the Seller.

3.1.2 (Refer to Paragraph 3.1.4 of API-617 - Addition).

Compressors driven by motors having drooping speed characteristics shall be rated at the actual motor speed for the load condition, not at synchronous speed.

3.2 Mounting Plates

(Refer to Paragraph 3.3 of API-617 - Addition).

When sole plates are specified to be furnished by the Seller, they shall have rounded corners (plan view) with a minimum radius of two inches.

3.3 Controls and Instrumentation

3.3.1 (Refer to Paragraph 3.4.1.1 of API-617 - Addition).

The Seller shall provide a piping and instrument diagram showing all required instruments and the connections between each instrument and the associated equipment. The diagram shall indicate which devices are provided by the Buyer and which are provided by the Seller. All flow ranges, temperatures and pressures, and all instrument and control specifications shall be indicated on the diagram or an associated bill of material.

3.3.2 (Refer to Paragraph 3.4.3.1 of API-617 - Additon).
(Refer to Paragraph 3.4.3.4 of API-617 - Exception).

The instrumentation specified on the compressor data sheets shall be provided in addition to that required by API Standard 617 and Buyer's appropriate specification.

3.4 Alarms and Shutdowns

(Refer to Paragraph 3.4.3.4 of API-617 - Addition).

Alarm and shutdown switches for high thrust bearing temperature shall be provided by the Seller when these thermocouples are specified. The preferred signal for this alarm and shutdown function for excessive thrust bearing temperature is the differential temperature between the oil to the thrust bearing and the thrust pad.

3.5 Auxiliary Piping

3.5.1 (Refer to Paragraph 3.5.2 of API-617 - Addition).

Casing drain valves shall be conveniently located at the edge of the baseplates.

3.5.2 (Refer to Paragraph 3.5.3 of API-617 - Addition).

Bearing lube oil from compressors, drivers, and speed changing gears shall not be drained through the coupling guards when non-lubricated couplings are used.

4.0 INSPECTION AND TESTING

4.1 Inspection

(Refer to Paragraph 4.2 of API-617 - Addition).

Rotors and stators (immediately adjacent to rotors) shall be checked for residual magnetism. De-gaussing shall be required if reading is above 2-1/2 gauss.

4.2 Testing

4.2.1 General

4.2.1.1 (Refer to Paragraph 4.3.1.2 of API-617 - Addition).

The Seller shall submit for the Buyer's approval, written test procedures for all tests at least six weeks before the scheduled test date.

4.2.1.2 Unless otherwise approved, the contract couplings shall be used for the mechanical and performance tests.

4.2.2 Hydrostatic Test

(Refer to Paragraphs 4.3.2 and 4.3.6.1 of API-617 - Addition).

In addition to the hydrostatic test, cast compressor casings for hydrogen-rich or hazardous gas service, shall have a helium leak test.

4.2.3 Mechanical Running Test

The four-hour running test shall commence when the bearing temperatures and vibration readings have stabilized. Bearing temperatures shall be considered to be stable when the oil temperature rise across the bearings does not vary by more than 2°F over a 15-minute period. Vibration readings shall be considered to be stable when a trend in vibration readings is not evident.

4.2.4 Optional Tests

(Refer to Paragraph 4.3.6.1 of API-617 - Addition).

4.2.4.1 To determine the slope of the surge line, each performance test shall include, in addition to the five points specified, at least one surge point at less than 100 percent speed and one surge point at more than 100 percent speed.

4.2.4.2 When a performance test is specified, the rotor and casing used for this test shall be shipped together as an assembled unit.

5.0 VENDOR'S DATA

5.1 Contract Data

5.1.1 Drawings

(Refer to Paragraph 6.2.2.3 of API-617 - Addition).

The Seller shall provide a composite diagram of all components of the compressor train showing the thermal and mechanical movements (vertical and horizontal) anticipated when the train is brought from rest to normal operating conditions. This diagram is to be approved by the Buyer, and will be used as the basis for setting the cold alignment of the train.

5.1.2 Curves

(Refer to Paragraph 6.2.3.1 of API-617 - Addition).

5.1.2.1 When specified, performance curves shall show the discharge temperatures at the end of each compression section.

5.1.2.2 "Quadrant" curves shall be furnished for all compressors which are required to operate over a range of suction and discharge conditions or with gases varying in composition and molecular weight.

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2		REVISED SPEC. REFERENCE	HP	TL	
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ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL SPECIFICATION
RECIPROCATING COMPRESSORS

JOB NO. 14222
SPECIFICATION 14222-K-2 REV 2

1.0 GENERAL

1.1 SCOPE

1.1.1 Except as modified by this Specification, reciprocating compressors shall be in accordance with API Standard 618 (Second Edition - July, 1974), "Reciprocating Compressors for General Refinery Services." An exception to API-618 deletes only the portion of the paragraph specifically noted in parentheses herein.

1.1.2 (Refer to Paragraph 1.1 of API-618 - Addition).

This specification covers the minimum requirements for reciprocating compressors, drivers, and auxiliaries in petroleum refinery and chemical plant services.

1.1.3 Data sheets defining the Buyer's requirements and service conditions form a part of this specification. Copies of these data sheets shall be completed by the Seller and returned to the Buyer.

1.2 Conflicting Requirements

(Refer to Paragraph 1.3, API-618 - Exception).

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-618
Other Standards

1.3 Referenced Publications

The publications referenced in this paragraph are subject to the modifications contained in the Buyer's specifications accompanying this specification.

1.4 Quality Control

Quality Control Procedures to be used for the manufacture of equipment included in this specification shall be agreed between the Buyer and Seller prior to start of manufacture. Any Seller's Quality Control Procedures accepted by the Buyer shall be available for review by the Buyer or his authorized representative upon request.

2.0 BASIC DESIGN

2.1 General

2.1.1 (Refer to Paragraph 2.1.2, API-618 - Addition).

The entire compressor train, including driver, couplings and gear unit, if needed, shall be designed to sustain full-load emergency trip-outs without damage.

2.1.2 Compressors driven by motors having drooping speed characteristics shall be rated at the actual motor speed for the load condition, not at synchronous speed.

2.1.3 (Refer to Paragraph 2.1.3, API-618 - Addition).

The Seller shall include, as a minimum, protective devices as required by the specifications. In addition, the Seller shall recommend, and quote separately, any protective devices he deems necessary to prevent damage to the equipment covered by this specification.

2.1.4 (Refer to Paragraph 2.1.5, API-618 - Exception).

2 Noise level criteria for the equipment installation shall conform to Specification 14222-A-12, "Noise Levels of Equipment."

2.2 Allowable Speeds

(Refer to Paragraph 2.2.1, API-618 - Addition).

Preferably, the maximum average piston speed shall not exceed 850 feet per minute for oil lubricated cylinders and 700 feet per minute for nonlubricated cylinders.

2.3 Allowable Discharge Temperature

A high discharge temperature shutdown or 100 percent unloader actuating device set at 350°F shall be provided on any hydrocarbon lubricated compressor. A synthetic lubricant is required for lubricated compressors handling air or other oxygen-bearing gas at discharge temperatures above 250°F.

2.4 Rod Loadings

(Refer to Paragraph 2.4, API-618 - Exception)

In the absence of accurate reciprocating inertial forces in the Seller's quotation, rod loading shall be evaluated on the basis of only gas pressures at the operating condition redulting in the highest loadings. At this condition, 110 percent of the discharge pressure shall be used to calculate the rod loading for each stage. Rod loads calculated in this manner shall not exceed 80 percent of the manufacturer's maximum continuous (not peak) load rating. Within one month after purchase commitment, the Seller shall submit actual net rod loading for each load step of every specified operating conditions (see Paragraph 10.2.12 of API-618). These loadings shall be

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based on the combined effects of the inertial forces and gas pressures. At 110 percent of the maximum anticipated discharge pressure of each stage, the resultant loads shall not exceed 90 percent of the manufacturer's maximum continuous rating.

2.5 Vibration and Critical Speeds

(Refer to Paragraph 2.5, API-618 - Addition).

All torsional studies shall be submitted to the Buyer for approval.

2.6 Compressor Cylinders

2.6.1 (Refer to Paragraph 2.6.2, API-618 - Addition).

All compressor cylinders shall be horizontal with bottom discharge, unless other arrangements are specifically approved by the Buyer.

2.6.2 (Refer to Paragraph 2.6.6, API-618 - Addition).

Liners shall be provided in all cylinders. Liner design shall allow liner removal with a portable hydraulic puller. Liners for services utilizing Teflon rings shall be Teflon burnished. All liners for nonlubricated service shall be honed to a finish of 6- to 8-micro inches RMS.

2.6.3 (Refer to Paragraph 2.6.8.1, API-618 - Addition).

Forced liquid cooling shall be provided for the jackets of all cylinders which are nonlubricated. Thermosyphon systems may be used subject to Buyer's approval.

When a forced liquid cooling system is required, it shall be console mounted and consist, as a minimum, of the components shown on Diagram 1. The air cooler shall be a radiator type mounted on the compressor building roof, if possible.

2.7 Valves

2.7.1 Damped or cushioned valves shall be provided for hydrogen-rich services, and are preferred for other services. (Hydrogen-rich is defined as any gas mixture containing 50 percent, by volume, or more of hydrogen).

2.7.2 Valve clearances and valve gas velocities shall be selected to suit the range of gas compositions and operating conditions specified. If a compressor is required to handle gases with a significantly higher molecular weight than those specified for normal operation (such as for regeneration service), Seller shall provide a spare set of valves suitable for loaded or unloaded service with the heavier gas.

2.8 Pistons and Piston Rods

(Refer to Paragraph 2.8.3, API-618 - Exceptions).

The bearing load of wear bands shall not exceed 5 psi, based on the weight of the piston plus one-half the weight of the rod divided by the wear band area (A), where A = the lenght of a 120-degree chord (0.866 x diameter) times the total width of the wear bands.

2.9 Distance Pieces

(Refer to Paragraph 2.10.1, API-618 - Substitution).

The compressor shall be equipped with an extra-long distance piece. A single compartment is acceptable for non-hazardous or toxic gases; two-compartment distance pieces are required for hazardous or toxic gases with segmental packing provided between the two compartments with lubrication provided as necessary.

(Refer to Paragraph 2.10.2, API-618 - Exception).

Distance pieces shall be equipped with gasketed solid covers.

2.10 Stuffing Boxes and Packing

2.10.1 (Refer to Paragraph 2.11.3, API-618 - Addition).

Vent piping inside the compressors shall be stainless steel.

2.10.2 (Refer to Paragraph 2.11.4, API-618 - Exception).

Liquid cooling of packing is required for cylinders operating in nonlubricated or hydrogen-rich services, in any service above 500 psig, or when flurocarbon-filled packing is used.

2.10.3 Liquid cooling shall be accomplished by either a thermosyphon system, if approved by the Buyer, or a forced circulation coolant system provided by the Seller.

a) Any packing cooling system shall be separated from the cylinder jacket cooling system.

b) A forced circulation system shall be console mounted and included a reservoir with level gauge and vent connection, motor driven pump, cooler, filter, amd all interconnecting piping and valves. Instrumentation shall include, as a minimum, the following:

Packing coolant temperature indicators
Flow indicators at each packing outlet
Reservoir level gauge
Reservoir low level alarm
Pump discharge pressure gauge
Cooler discharge temperature gauge - coolant.

2.11 Compressor Frame Lubrication

2.11.1 (Refer to Paragraph 2.12.2, API-618 - Exception).

The compressor frame lubrication is not required to be in accordance with API-614.

2.11.2 (Refer to Paragraph 2.12.3, API-618 - Addition).

A pressure lubrication system shall consist of a shaft-driven main oil pump, a motor-driven auxiliary pump, two oil coolers and twin oil filters with a four-way, continuous flow transfer valve. Means shall be provided to pre-lube the frame and rod bearings by using the auxiliary pump prior to start-up, and a pressure device provide to prevent the main driver from being started until the pre-lube requirements of the compressor have been satisfied. The control system shall also start the auxiliary lube oil pump on low lube pressure.

2.11.3 (Refer to Paragraph 2.12.3.1 & 2.12.3.2, API-618 - Addition).

Lube oil pumps shall be equipped with mechanical seals where shaft seals are required.

2.11.4 (Refer to Paragraph 2.12.3.1, API-618 - Addition and to Paragraph 2.12.3.2, API-618 - Exception).

The capacity of each lube oil pump shall not be less than 125 percent of the lube system requirements.

2.11.5 Pumps shall have cast steel cases, except that oil pumps driven directly by the compressor shaft may be of cast iron or modular iron construction.

2.11.6 (Refer to Paragraph 2.12.3.3, API-618 - Exception).

Shell and tube type cooler shall bave removable bundles.

2.11.7 (Refer to Paragraph 2.12.3.3, API-618 - Addition).

Coolers shall be suitable for injection of saturated steam at 30 psig to facilitate a fast warm-up of the oil prior to start-up when specified site minimum ambient temperature is 40°F or lower.

2.11.8 (Refer to Paragraph 2.12.3.4, API-618 - Addition).

Seller shall furnish twin full flow filters. Filters shall be of the replaceable cartridge type.

2.11.9 Lube oil systems shall not be subcontracted for design and/or manufacture without the written approval of the Buyer.

2.11.10 Seller shall furnish a console type lube oil cooling system with reservoir sized for 8-minute retention time, electric motor-driven oil pump, single filter an single cooler for the driver and gear when turbine dirvers are specified.

2.12 Cylinder and Packing Lubrication

2.12.1 (Refer to Paragraph 2.13.1, API-618 - Addition).

Motor-driver lubricators shall be interlocked so that the compressor cannot be started without oil supply to the cylinders.

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2.13 Soleplates and Rails

2.13.1 (Refer to Paragraph 2.15.1,API-618 - Addition).

Compressor frames having more than three crank spaces shall be mounted on soleplates or rails. Cylinders or cross-head guide pedestals shall be provided with soleplates. Drivers and gears, if required, shall be mounted on a common baseplate. All rails, soleplates, and baseplates shall be supplied by the Seller.

2.13.2 (Refer to Paragraph 2.15.2, API-618 - Addition).

All components directly connected to the compressor, such as gear reducers and drivers, shall be provided with 1/8-inch shims between the support feed and the top of the baseplate or soleplate to facilitate field assignment.

2.13.3 Expoxy grout will be used on all reciprocating compressors.

2.14 Tools

(Refer to Paragraph 2.17.2, API-618 - Exception).

Pneumatically operated turning devices are required for compressors rated at 1000 bhp and above.

2.15 The compressor shall be equipped with a flywheel of sufficient mass and inertia to minimize rotational speed variations.

3.0 PIPING AND APPURTENANCES

3.1 Piping and Connections

3.1.1 General Piping Requirements

a) (Refer to Paragraph 3.2.1.2, API-618 - Addition).

If special flanges, not in accordance with ANSI Standards, are unavaoidable, the Seller shall supply a welding neck companion flange, bolting and gasket, to be installed by the Buyer.

b) (Refer to Paragraph 3.2.1.4, API-618 - Addition).

All pipe 2-inch or larger shall be of seamless steel not lighter than Schedule 40 and shall have flanged connections.

c) All pressure vessel connections shall be flanged.

d) All control valves shall be flanged and control valve manifolds shall be provided with bypass valves and a 3/4-inch bleed valve. Shutoff valves shall be provided on each side of the control valve.

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e) Seller shall indicate on piping drawings or diagrams all lines which are subject to freeze-up. Steam or electric tracing and insulation of these lines will be provided by the Buyer.

f) Bolt holes on all flanges. including nozzles, shall be back-faced or spot-faced.

3.1.2 Frame Lubricating Oil Piping Requirements

a) (Refer to Paragraph 3.2.3.1, API-618 - Addition).

External reservoirs, pumps, coolers, filters, and control valves not integral with the compressor shall be furnished in an assembled console. Consoles shall have a steel baseplate with rim and drip lip for drainage.

b) (Refer to Paragraph 3.2.3.2, API-618 - Addition).

All piping downstream of the lubricating oil filters (between the filters and compressor) shall be stainless steel. This material shall also be used for any branch piping for gauges and instruments. Valves in stainless steel lines shall have carbon steel bodies with stainless steel trim. 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 oil piping.

3.1.3 Coolant piping Requirements

a) (Refer to Paragraph 3.2.5.1, API-618 - Addition).

The seller shall supply all cooling water piping and manifolds for all equipment mounted on the compressor or compressor base.

b) (Refer to Paragraph 3.2.5.2, API-618 - Addition).

The Seller shall provide valves and unions in the coolant inlet and outlet lines to each compressor cylinder.

c) (Refer to Paragraph 3.2.5.3, API-618 - Addition).

The Seller shall provide coolant piping including all interconnecting piping for any system components that are console mounted. See Diagram 1.

d) (Refer to Paragraph 3.2.5.4, API-618 - Addition).

Drains with valves and plugs shall be provided at all low points in the piping systems. Plugged vent connections shall be provided at all high points of piping systems.

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3.2 Pulsation Suppression Devices

3.2.1 (Refer to Paragraph 3.2.1, API-618 - Addition).

The Seller shall supply pulsation suppression devices and shall have the overall responsibility for coordinating the selection and design of same to adequately eliminate objectionable pulsations, excessive piping vibrations, and to avoid harmful system resonant conditions.

3.2.2 (Refer to Paragraph 3.3.2, API-618 - Addition).

The Seller shall select the pulsation suppression devices in accordance with the applicable design approach outlined in Paragraph 3.3.3, API-618, Table 1 or Table 2.

a) (Refer to Paragraph 3.3.2.1, API-618 - Addition).

(Refer to Paragraph 3.3.2, API-618 - Substitution).

Design Approaches: Analog evaluation of any of the above methods planned for pulsation suppression shall be accomplished, including study of mechanical and acoustical interaction of compressor components, suppression devices, and the piping system for all compressors rated at 500 horsepower or larger.

This paragraph shall apply.

3.2.3 (Refer to Paragraph 3.3.3, API-618 - Addition).

This paragraph shall apply. See Paragraph 3.2.2 of this specification.

3.2.4 (Refer to Paragraph 3.3.6, API-618 - Substitution).

Pulsation suppression devices shall have pressure ratings consistent with cylinder design and shall comply with the ASME Boiler and Pressure Vessel Code, Section VIII. All vessels in service where the gas contains H_2S shall be fabricated of copper-free alloys and shall be stress-relieved.

3.2.5 (Refer to Paragraph 3.3.12, API-618 - Addition).

Suction pulsation suppressors shall be of the combination liquid-separator snubber type. Provision for liquid level indication and alarm shall be furnished.

3.2.6 (Refer to Paragraph 3.3.18, API-618 - Addition).

A vent connection shall be provided in each chamber of each pulsation suppressor.

3.3 Intercoolers and Aftercoolers

The Buyer will furnish all coolers in gas service except for standard air compressors.

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4.0 CONTROLS AND INSTRUMENTATION

4.1 General

(Refer to Paragraph 4.1, API-618 - Addition).

Provisions for controls and instrumentation shall be in accordance with the acompanying specification for packaged equipment instrumentation.

4.2 Capacity Control

(Refer to Paragraph 4.2.1, API-618 - Exception).

Capacity control shall be obtained by suction valve unloading, using five-step unloading for 0,25,50,75, and 100% loading capacity.

4.3 Instrument Panels

(Refer to Paragraph 4.3, API-618 - Addition).

A separately mounted instrument panel will be provided by the Buyer.

4.4 Gauges

4.4.1 All instruments connected to lines under pressure shall be provided with block and bleed valves.

4.4.2 (Refer to Paragraph 4.4.3, API-618 - Addition).

all thermometers shall be provided with thermowells.

4.4.3 Level gauge glasses shall not be used for pressures above 1000 psig. Alternative level indication devices shall be provided.

4.4.4 A pressure gauge hall be provided on the discharge side of each lube oil pump and packing coolant pump (if any).

4.4.5 Packing temperature gauges shall be provided for cylinders operating at 500 psig and above, and for all cylinders with cooled packing.

4.4.6 Temperature indicators shall be provided on each bearing of any speed-changing gear between the compressor and driver.

4.4.7 Compressors shall be provided with a protected crankcase oil level gauge marked to show the required oil level.

4.5 Alarms and Shutdowns

4.5.1 (Refer to Paragraph 4.5.2, API-618 - Addition).

The following extra alarms shall be provided:

1. High lube oil temperature at outlet of cooler.

2. Excessive pressure drop across lube oil filters.

4.5.2 Each shutdown switch shall be provided with additional contacts

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for an indicating device to show which switch caused the compressor to shut down.

4.5.3 Pressure and temperature switches shall not be combined with indicating devices, except for filter differential pressure indicators.

4.4.4 Permissive start switches shall be separated from shutdown switches.

4.4.5 (Refer to Paragraph 4.5.8, API-618 - Addition).

The trip system shall be suitable for actuation by remote emergency shutdown system.

4.5.6 Separate switches are required for pre-alarms and shutdowns. All switches shall be double thrown so that they can be used either in normally-open or normally-closed circuits.

4.5.7 Buyer will provide all annunciator and audible alarm equipment.

4.6 Tachometers

(Refer to Paragraph 4.6, API-618 - Exception).

Tachometers of the electrical or mechanical type shall be provided for all variable speed compressors. Mechanical tachometers shall be equipped with a disengaging clutch. Minimum tachometer range shall be from the lowest control point to 115 percent of maximum continuous speed. The output of each electrical tachometer generator system shall be an analog signal suitable for the simultaneous indication of speed at a local panel and in the control room. Vibrating-reed tachometers are unacceptable.

5.0 MATERIALS

5.1 (Refer to Paragraph 5.1.8.1 of API-618 - Addition).

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.

6.0 DRIVERS

6.1 Motor Drivers

(Refer to Paragraph 6.2.2, API-618 - Addition).

Motor enclosures shall be specified Class I, Group D, explosion-proof or totally-enclosed forced ventilated, suitable for Division 1 areas per API-RP 500A. For totally enclosed forced-ventilated enclosure, a dual-blower arrangement with automatic switch-over and alarm shall be furnished. The vendor shall specify the coolant air flow and pressure drop.

(Refer to Paragraph 6.2.4, API-618 - Exception).

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Synchronous motor drivers shall be mounted directly on the compressor drive extension. If required, an outboard bearing to support the end of the shaft extension shall be provided by the Seller. Induction motor drivers shall be flexibly coupled.

6.2 Gas Engine Drivers

(Refer to Paragraph 6.4.5, API-618 - Addition).

Gas engine ignition systems shall be of the low-fire hazard type.

6.3 Couplings

(Refer to Paragraph 6.6.1, API-618 - Addition).

Seller shall supply all couplings and guards between the compressor and the driver. The manufacturer and type shall be subject to Buyer's approval.

6.4 Reducing Gears

(Refer to Paragraph 6.7.1 & 6.7.3, API-618 - Exception).

Gear units, if required, shall be separated from the drivers and shall have a service factor of at least 2.5.

7.0 SHOP INSPECTION

7.1 (Refer to Paragraph 7.1.1 & 7.1.2, API-618 - Exception).

The responsibility for inspection rests with the Seller. The Buyer reserves the right to inspect at any time during fabrication of the equipement and to witness all hydrostatic, mechanical, and performance tests. Inspection shall be by the Buyer or his authorized representative, who shall have entry to plants, including the sub-Seller's plants while work on or testing of the equipment is being performed, and shall have the right to reject any equipment which does not conform with the specifications or the purchase order.

7.2 (Refer to Paragraph 7.1.2, API-618 - Addition).

The Seller shall furnish notice to the Buyer approximately 5 days in advance of any hydrostatic, mechanical, or perfromance test, or when equipmet is to be ready for inspection prior to shipment.

7.3 (Refer to Paragraph 7.2.1, API-618 - Addition).

Proposed cleaning procedures shall be subject to Buyer's review prior to their use.

7.4 (Refer to Paragraph 7.2.2, API-618 - Addition).

A final cleanliness inspection shall be performed on the compressor, piping, and all appurtenances furnished by the Seller.

8.0 SHOP TESTS

8.1 (Refer to Paragraph 8.3.1, API-618- Addition).

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Shop tests shall include assembly and bar over to check fits and clearances.

8.2 (Refer to Paragraph 8.3.6, API-618 - Addition).

Certified copies of test data shall be submitted to Buyer prior to shipment.

8.3 The Buyer reserves the right to conduct a field performance test under the supervision of the Seller's representative. The Seller shall be responsible for the satisfactory operation and performance of the equipment.

9.0 PREPARATION FOR SHIPMENT

2 Equipment shall be prepared for shipment and/or storage in accordance with Specification 14222-A-13, "Shop Preparation of Materials for Shipping & Storage." Any exceptions to this specification shall be stated in the Seller's proposal.

10.0 DRAWINGS AND OTHER DATA

10.1 (Refer to Paragraph 10.1.2, API-618 - Addition).

Any fabrication, installation, or construction work done prior to Buyer's approval of drawings shall be at Seller's risk.

10.2 (Refer to Paragraph 10.2.1, API-618 - Addition).

Installation, operation, and maintenance manuals shall also include the following additional information:

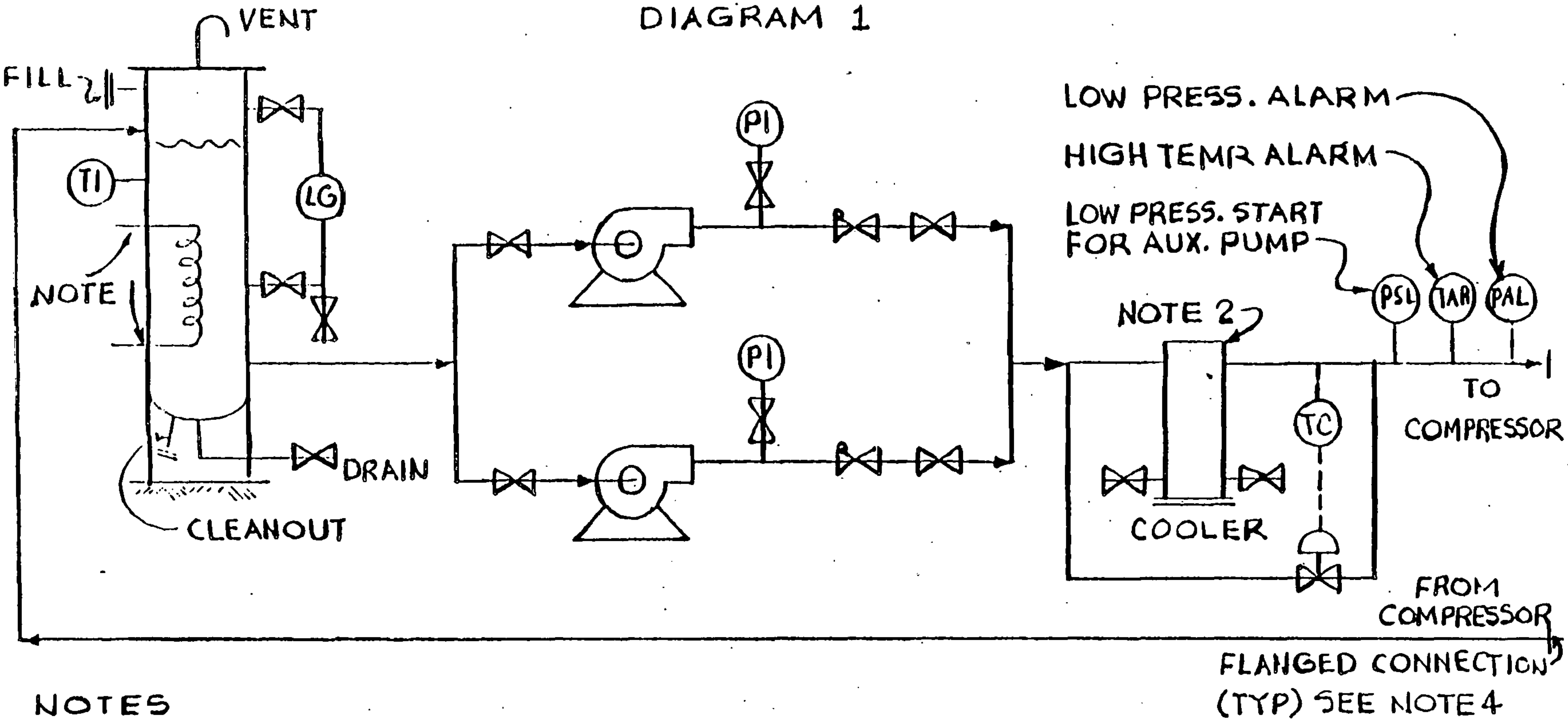
1. A list of as-built clearances for all cylinders.
2. Alignment diagram showing thermal growths of components (for other than direct connected motor driven units).

10.3 (Refer to Paragraph 10.2.12, API-618 - Addition).

Crosshead-load reversal diagrams shall be furnished.

FORCED LIQUID COOLING SYSTEM

DIAGRAM 1



NOTES

1. HEATER, IF SPECIFIED. (SEE DATA SHEETS)
2. TWIN COOLERS, IF SPECIFIED. (SEE DATA SHEETS)
3. PROVIDE VALVED DRAINS AT ALL LOW POINTS IN SYSTEM, AND PLUGGED VENTS AT ALL HIGH POINTS.
4. PARAGRAPHS 3.2.5.1 & 3.2.5.2 OF API-618/2 SHALL APPLY.

Piping—L

CONTENTS

1.0 Codes and Standards

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GENERAL NOTES

These notes pertain to all service classes, unless otherwise noted in the individual Service Class Specification. Where in conflict, the Notes in the Individual Service Class Specification shall govern.

1.0 CODES AND STANDARDS

This specification applies to the following issue of Codes and Standards to the materials and work covered.

1.1 Codes

1.1.1 American National Standard Code for Pressure Piping:

ANSI B31.3, 1976, "Chemical Plant and Petroleum Refinery Piping"

ANSI B31.1, 1977, "Power Piping"

1.1.2 The ASME Boiler and Pressure Vessel Code:

Section I, 1977, "Power Boilers"
Section II, 1977, "Material Specifications"
Section VIII, Div. 1, 1977, "Pressure Vessels"

2.0 DESIGN CONSIDERATIONS

2.1 Pressures and temperatures referred to are design conditions; each service class shall be used only within the pressure-temperature range specified.

2.2 API Publication 941 "Operating Limits for Steels in Hydrogen Service", shall be used for piping material selection in hydrogen service above 450°F. (Hydrogen shall be considered only where there is 100 psia partial pressure hydrogen or greater.)

2.3 In hydrogen service vents and drains other than those shown in P&ID's shall not be used.

2.4 Reference shall be made to the following Specifications, as applicable:

2.4.1 Project Specification L-3, "Piping Design Basis"

2.4.2 Project Specification L-4, "Piping Design & Layout"

2.4.3 Project Specification L-5, "Piping Fabrication"

2.4.4 Project Specification L-6, "Piping Installation and Testing"

2.4.5 Project Specification L-7, "Coated and Wrapped Pipe"

2.4.6 Project Specification L-8, "Chemical Cleaning of Carbon Steel Pipe at Jobsite"

2.4.7 Project Specification L-9, "Equipment Layout"

2.5 "Maximum Hydrotest" pressure specified in individual service classes is the maximum hydrotest pressure allowed for the pipe sizes listed in the service class. Wall thickness for piping sizes not shown in the service class shall be calculated to meet specific design conditions in accordance with ANSI B31.3 and B31.1 and Boiler Code (ASME Section 1) when applicable.

3.0 VALVES

3.1 Gear operators may be required where frequent and/or rapid valve operation is required. The requirement for gear operators other than those specified in the individual service classes and piping and instrument diagrams are as follows:

Gear Operators shall be provided on all ball valves size 8" and larger, and generally for others as follows:

Class 150 - 16" and larger
Class 300 - 12" and larger
Class 600 - 10" and larger
Class 900 - 6" and larger

For infrequently operated valves in water service, gear operators are only required for 24" and larger.

Gear operators shall be provided on all valves 8" and larger operated once per shift.

3.2 Check valves that must be installed in one position only are designated as horizontal or vertical, as applicable, in the individual service class. Check valves that can normally be used either horizontally or vertically shall not have reference to positinn.

3.3 Conventional check valves, 2 inch and larger, shall be drilled and tapped at location "G", in accordance with MSS-SP-45.

3.4 All check valves, other than conventional check valves covered in paragraph 3.3 shall be drilled and tapped downstream of pressure block in accordance with manufacturer's standard.

3.5 All valves specified to be drilled and tapped shall have tapped holes fitted with forged plugs, per MSS-SP-50, of same basic material as the valve body.

3.6 Split disc wafer type check valves shall be installed with the shaft in the vertical position.

3.7 When valves other than those specified in the individual service classes are required, they shall be indicated on the P&ID's as specialty valves.

3.8 Intrinsically dampened, non-slam check valves shall be used in pulsating or compressor discharge applications.

4.0 PIPE

4.1 All seamless or fusion welded carbon steel pipe shall be ASTM-A106 Grade B carbon steel seamless silicon killed open hearth basic oxygen or electric furnace.

4.2 Where calculated wall thickness are required, the following letters or numbers shall be substituted for asterisks in the material code numbers listed in section 4 of Specification L-1, 14222-L-1, to indicate the pipe schedule or wall thickness:

1 = SCH 10	C = SCH 140	K = SCH 80S
2 = SCH 20	D = SCH 160	P = 0.250" Wall
3 = SCH 30	5 = STD WT	Q = 0.312" Wall
4 = SCH 40	7 = XS	R = 0.375" Wall
6 = SCH 60	9 = XXS	S = 0.500" Wall
8 = SCH 80	H = SCH 10S	T = 0.625" Wall
A = SCH 100	J = SCH 40S	U = 0.750" Wall
B = SCH 120		

Other designations will be added as required.

4.3 Pipe sizes 3/8", 1¼", 2½", 3½", 4½", 5", 7", and 22" shall not be selected.

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5.0 FLANGES AND GASKETS

5.1 Class 150 flat face steel flanges with full face gaskets shall be used to mate with Class 125 face cast iron flanges.

5.2 Class 300 raised face steel flanges with flat ring gaskets shall be used to mate with Class 250 raised face cast iron flanges, where they occur, such as at equipment.

5.3 Flanges shall be in accordance with ANSI Standards.

5.4 ANSI B16.5 flanges used within the jurisdiction of ASME Code Section I shall be de-rated in accordance with the provisions stated in paragraph PG-42.6 and Table PG-42.

5.5 Letters or numbers (in accordance with paragraph 4.4) shall be substituted for asterisks in the material code numbers to indicate bore of weld neck flanges selected.

6.0 ORIFICE FLANGES

6.1 Flanges shall have AGA Standard Flange tappings:

½" for Class 300 and Class 600 flanges.

3/4" for Class 900 and Class 1500 flanges.

6.2 Flanges shall be ordered in pairs, without bolting or gaskets, but with jackscrews.

6.3 Letters or numbers (in accordance with paragraph 4.4) shall be substituted for asterisks in the material code numbers to indicate bore of weld neck orifice flanges.

6.4 Orifice tap orientation shall be in accordance with Project Instrument Standards.

7.0 FITTINGS

7.1 Long radius elbows shall be used. Short radius elbows may be used only where space limits the use of long radius elbows. Reducing elbows may be used for all carbon steel pump suction lines in lieu of long radius elbows and reducers.

7.2 Letters or numbers (in accordance with paragraph 4.4) shall be sustituted for asterisks in the material code numbers to indicate the fitting scheduled or wall thickness selected.

7.3 Plain end nipples shall be cut from pipe.

7.4 Socket weld pipets, threaded pipets, elbow pipets, and welded pipets, may be substituted for sockolets, threadolets, elbolets, and weldolets respectively.

8.0 PIPE BENDS

8.1 All pipe bends, when permitted in the individual service class, shall be limited to seamless pipe.

8.2 Pipe bends may be used in place of steel screwed or socket weld elbows. Bending radius shall be a minimum of 5 times the nominal pipe diameter, or as specified on piping drawings.

8.3 Pipe bends may be used in place of butt welding elbows as follows:

8.3.1 Alloy piping including aluminium over 0.500" nominal wall thickness.

8.3.2 Carbon steel piping over 0.750 nominal wall thickness.

8.3.3 Carbon steel fuel gas ring headers at heaters.

8.3.4 Field piping misalignments of up to 10^{o}.

8.4 Cold bends shall be limited to 6 inch size and smaller.

8.5 Bending radius shall be a minimum of five times the nominal pipe diameter or as specified on the piping drawings.

8.6 Stainless steel pipe cold bent with a radius less than 20 times nominal pipe diameter and all hot bent stainless steel pipe shall be solution annealed after bending.

8.7 Stainless steel pipe scheduled 10S pipe bends shall be limited to 15^{o}

8.8 Impact tested pipe shall not be bent.

9.0 MITRED ELBOWS

If mitred elbows are economically justified and approved by engineering, they may be substituted for bends or wrought fittings as follows:

9.1 Two-weld (90-degree) and one-weld (45-degree) mitre elbows may be used for atmospheric air compressor intake lines and vent lines to atmosphere.

9.2 Three-weld (90-degree) and two-weld (45-degree) mitre elbows may be used in low pressure process or utility lines (not higher than ANSI Class 150 rating) in sizes larger than 24 inch. The nominal radius of the mitre elbow shall not be less than 1½ times the diameter of the pipe.

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9.3 Mitred elbows shall not be used unless specified in the individual service class, or otherwise approved by construction management contractor.

10.0 BRANCHES

10.1 Branch connections shall be made in accordance with ANSI B31.3 or Boiler Code (ASME Section 1) whichever is applicable. See individual service classes.

10.2 Branch connections referenced in the individual service classes are for 90° branches only.

11.0 LINE REDUCTIONS

11.1 Line reductions in metallic piping shall normally be made as follows:

For large end 2" and smaller - use swage nipples.

For large end 3" and larger - use reducer.

11.2 The wall thickness of reducing fittings shall be that required for the connection with the greater wall thickness.

12.0 PRIMARY CONNECTIONS

Unless otherwise detailed on piping drawings, primary connections shall be made in accordance with the following:

12.1 Connections for pressure/temperature probes, pressure test, vents/drains, and orifice flange connections as per the service class specification.

12.2 Sample connections - as per the service class specification, or in accordance with the job Sample System P&ID's.

13.0 LINE BLINDS

Jackscrews shall be installed in one flange of line blind assemblies 3 inches and larger.

14.0 BOLTING

14.1 Machine bolt length shall be measured from the bearing surface of the head and includes the end point

14.2 Stud bolt length shall be the effective thread length, excluding the end points.

15.0 THREAD COUMPOUND ON PIPE THREADS

15.1 For services to 450°F teflon tape ½" wide, .003/.004" thick shall be used. It shall be applied starting about one and a half threads from the ends. The tape shall be wrapped around in the direction of the threads.

15.2 For services above 450°F use Armite No. 250 "Lead Plate" Molycote "G" or approved equal.

15.3 No thread compound shall be used on joints to be seal-welded.

16.0 SEAL WELDING

16.1 All threaded joints used in socket or butt weld services classes shall be seal-welded, except the following shall not be seal-welded:

16.1.1 Screwed ends of control valves, relief valves or steam traps.

16.1.2 Screwed ends of gauge glasses, gauge cocks, level alarms and pressure gauges.

16.1.3 Thermowells screwed into line fittings.

16.1.4 Union nuts.

16.1.5 Ball valves or plug valves.

16.1.6 Tubing connections and tubing fittings.

16.1.7 Open end vent or drain piping (including vent plugs and/or caps) downstream of last block valve.

16.1.8 Connections to pumps or other mechanical equipment.

16.1.9 Galvanized piping, malleable iron and bronze valves.

16.2 Pressure test vent plugs or caps in hydrocarbon service shall seal-welded after testing.

17.0 PROTECTIVE SHIELDING

Flange and valve bonnet covers shall be used on all lines handling caustic, hydrochloric and sulphuric acids or other hazardous fluids.

18.0 UNDERGOUND PROTECTION

Buried carbon steel pipe shall be externally protected in accordance with Specification 14222-L-7.

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19.0 ITEM DESCRIPTIONS

The piping item description in the individual service classes are not necessarily complete for purchasing. Complete purchasing description are given in Supplement I, "Piping Stock Code Book". to be provided during Phase I engineering.

20.0 Service Class Index.

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SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
D14	Liquid Chlorine	-20 @ 720 100 @ 720	300 RF	304/ASB SP WD	0.063	Carbon Steel A106-B	3000 LB SW	Carbon Steel	Monel & Hastelloy
B15	Gen. HC with no Sulfur Fuel Gas, Boiler Flue Gas Purge Gas, Deriming Gas, Acid Gas Recycle,Reducer Gas, Flash Gas, Process Air, Process Cond. Merox Blend, Hydrogen, Carbon Dioxide, Natural Gas	-20 @ 285 550 @ 155	150 RF	304/ASB SP WD	0.0625	Carbon Steel A106-B	3000 LB SW	Carbon Steel	11-13 CR
B16	General Hydrocarbons Liquids with Low Sulfur Content Gray Water, Sour Gas Process Liquids (Solvent and Amine Only	20 @ 285 550 @ 155	150 RF	304/ASB SP WD	0.125	Carbon Steel A106-B	3000 LB SW	Carbon Steel	11-13 CR
B17	Steam, Condensate, Boiler Feedwater	-20 @ 285 750 @ 95	150 RF	304/ASB SP WD	0.0625	Carbon Steel A106-B	3000 LB SW	Carbon Steel (Seal weld seat rings)	11-13 CR
B18	DEA/MEA Sour Water, Sour Steam Acid Gas, Syngas, Selexol Process Condensate, Recycled Carbon	-20 @ 285 250 @ 245	150 RF	304/ASB SP WD	0.125	Carbon Steel A106-B	3000 LB SW	Carbon Steel	316 S.S.

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
B21	Hydrocarbon Slurry Coal and/or Catalyst, Slag Slurry	-20 @ 285 550 @ 155	150 RF	304/ASP SP WD	0.125	Carbon Steel A106-B	6000 LB SW	Carbon Steel Plug Valve	Carbon Steel Stellited
B22	Caustic (20%)	160 @ 267	150 RF	Asbestos	0.250	Carbon Steel A106-B	6000 LB THD	Carbon Steel	Monel
B23	Sulfuric Acid (93% Conc.)	-20 @ 235 130 @ 230	150 RF	Asbestos	0.125	Carbon Steel A106-B	BW	Ducticle Iron Plug	Alloy 20/ TFE
B24	Caustic (50%)	141 @ 280 200 @ 260	150 RF	Asbestos	0.250	Carbon Steel A106-B	3000 lb SW	Carbon Steel	Monel
B25	Liquid Sulfur	Product 400 @ 200 Jacket 450 @ 100	150 RF	Asbestos	0.125	Carbon Steel A106-B	---	Ductile Iron - Jacketed	TFE/CS
B26	Demineralized Water	100 @ 175	125 FF	TFE Envelope	None	Carbon Steel Saran Lined	Carbon Steel Saran Lined	D. I. Rubber Lined	D.I. Rubber Lined
B51	Hydrocarbon Slurry Coal and/or Catalyst, Slag Slurry	551 @ 154 800 @ 80	150 RF	304/ASB SP WD	.125	304L S.S.	6000 LB S.W. 304 S.S.	316 S.S.	316 S.S.
B52	Oxygen	100 @ 275	150 RF	304/ASB SP WD		304L SS	Monel BW	316 SS	Monel
H52	Oxygen	200 @ 925	600 RTJ	316 SS Oct. RNG.		304L SS	Monel BW	316 SS	Monel

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
B53	Flash Condensate Quench Water	-20 @ 275 300 @ 205	150 RF	304/ASB SP WD	None	304L S.S.	3000 LB SW	316 S.S.	316 S.S.
B54	Liquid Oxygen Liquid Nitrogen	-320 @ 150	150 RF	Asbestos (Special)	None	304L S.S.	BW	316 S.S. (Cryogenic)	316 S.S. (Cryogenic)
B55	Stripper Reflux R. O. Feed	20 @ 230 140 @ 230	150 RF	304/ASB SP WD	None	304L S.S.	3000 LB	Alloy 20	Alloy 20
B56	Lube Oil Neutral Oil Glycol	20 @ 230	150 RF	304/ASB SP WD	None	304L S.S.	3000 LB SW	316 S.S.	316 S.S.
B63	Gen. Hydrocarbon with H_2S/H_2	551 @ 154 650 @ 125	150 RF	304/ASB SP WD	0.0625	5 CR-1/2 MO	3000 LB SW	5 CR-1/2 MO	11-13 CR Stellited
B64	Gen. Hydrocarbon with H_2S/H_2	650 @ 125 800 @ 80	150 RF	304/ASB SP WD	0.125	5 CR-1/2 MO	3000 LB SW	5 CR-1/2 MO	11-13 CR Stellited
B65	Acid/Gas (Wet), Sodium Hexametaphosphate, Demineralizer Water, Ammonia Hydrazing Solution, Phosphate Solution, Demineralized Water 20% Sodium Sulfite	20 @ 230 400 @ 160	150 RF	304/ASB SP WD	None	304L S.S.	3000 LB SW	316 S.S.	316 S.S.
B71	R. O. Stripper Sulfuric Acid (dilute)	141 @ 230 250 @ 230	150 RF	304/ASB SP WD	None	Alloy 20	150 LB	Alloy 20	Alloy 20

Note: Class B63 & B64 apply to HRI plants only

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
B72	VCE Conc. Bring Cystalizer Feed	-20 @ 275 480 @ 180	150 LJ	304/ASB SP WD	None	Titanium B-337 GR.7	BW	D. I. TFE Lined	D.I. TFE
B90	Effluent - Sulfuric Acid (20% Conc.) Polymer Water Treatment Chemicals	147 @ 150 140 @ 110	150 FF	Neoprene	None	CPVC	Socket Type	CPVC	TFE
B91	Vent Gas	160 @ 40	150 FF	304/ASB SP WD	None	CPVC/FRP	CPVC	CPVC/PVFD	CPVC/PVFD
B92	Incinerator Reacter Gases	1700 °F	---	---	None	C. S. Refactory Lined	---	---	---
D15	General Hydrocarbons: Gases Without sulfur or H_2S	20 @ 740 850 @ 270	300 RF	304/ASB SP WD	0.0625	Carbon Steel A106-B	3000 LB SW	Carbon Steel	11-13 CR Stellited

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
D16	General Hydrocarbons: liquids With Low Sulfur Content, No H_2	20 @ 740 750 @ 505	300 RF	304/ASB SPWD	.125	Carbon Steel A106-B	3000 LB SW	Carbon Steel	11-13 CR Stellited
D18	Sour Steam, Stripper OVHD Vapor & Gas, Sour Water, Grey Water, DEA/MEA Sour Gas with H_2	20 @ 740 550 @ 575	300 RF	304/ASB SP WD	0.125	Carbon Steel A106-B	3000 LB SW	Carbon Steel	316 S.S.
D21	Hydrocarbon Slurry/ Coal and/or Catalyst	20 @ 740 550 @ 575	300 RF	304/ASB SP WD	.125	Carbon Steel A106-B	6000 LB SW	Carbon Steel (Plug)	CS/ Stellited
D51	Hydrocarbon Slurry/Coal and/or Catalyst	551 @ 370 800 @ 325	300 RF	304/ASB SP WD	.125	304 L S.S.	6000 LB SW	316 S.S. (Plug)	316 S.S. Stelitted
D52	Butane Propane Refrigerants	-21 @ 285 -50 @ 285	300 RF	304/ASB SP WD	0.0625	Carbon Steel A333 GR 6	3000 LB SW	Carbon Steel	316 S.S.
D53	Phenol Polyelectrolite	20 @ 230 400 @ 160	150 RF	304/ASB. SP. WD.	None	316L S.S.	SW	316 S.S.	316 S.S.
D61	Ammonia	-50 @ 285 100 @ 285	300 RF	304/ASB SP WD	0.0625	Carbon Steel A333 GR 6	3000 LB SW	Carbon Steel	For Ammonia Service

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
D63	Gen. Hydrocarbon with H_2S/H_2	551 @ 576 850 @ 270	300 RF	304/ASB SP WD	0.0625	5 CR-1/2 MO	3000 LB SW	5 CR-1/2 MO	11-13 CR Stellited
D64	Gen. Hydrocarbon with H_2S/H_2	551 @ 636 850 @ 270	300 RF	304/ASB SP WD	0.125	5 CR-1/2 MO	3000 LB SW	5 CR-1/2 MO	11-13 CR Stellited
H12	Gray Water Process Gas Syngas (Saturated) Saturation Circulation Water	100 @ 1200 550 @ 745	600 RF	304/ASB SP WD	None	304L S.S.	3000 LB SW	316 S.S.	316 S.S.
H15	General Hydrocarbons: with No Sulfur	100 @ 1480 750 @ 1010	600 RF	304/ASB SP WD	0.0625	Carbon Steel A106-B	3000 LB SW	Carbon Steel	11-13 CR Stellited
H16	General Hydrocarbons: With Low Sulfur Content No H_2	100 @ 1480 750 @ 1010	600 RF	304/ASB SP WD	0.125	Carbon Steel A106-B	6000 LB SW	Carbon Steel	11-13 CR Stellited
H17	Steam, Condensate Boiler Feedwater	20 @ 1480 750 @ 1010	600 RF	304/ASB SP WD	0.0625	Carbon Steel A106-B	3000 LB SW	Carbon Steel (Seal weld seat rings)	11-13 CR Stellited
H18	Steam, Condensate BFW (ASME SECTION I)	20 @ 1480 750 @ 1010	600 RF	304/ASB SP WD	0.0625	Carbon Steel A106-B	3000 LB SW	Carbon Steel (Seal- Weld Seat Rings)	11-13 CR Stellited

Note: Class D63 & D64 apply to HRI Plants only

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
H20	Hydrocarbon Slurry Coal and/or Catalyst	500 @ 765 850 @ 645	600 RTJ	347 SS OCT. RNG	.125	304 L SS	6000 LB THD	304 SS	11-13 CR Stellited
H53	Process Gases - Shift Section	501 @ 955 650 @ 855	600 RTJ	304 ASB SP WD	0.125	321 S.S.	6000 LB SW	347 S.S.	347 S.S.
H63	Gen. Hydrocarbon with H_2S/H_2	650 @ 1175 850 @ 975	600 RF	304 ASB SP WD	0.0625	5 CR- 1/2 MO	3000 LB SW	5 CR- 1/2 MO	11-13 CR Stellited
H64	Gen. Hydrocarbon with H_2S/H_2	851 @ 975 950 @ 755	600 RTJ	347 S.S. OCT. RNG	0.125	5 CR- 1/2 MO	6000 LB SW	5 CR- 1/2 MO	11-13 CR Stellited
H51	Hydrocarbon Slurry/Coal and/or Catalyst	501 @ 765 650 @ 700	600 RF	304 ASB SP WD	0.125	304 L	6000 LB SW	316 SS	316 SS Stellited
K18	Steam, Condensate (ASME Section I)	100 @ 2160 750 @ 1275	900 RTJ	Soft Iron (90 BHN)	0.0625	Carbon Steel A106-B	6000 LB SW	Carbon steel (Seal Welded Seat Rings)	11-13 CR Stellited
M15	Main Steam	950 @ 1500	1500 RTJ	Soft Iron (90 BHN)	0.0625	1-1/4 CR, 1/2 MO	6000 LB SW	1-1/4 CR, 1/2 MO	11-13 CR
L63	Gen. Hydrocarbon with H_2S/H_2	550 @ 1825 650 @ 1765	900 RTJ	347 SS OCT. RNG	0.0625	5 CR- 1/2 MO	6000 LB SW	5 CR- 1/2 MO	11-13 CR Stellited

Note: Class H63, H64 & H51 & L63 apply to HRI plants only

SERVICE CLASS INDEX

CLASS	COMMODITY	TEMP. PRESS LIMITS DEG. F @ PSIG	FLANGE CLASS FACING	GASKET MATERIAL TYPE	NOMINAL CORROSION ALLOWANCE	PIPING MATERIAL	SMALL FTGS.	VALVE BODY MATERIAL	VALVE TRIM
L64	Gen. Hydrocarbon with H_2S/H_2	650 @ 1765 850 @ 1460	900 RTJ	347 SS OCT. RNG	0.125	5 CR- 1/2 MO	6000 LB SW	5 CR- 1/2 MO	11-13 CR Stellited
M20	Coal Slurry H_2 Purge Gas	100 @ 3750 500 @ 3325	1500 RTJ	347 SS OCT. RNG	0.250	1-1/4 CR- 1/2 MO	6000 LB SW	Carbon Steel	316 SS
Q21	Hydrocarbon Slurry Coal and/or Catalyst (ASME Section 1)	20 @ 6250 550 @ 3500	2500 Grayloc	ANSI 660	0.125	Carbon Steel A106-B	6000 LB SW	Carbon Steel	11-13 CR Stellited
Q51	Hydrocarbon Slurry Coal and/or Catalyst	900 @ 3300	2500 Grayloc	ANSI 660	0.125	Carbon Steel A106-B	6000 LB SW	347 SS	347 SS
UI	Utility Water Cooling Water	ANSI B16.1 Limits Max 175 PSIG	125 FF	Asbestos	0.0625	Carbon Steel A106-B	3000 LB THD	Forged Steel Iron Body	11-13 Cr/ Bronze/ BUNA-N
U2	Drinking Water Instrument Air Utility Air Nitrogen, Combustion Air	ANSI B16.1 Limits Max 175 PSIG	125 FF	Asbestos	0.0625	C.S. Galv/ Carbon Steel	3000 LB THD (Galv.)	Bronze/ Iron Body	Bronze
U3	Fire Water (Above Ground)	ANSI B16.1 Limits Max 195 PSIG	125 FF	Asbestos	0.0625	C.S. Galv/ Carbon Steel	3000 LB THD (Galv.)	Bronze/ Iron Body	Bronze
U3U	Fire Water (Under Ground)					Carbon Steel Coated & Wrapped	None	Iron Body (U.C.)	Bronze
Q15	Gen. Hydrocarbon with Sulfur	374 @ 3300	2500 Grayloc	ANSI 660	0.0625	Carbon Steel A-106 B	6000 LB SW	Carbon Steel	Carbon Steel Stellitted

Note: Class L64 Applies to HRI Plants only

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FORM H-292 7-66

△					
△		FORM L-538 ATTACHED			
△	11/10/80	ISSUED FOR PHASE ZERO	JK	HS	
△	2/21/80	ISSUED FOR APPROVAL		HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S.DOE COOPERATIVE AGREEMENT NO. DE-F-C05-800R2717
PROJECT SPECIFICATIONS
PIPING DESIGN BASIS

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

1. SCOPE

1.1 Intent

This specification describes the basis for over-all design of process and utility piping within battery limits of the plant. It is intended to establish designs conforming to codes and accepted practices currently applicable to piping systems.

1.2 Application

This specification applies to engineering of piping systems. It applies particularly to such design-engineering as development and interpretation of piping and instrument diagrams, line designation tables, and material specifications.

2. CODES

2.1 Local Codes

Where local codes take precedence over the ANSI or ASME Codes, such codes shall govern.

2.2 Boiler Code Piping

Section 1, Power Boilers, of the ASME Boiler and Pressure Vessel Code, latest edition, applies to certain portions of steam, feedwater, and blow-off piping associated with boilers and steam generating equipment, as defined by that code. Such piping shall be designed in accordance with the rules for that piping as stipulated in the Code for Power Piping, ANSI B31.1.

2.3 Refinery Code Piping

The ANSI Code for Pressure Piping, Petroleum Refinery Piping, B31.3, latest edition, applies generally to all other piping within property limits of the plant. See Paragraph 300.1.4 of that code, and Other Requirements, paragraph 2.4 below, for exceptions.

2.4 Other Requirements

Separate specifications cover the special requirements for sewer and drainage systems. Special requirements may apply to fire protection systems. Heating, ventilating, air and water systems serving buildings rather than plant or process areas may conform to applicable plumbing, heating, and ventilating, or refrigeration codes.

2.5 Designation on P&I Diagrams

The P&I Diagrams show limits of the piping governed by the Boiler Code. They indicate which codes or requirements, other than Refinery Piping Code, apply to various parts of the piping systems.

3. DESIGN CONDITIONS

3.1 Operating Conditions

3.1.1 Normal Conditions

Normal design conditions of pressure and temperature will be the most severe conditions expected to coexist under usual long-time operating conditions. These usual operations include all manipulation and control functions such as throttling, blocking and bypassing likely to be used for operation and control.

3.1.2 Temporary Conditions

Usual operating conditions do not include more severe temporary conditions, such as those incidental to start-up, shutdown, steamout or abnormal operation. Temporary conditions govern as design conditions only when there is clear evidence they definitely exceed time and severity limits in Paragraph 302.2.4 of the Refinery Piping Code.

3.2 Design Temperature

3.2.1 Definition

Design temperature is the most severe sustained fluid temperature, subject to conditions of Section 3.1 above. Design temperature of internally-insulated or noninsulated components may be the metal temperature rather than the fluid temperature.

3.2.2 Steam Traced Piping

Design temperature for steam traced piping will be the fluid temperature or 20F below saturation temperature of tracing steam, whichever is greater.

3.2.3 Low Temperature Piping

Design temperature for piping with a fluid operating temperature below minus 20F, will be the normal fluid operating temperature. In addition, design will be suitable for design pressure at 100F.

3.3 Design Pressure

3.3.1 Definition

Except for Boiler Code Piping (ASME Section I) the design pressure will be the most severe condition of internal or external fluid pressure, subject to conditions of Section 3.1 above. The design pressure for Boiler Code Piping will be established in strict accordance with the Code for Power Piping ANSI B31.1.

3.3.2 Minimum Design Pressure

Minimum positive design pressure will normally be 25 psig.

3.3.3 Pump Discharge Systems

3.3.3.1 Design pressure for unrelieved piping systems subject to pump discharge pressure will be either normal operating pump discharge pressure or pump shut-off discharge pressure, whichever is greater, where:

a. Normal operating pump discharge pressure is the pump differential pressure plus normal suction pressure and hydrostatic head.

b. Pump shut-off discharge pressure is pump differential pressure at shut-off or stalling conditions plus suction pressure and hydrostatic head, adjusted for allowances per Par. 302.2.4 of the Refinery Piping Code ANSI B31.3.

3.3.3.2 Design pressure for relieved piping systems subject to pump discharge pressure will be either the normal operating pump discharge pressure or the safety valve set pressure, whichever is greater, where:

a. Normal operating pump discharge pressure is the pump differential pressure plus normal suction pressure and hydrostatic head.

b. Relief or safety valve set pressure is this pressure plus hydrostatic head below relief valve adjusted for allowances per Par. 302.2.4 of the Refinery Piping Code ANSI B31.3.

3.3.4 Vacuum Systems

Design pressure for piping systems operating under vacuum will be full vacuum. Exception may be taken where suitable protection against vacuum failure is provided.

3.3.5 Relief Valves Set Pressure

For piping systems protected by relief valves, the relief valve set pressure will be equal to the design pressure minus the hydrostatic head below the relief valve.

3.4 Loads Affecting Piping Stresses

Allowable stress values apply to total loads imposed on piping materials. Design shall provide for all loading significantly affecting pipe material stresses. See Sections 301.4 through 301.7 of Refinery Piping Code for loadings, in addition to fluid pressure which may affect piping stresses.

4. MATERIALS

4.1 Piping Materials Specification

The Piping Materials Specification includes individual Line Service Material Classes. The specification shows in detail pipe, valve, flange, fitting, bolting, gasket, branch connection and other specific material requirements for various classes of fluid, temperature and pressure services.

4.2 Corrosion Allowances

Corrosion allowances shown in the Piping Materials Specification are minimum for the respective services.

4.3 Wall Thickness and Reinforcement

4.3.1 Wall thickness and branch connection reinforcement requirements shown in Piping Material Specification are satisfactory for the most severe pressure-temperature conditions within limits indicated. Where mechanical loads increase stresses above those due to internal or external pressure, appropriate reinforcement will be added.

4.3.2 Branch reinforcement is based on "limited" corrosion, where all excess metal in pipe wall, other than required for pressure and corrosion allowance, is credited to branch reinforcement.

5. PIPE SIZING

Piping will be sized for normal operating conditions. Provision for future increased capacity will be made only when specifically required.

6. VALVING

6.1 Valves

6.1.1 Operating and block valves will be provided in minimum quantity consistent with good design and operating practice.

6.1.2 Unless specifically required for operation, block valves will not be provided at vessel nozzles when following conditions exist:

6.1.2.1 Line to or from vessel can be blocked by valve located within 40-ft horizontal radius from vessel surface.

6.1.2.2 No undrainable liquid pocket in line between vessel and valve.

FORM 203

6.1.3 No block valve will normally be provided in lines or at vessel nozzles for services as follows:

6.131 Vapor lines to condensers.

6.132 Liquid and vapor lines to and from syphon reboilers.

6.133 Lines from condensers to accumulators.

6.134 Lines between exchangers in series.

6.1.4 Block valves will be provided at all 1-1/2 and smaller connections at equipment.

6.1.5 Valve requirements as follows, will be shown on P&I Diagrams.

6.151 All line operating and block valves.

6.152 All vent, drain, etc., valves required for operation.

This includes startup, shutdown, testing, purging, rundown and like auxiliary operations. Hydrotest vents and drains will not be shown.

6.1.6 Valves will be provided for instrument connections, and will be shown on P&I Diagrams.

6.2 <u>Sizing</u>

Where system flow and pressure characteristics permit, and arrangement economically justifies, valves may be smaller than line size.

6.2.1 <u>Control Valve Manifolds</u>

See Standard Drawing L-538 for control valve manifold arrangements and block and bypass valve sizes.

6.2.2 <u>Equipment Connections</u>

Where practical, valving at equipment connections smaller than line size will be the same size as the connection. Where line and connection differ by two or more sizes, valving may be an intermediate size.

6.3 <u>Type Selection and Identification</u>

Valve type will be shown in Piping Materials Specification. P&I Diagrams will show size of all valves not line size.

7. <u>PIPE SIZE LIMITATIONS</u>

Piping smaller than 3/4 inch shall not be used except in instrument and steam tracing services and in auxiliary services such as pump cooling.

Pipe sizes 1¼", 2½", 3½", 4½", 5", 7" and 9" shall not be used except where equipment connections are these sizes. In such cases, transitions to other commercial pipe sizes shall be made as close as possible to the equipment connection.

8. SAFETY AND RELIEF VALVES

Safety and relief valves will be provided and sized in compliance with OSHA and the applicable boiler, pressure vessel and piping codes.

8.1 Disposition of Discharged Fluids

Safety and relief valves in steam and air service will discharge to atmosphere at a safe distance above grade, adjoining equipment and platforms. Those in water service will discharge to paving or suitable drain. Small reliefs, protecting blocked-in process piping or equipment against fluid thermal expansion will discharge to a suitable drain or closed blowdown system. All other safety and relief valves will discharge to atmosphere or closed blowdown system in compliance with OSHA and/or EPA as shown on the P&I Diagrams.

150# R.F. — 300# CONTROL VALVE

GASKET THICKNESS WILL CONFORM WITH INDIVIDUAL PIPING CLASSIFICATION.

LINE SIZE	BLOCK VA. SIZE	CONTROL VA SIZE	BY-PASS VA SIZE	A	B	C	D	E1 REG.	E2 C.FINS	E3 HW	E4 C.FINS HW	F	G	H	J	K	L
1½/2	1½	1	1½	7 3/16	7¾	6½	4 11/16	40½ ✱	43 ✱	45¼ ✱	47¾ ✱	6	6½	7⅜	4 11/16	7 15/16	18
2/3	2	1½	2	8 11/16	9¼	7	5½	41½ ✱	44 ✱	46¼ ✱	48¾ ✱	7	8	8 3/16	5½	9⅜	18
3/4	3	2	2	10¾	10½	8	7¼	50¾ ✱	56¼ ✱	57 ✱	64 ▲	9	8	9	5½	10⅞	18
4/6	4	3	3	13⅛	12½	9	9	64½ ▲	64½ ▲	64½ ▲	64½ ▲	10	9½	10⅛	7¼	14⅛	18
6/8	6	4	4	17⅞	14½	10½	12½	65 ▲	65 ▲	65 ▲	65½ ▲	12	11½	12⅜	9	16½	18
8/10	8	6	6	21⅞	18⅝	11½	16	61 ▲	64¾ C.O.	67½ C.O.	71¼ C.O.	14	10½	13⅞	12½	19½	24
10/12	10	8	8	26⅜	22⅜	13	19	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	11½	15⅜	16	22	24

300# R.F. ALL VALVES

GASKET THICKNESS WILL CONFORM WITH INDIVIDUAL PIPING CLASSIFICATION.

LINE SIZE	BLOCK VA. SIZE	CONTROL VA SIZE	BY-PASS VA SIZE	A	B	C	D	E1 REG.	E2 C.FINS	E3 HW	E4 C.FINS HW	F	G	H	J	K	L
1½/2	1½	1	1½	7¾	7¾	7½	4 3/16	40½ ✱	43 ✱	45¼ ✱	47¾ ✱	6	9½	7⅜	4 3/16	8⅜	18
2/3	2	1½	2	8⅛	9¼	8½	5¾	41½ ✱	44 ✱	46¼ ✱	48¾ ✱	7	10½	8⅞	5¾	9⅜	18
3/4	3	2	2	10¾	10¼	11⅛	7⅝	50¾ ✱	56¼ ✱	57 ✱	65 ▲	9	10½	9⅜	5¾	11¼	18
4/6	4	3	3	13⅛	12½	12	9⅜	66 ▲	66 ▲	66 ▲	66 ▲	10	12½	10½	7⅝	14½	18
6/8	6	4	4	17⅞	14½	15⅞	12⅞	67 ▲	67 ▲	67 ▲	69½ C.O.	12	14	12¾	9⅜	16⅞	18
8/10	8	6	6	21⅞	18⅞	16½	16⅜	62 ▲	67½ C.O.	70½ C.O.	74¼ C.O.	14	15⅞	14¼	12⅞	19⅞	24
10/12	10	8	8	26⅜	22⅜	18	19⅞	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	16½	16	16⅜	22⅜	24

600# R.F. ALL VALVES

GASKET THICKNESS ⅛

LINE SIZE	BLOCK VA. SIZE	CONTROL VA SIZE	BY-PASS VA SIZE	A	B	C	D	E1 REG.	E2 C.FINS	E3 HW	E4 C.FINS HW	F	G	H	J	K	L
1½/2	1½	1	1½	7⅞	8¼	9½	5¼	40½ ✱	43 ✱	45¼ ✱	47¾ ✱	7	9½	8⅜	5¼	8½	18
2/3	2	1½	2	9	9⅜	11½	6⅛	41½ ✱	44 ✱	46¼ ✱	48¾ ✱	7	11½	9⅛	6⅛	10	18
3/4	3	2	2	11⅛	11¼	14	8	50¾ ✱	56¼ ✱	57 ✱	66 ▲	9	11½	10⅛	6⅛	11⅞	18
4/6	4	3	3	13½	13¼	17	10¼	67 ▲	67 ▲	67 ▲	67 ▲	10	14	11¾	8	15⅜	18
6/8	6	4	4	18¾	15½	22	13⅞	69 ▲	69 ▲	69 ▲	69½ C.O.	12	17	14⅞	10¼	17⅞	18
8/10	8	6	6	22⅞	20	26	17½	65 ▲	68¾ C.O.	71½ C.O.	75¼ C.O.	14	22	16⅜	13⅞	21	24
10/12	10	8	8	27⅞	24	31	21¼	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	26	18⅞	17½	24¼	24

300# R.J. ALL VALVES

RING JOINT GAP VARIES

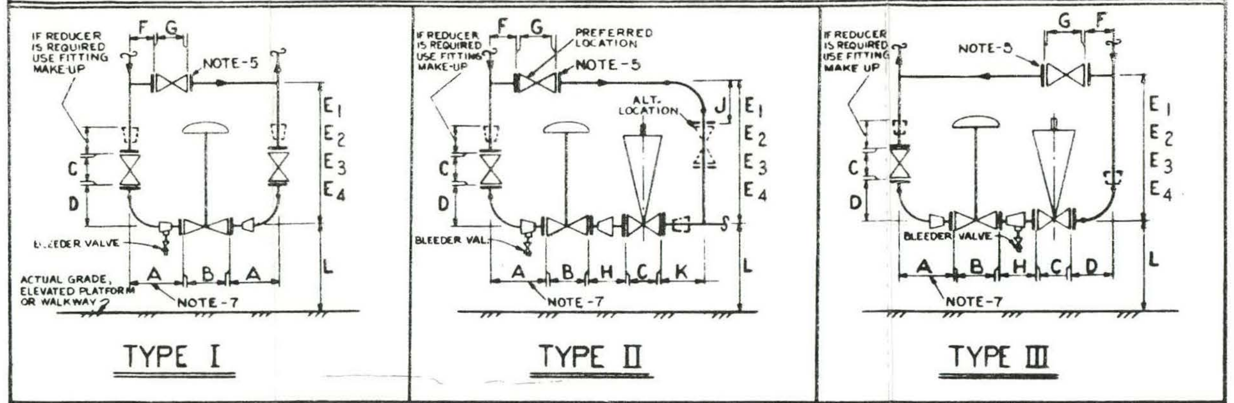
LINE SIZE	BLOCK VA. SIZE	CONTROL VA SIZE	BY-PASS VA SIZE	A	B	C	D	E1 REG.	E2 C.FINS	E3 HW	E4 C.FINS HW	F	G	H	J	K	L
1½/2	1½	1	1½	7 1/16	8¼	8	5¼	40½ ✱	43 ✱	45¼ ✱	47¾ ✱	7	10	8⅛	5 3/16	8 7/16	18
2/3	2	1½	2	8 7/16	9¾	9⅛	6¼	41¼ ✱	44 ✱	46¼ ✱	48¾ ✱	7	11⅛	9	6⅛	9 7/16	18
3/4	3	2	2	11 1/16	11⅛	11¾	7 5/16	50¾ ✱	56¼ ✱	57 ✱	65 ▲	9	11⅛	10	6 1/16	11 9/16	18
4/6	4	3	3	13¾	13⅛	12⅝	9 1/16	66 ▲	66 ▲	66 ▲	66 ▲	10	13⅛	11⅛	7 1/16	14 3/16	18
6/8	6	4	4	18 3/16	15⅛	16½	13 3/16	67 ▲	67 ▲	67 ▲	69½ C.O.	12	14⅝	13⅜	9 11/16	17 3/16	18
8/10	8	6	6	22 3/16	19¼	17⅛	16 11/16	62 ▲	67¾ C.O.	70½ C.O.	74¼ C.O.	14	16½	14⅞	13 3/16	20 3/16	24
10/12	10	8	8	26 11/16	23	18⅝	19 15/16	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	17⅛	16⅝	16 11/16	22 15/16	24

600# R.J. ALL VALVES

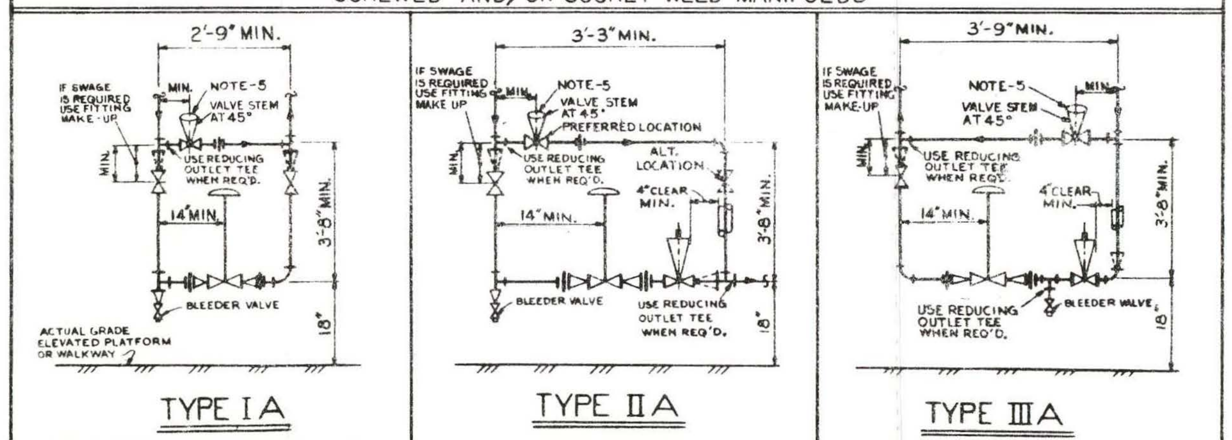
RING JOINT GAP VARIES

LINE SIZE	BLOCK VA. SIZE	CONTROL VA SIZE	BY-PASS VA SIZE	A	B	C	D	E1 REG.	E2 C.FINS	E3 HW	E4 C.FINS HW	F	G	H	J	K	L
1½/2	1½	1	1½	7 7/16	8¼	9½	5¼	40½ ✱	43 ✱	45¼ ✱	47¾ ✱	7	9½	8 3/16	5¼	8½	18
2/3	2	1½	2	9	9⅞	11⅝	6 3/16	41½ ✱	44 ✱	46¼ ✱	48¾ ✱	7	11⅝	9 3/16	6 3/16	10 1/16	18
3/4	3	2	2	11 3/16	11⅜	14⅛	8 1/16	50¾ ✱	56¼ ✱	57 ✱	66 ▲	9	11⅝	10¼	6 3/16	11 11/16	18
4/6	4	3	3	13 9/16	13⅜	17⅛	10 5/16	67 ▲	67 ▲	67 ▲	67 ▲	10	14⅛	11⅞	8 1/16	15 7/16	18
6/8	6	4	4	18 13/16	15⅝	22⅛	13 15/16	69 ▲	69 ▲	69 ▲	69½ C.O.	12	17⅛	14¾	10 5/16	17 15/16	18
8/10	8	6	6	22 [illegible]	20⅛	26⅛	17 9/16	65 ▲	68¾ C.O.	71½ C.O.	75¼ C.O.	14	22⅛	16½	13 15/16	21 1/16	24
10/12	10	8	8	27 [illegible]	24⅛	31⅛	21 5/16	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	26⅛	18⅞	17 9/16	24 5/16	24

FLANGED CONTROL VALVE MANIFOLDS



SCREWED AND/OR SOCKET WELD MANIFOLDS



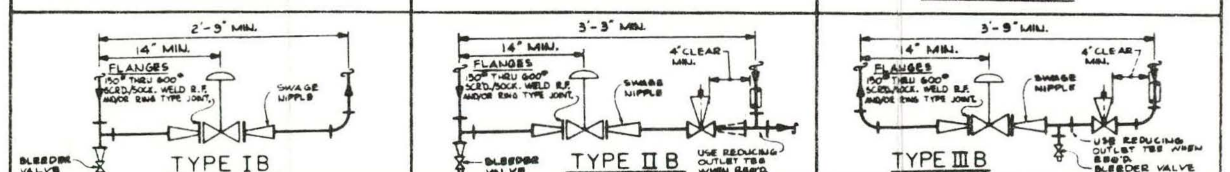


TABLE OF VALVE SIZES FOR MANIFOLDS SCREWED AND/OR SOCKET WELD

NOTE: TYPES IIIB & IIIB ALSO REQUIRE SAME VALVING AND BY-PASSES AS SHOWN FOR TYPES IA, IIA, IIIA

CONTROL VA. SIZE ¾ REDUCED PORT			CONTROL VA SIZE ¾" BODY			CONTROL VA. SIZE 1" REDUCED PORT			CONTROL VA. SIZE 1" BODY			CONTROL VA. SIZE 1½" PORT 1½" BODY			CONTROL VA SIZE 1½" BODY		
LINE SIZE	BLOCK VA. SIZE	BY-PASS VA SIZE	LINE SIZE	BLOCK VA SIZE	BY-PASS VA SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA SIZE
¾/1	¾	¾	¾/1	¾	¾	¾/1	—	—	¾/1	—	—	¾/1	—	—	¾/1	—	—
1/1½	1	¾	1/1½	1	1	1/1½	1	1	1/1½	1	1	1/1½	—	—	1/1½	—	—
1½/2	1½	¾	1½/2	1	1	1½/2	1½	1	1½/2	1½	1½	1½/2	1½	1½	1½/2	1½	1½

GENERAL NOTES

1. THIS DRAWING IS TO BE USED FOR SELECTING CONTROL VALVE MANIFOLDS USING GATES AND GLOBES FOR BLOCK AND BY-PASS VALVES. MANIFOLDS ARE TO BE CONSIDERED SPECIAL WHEN PIPING CLASSIFICATIONS SPECIFY OTHER TYPE VALVES OR WHEN THE PROJECT CONTROL SYSTEMS ENGINEER INDICATES THAT THE CONTROL VALVE APPLICATION IS SPECIAL, SUCH AS: NOISE REQUIREMENTS, PRESSURE DROP MAY BE TOO HIGH THROUGH VALVE, FLASHING OR CAVITATING MAY BE OCCURING OR EROSION PROBLEMS MAY EXIST.
2. CONTROL VALVE TYPE, SIZE RATING, ETC., SHALL BE CHECKED AGAINST THE INSTRUMENT DATA SHEET AND THE CERTIFIED VENDOR DRAWING.
3. CONTROL VALVE MANIFOLD ACCESSIBILITY AND LOCATION.
   - 3.1 ACCESSIBILITY
     - a) ALL CONTROL VALVES SHALL BE INSTALLED SO THAT THEY ARE READILY ACCESSIBLE FOR MAINTENANCE.
     - b) THEY SHALL BE LOCATED AT GRADE UNLESS PRESSURE OR OTHER DESIGN CONDITIONS MAKE SUCH AN ARRANGEMENT IMPRACTICABLE. WHEN LOCATED ABOVE GRADE, THEY SHALL BE INSTALLED SO THAT THEY ARE READILY ACCESSIBLE FROM A PERMANENT PLATFORM OR WALKWAY WITH AMPLE CLEARANCES FOR MAINTENANCE.
   - 3.2 LOCATION
     - PREFERABLY THE CONTROL VALVE SHALL BE INSTALLED NEAR THE OPERATING EQUIPMENT TO BE OBSERVED WHILE ON LOCAL MANUAL CONTROL.
     - a) CONTROL VALVES SHALL BE INSTALLED IN HORIZONTAL LINES WITH THE DIAPHRAGM (ACTUATOR) OPERATORS LOCATED DIRECTLY ABOVE THE VALVE BODY. ANY DEVIATION SHOULD BE CHECKED WITH THE PROJECT CONTROL SYSTEMS ENGINEER.
4. BLOCK VALVES LOCATED UPSTREAM AND DOWNSTREAM OF THE CONTROL VALVE ARE GATES AND ARE NORMALLY LINE SIZE. WHERE THE CONTROL VALVE IS TWO OR MORE SIZES SMALLER THAN LINE SIZE, THE BLOCK VALVES MAY BE ONE SIZE SMALLER THAN LINE SIZE.
5. BY-PASS VALVES AND PIPING SHALL BE SAME SIZE AS CONTROL VALVE. TYPE OF VALVES ARE AS FOLLOWS:
   - a) SIZES 6" AND LARGER SHALL BE GATES.
   - b) SIZES 4" AND SMALLER SHALL BE GLOBES.
6. BLEEDER VALVES ARE NORMALLY LOCATED UPSTREAM OF CONTROL VALVES UNLESS JOB REQUIREMENTS DICTATE OTHERWISE.
7. FOR FLANGED CONTROL VALVES SIZES 1", 1 1/2" AND 2" - INCREASE DIMENSION "A" BY 3", ADDING A PIECE OF MAKE-UP PIPE BETWEEN THE REDUCER AND ELBOW ONLY WHEN LINE IS ONE SIZE LARGER THAN BLOCK VALVE AND TWO SIZES LARGER THAN CONTROL VALVE.
8. REDUCERS AND SWAGES UPSTREAM AND DOWNSTREAM OF CONTROL VALVE ARE CONCENTRIC UNLESS OTHERWISE SPECIFIED.
9. ANGLE AND 3-WAY CONTROL VALVES ARE CONSIDERED SPECIAL AND ARE NOT SHOWN ON THIS DRAWING. HOWEVER WHEN USING THESE VALVES, CAUTION MUST BE EXERCISED TO ALWAYS INSTALL VALVES IN THE PROPER DIRECTION OF FLOW. CHECK WITH CONTROL SYSTEMS ENGINEER.
10. SUPPORTS AT CONTROL VALVE MANIFOLDS SHALL BE LOCATED IN A WAY, SO THAT THE ASSEMBLY IS SELF-SUPPORTING WITH THE CONTROL VALVE REMOVED.

LEGEND

E1 REG	REGULAR CONTROL VALVE
E2 C.FINS	CONTROL VALVE WITH COOLING FINS
E3 HW	CONTROL VALVE WITH TOP MOUNTED HANDWHEEL
E4 C.FINS HW	CONTROL VALVE WITH COOLING FINS AND TOP MOUNTED HANDWHEEL.
C.O.	CHAIN OPERATED BY-PASS VALVE
✱	BY-PASS VALVE STEM ORIENTATION AT 45° UP FROM HORIZONTAL ℄
▲	BY-PASS VALVE SHALL NOT EXCEED 6'-6" TO BOTTOM OF HANDWHEEL FROM ACTUAL GRADE, ELEVATED PLATFORM OR WALKWAY.

NOTE:

THIS DRAWING IS BASED ON AMERICAN PETROLEUM INSTITUTE STANDARD (API) RP 550-PART 1 SECTION G, CONTROL VALVES AND POSITIONERS.

REV	DATE	DESCRIPTION					
4	6/74	ADDED DETS. TYPE IB, IIB & IIIB, FLGD. C.V. W/ SCRD. OR S.W. FITTINGS					
3	5/74	REVISED & REDRAWN					
2	6/23/66	RELOCATED DRAIN VALVE AT DRIP LEG & ADDED NOTE					

SCALE NONE — G. FUSKEL/HAUSER — L. STUMPS

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

CONTROL VALVE MANIFOLDS

JOB No. STD. — DRAWING No. L-538 — REV. 4

SIZE E

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Rev	Date	Description	By	Chk	App
3					
2	10-21-81	REVISED SPEC. REFERENCES. ADDED STD DWGS & DC	[illegible]	[illegible]	[illegible]
1	11/10/80	ISSUED FOR PHASE ZERO	JK	HS	[illegible]
0	2/21/80	ISSUED FOR APPROVAL	JWH	HS	

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10. PIPE SPANS

2 11. DELETE

FORM II-293 7/66

1. GENERAL REQUIREMENTS

1.1 Scope

This specification describes general requirements governing piping layout and design that will produce a safe, economical and easy to operate installation.

1.2 Basis for Design

Project Specification 14222-L-1 specifies the piping codes applicable to piping systems. Piping & Instrument diagrams will show clearly the extent of piping governed by codes other than The American Standard Code for pressure piping, ANSI B31.3 "Petroleum Refinery Piping". Project Specification 14222-L-3, Piping Design Basis, specifies the design conditions applying to piping systems. Engineering Std. Drawings A-521, A-522, and Project Specification 14222-L-9 set minimum requirements and clearances for piping and equipment layout.

2. LAYOUT

Piping shall be arranged for ease of operation, accessibility, maintenance, economy and appearance.

2.1 Piping Routing

Piping shall be arranged in an orderly manner and routed as directly as practical, preferably in established banks or pipeways, as follows:

a) Piping shall run at different elevations designated for north-south and east-west banks, and will change elevation when changing direction. See Engineering Std. Drawing A-522.

b) Piping outside of main pipeways shall parallel main pipeways wherever possible.

c) Relative elevations of pipeways shall be set to provide sufficient clearance between lines at intersections.

d) Flat turns to eliminate fittings at changes in direction may be used where the layout of piping is sufficiently advanced to insure that the flat turn will not cause interferences or block future line extensions.

e) Dead ends and pockets in lines shall be avoided.

f) Pipe spacing for bare and insulated lines shall follow Eng. Std. Drawing L-535.

g) Shoe heights for hot insulated lines shall normally be 4" per Eng. Std. Drawing L-581. Refer to Eng. Std M-624 for cold insulated lines.

h) Future pipeway space shall be provided as specified in Project Specification 14222-L-9.

j) Avoid compound angles in piping configurations, unless absolutely necessary.

2.2 Piping Flexibility

Piping shall be designed with sufficient flexibility to absorb any excessive

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stresses. All lines shall be reviewed by stress group to conform with ANSI B31.3, para. 319 and the dynamic effects listed in para. 301.5.

2.3 Critical Piping

Where dynamic loading, minimal flow conditions or other severe service conditions apply, piping shall be carefully designed and checked to insure that its size, configuration, mechanical strength, supports and restraints will prevent excessive stress, pressure drop, vibration or noise.

2.3.1 Dynamic Loading

Dynamic loading may be expected when pulsating flow (such as at reciprocating compressors), high velocity flow, flashing fluid, fluctuating temperature or pressure or mechanical vibration (including wind) conditions exist.

2.3.2 Limited Pressure Drop

Limited pressure drop conditions may be expected in large vapor lines, heater transfer lines, reboiler circuits, pump suctions, and gravity flow lines. Such piping shall be routed as directly as practical.

2.3.3 Other Severe Services

Other severe services include erosive, corrosive, high or low temperature or pressure conditions or any fluids containing solids. Many such services require alloy or special materials.

2.4 Supports and Anchors

2.4.1 All piping shall be supported, guided or anchored so as to prevent excessive vibration, deflections or stress on equipment in accordance with design guides to be issued in Phase 1.

△2

3. EQUIPMENT PIPING

3.1 Piping at columns shall be located radially about the column on the pipeway side, manways and platforms on the access side. For piping location and supports, see Engineering Std. Drawing M-600, 601, 602 & 603. Overhead vapor lines and similar connections 18" and larger may have a welded connection to the vessel, except where flanges are required for maintenance or blinding. Additional details for vessel nozzles and internals, refer to Eng. Std. Dwgs. B-501 through B-504, C-525 and C-550.

3.1.1 Connections Inside Skirts

Valves and flanges shall not be located inside vessel skirts.

3.1.2 Drawoff Boots

Drawoff boots on elevated horizontal vessels may be extended a reasonable amount to place the centers of gage glass and level controller not over 5 feet from grade, platform or ladder access. See Eng. Std. Dwg. L-551.

3.1.3 Vents and Drains

a) Vents - A valved and blinded atmospheric vent shall be provided at vessel high points and/or overhead piping with platform access provided for valve operation.

b) Drains - Drains provided at vessels shall run to underground systems with open connections terminating 2 inches above the drain hub so that discharge is plainly visible. When practicable, connection may be piped from the bottoms-out line.

3.1.4 Relief Valves

a) Relief valves discharging into a closed blowdown system shall be elevated to provide self-draining of discharge side into blowdown system.

b) Relief valves discharging vapor to atmosphere must be provided with a pipe stack ending at least 10 feet above any platform within a 25 foot radius. Provide a ½" weep hole in bottom of stack to prevent liquid accumulation.

3.2 Exchanger Piping

Piping, except removable local interconnections, shall not be run over channel or shell cover areas, or in the way of built-in or mobile handling facilities. Wrench clearance shall be provided at the exchanger flanges. Spool pieces shall be provided beyond the channel nozzles to permit the removal of the exchanger tube bundle. See Engineering Std. Drawing A-522.

3.3 Pump and Turbine Piping

3.3.1 Pump Suction Piping

Pump suction piping shall be arranged with particular care to avoid unnecessary pressure drop and vapor pockets. Concentric reducers are preferred where size changes are necessary, except in horizontal suction lines at pumps with front or side suction. In these locations, irrespective of suction piping being routed from above or below the pump, eccentric top flat reducers shall be used.

3.3.2 Access to Pumps and Turbines

Piping at pumps and turbines shall be arranged to avoid interference with operation or maintenance access. Removable spool piece shall be provided as appropriate, such as at end suction pump inlets, to permit maintenance without major piping disassembly.

3.3.3 Weight and Thermal Stress

Suitable supports or anchors shall be provided so that excessive weight and thermal stresses will not be applied to the casings. Careful design consideration shall be given to piping configuration to minimize these stresses.

3.3.4 Suction and Inlet Strainers

Temporary strainers shall be provided at all pump suctions and turbine inlet unless permanent strainers are specified.

3.4 Compressor Piping

Piping and auxiliaries at compressors shall be arranged for convenient access and maintenance and shall conform to the following documents: General Specifications 14222-K-1 and 14222-K-2 and Project Specification 14222-L-4; Design Guides to be issued in Phase 1.

3.4.1 Vibration

a) Particular consideration shall be given to design of piping subject to vibration from dynamic loading associated with reciprocating compressors. Volume bottles may be provided as required.

b) Suction and discharge piping shall be run on sleepers at grade, if at all possible. This arrangement permits simple and effective supports of the lines to reduce vibration, particularly on reciprocating compressors.

3.4.2 Suction Piping

Piping drawings shall show the extent of piping requiring special internal cleaning. For compressor suction screen requirements, refer to Engineering Design Guide K-5, to be issued in Phase 1.

3.4.3 Removable Piping for Maintenance

Removable spool pieces shall be provided at compressors where needed to permit maintenance without major piping disassembly.

3.5 Burner and Snuffing Steam Piping at Fired Heaters

3.5.1 Burner piping shall be kept clear of all access and observation openings. Keep space required for tube maintenance free of all piping. Piping to the burners shall be made using unions, flexible connectors or other specified means to provide for easy and convenient removal of burners for maintenance. Piping should be located to maintain a minimum 6'-8" clear under the heater. In general, burner piping shall conform to the following requirements:

a) Take-off connections shall be made from the top of the steam and gas headers and piping arranged for equal flow distribution. Condensate legs, knockout pots or other approved methods for the collection and elimination of condensate shall be provided.

b) Snuffing steam manifold shall be located 50' min. from furnace.

4. VALVES

4.1 Valve Locations

For valve locations, see Engineering Std. Drawing L-552.

4.1.1 Header Block Valves

Branch line block valves from pipeway headers shall be located at edge of pipeway for access by portable ladder.

4.1.2 Valves and Flanges in Caustic and Acid Service

Valves shall be located no higher than 4'-6" above grade and also provided with a protective shield, so as not to present a hazard to personnel.

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Flanges in such hazardous service shall also be provided with spray shields.

4.2 Valve Access

TYPE OF VALVE	Grade	Fixed Platf.	Rolling Platf. or Scaffold	Fixed Ladder	Port. Ladder
	Type of Access Required				
Operating Valves (para. a.)	Yes	Yes	No	No	No
Operating Valves, Sm. (para. a&c)	Yes	Yes	No	Yes	No
Non Operating Valves (para. b)	*	*	Yes	No	No
Non Operating Valves, Sm (para b&c)	*	*	Yes	Yes	Yes
Instrument Valves	(See Para. 6.4 - Instrument Access)				

a) Operating valves are valves that are essential for plant operation.
b) Non operating valves are valves that are not essential for plant operation.
c) Small valves are defined as valves that can be easily operated with one hand and are normally 1½" and smaller.
* To be used if available.

4.2.1 Chain Operators

Operating valves with bottom of handwheel over 6'-6" above actual grade or platform shall be chain operated. Chain must not hang in a walkway or access area and shall terminate approx. 3'-0" above grade or platform. Chain operators shall not be used for screwed valves or any valve 1½" and smaller.

4.3 Line Vents and Drains

Line vents and drains fall into two categories, operating and non-operating.

4.3.1 Operating Vents and Drains for equipment and piping will be valved and plugged and are shown on the piping and instrument diagrams.

4.3.2 Non-Operating Vents and Drains will conform to the following:

a) In hazardous services, such as Hydrogen, Chlorine Gas, etc., vent and drain connections shall be provided only when it is not possible to vent or drain through flanges in the system.

b) Systems for air, inert gas, and steam not exceeding design pressures or temperatures of 125 psig and 350°F do not require high point vent connections on piping.

c) All other services will have plugged vent and drain connections provided at the high and low points of the piping system to facilitate maintenance and hydrostatic testing.

d) Vents and drains, used only for hydrotesting shall have the valves, if any, removed and the vents and drains plugged or blinded.

4.4 Sample Connections

4.4.1 Sample connections shall be located for easy access from grade (grade preferred) or fixed platform.

4.4.2 Length of sample piping shall be kept to a minimum.

4.4.3 Sample coolers shall be per Engineering Std. Drawing L-514.

5. UTILITY PIPING

5.1 Steam Piping

a) Design piping for complete condensate removal. Drip legs shall be provided on all steam lines at all low points and dead ends. Refer to Engineering Std. Drawing L-519.

b) Branch connections shall be made from the top of the headers.

c) Block valves shall be installed in the horizontal run of each branch line or group of common users.

d) Design piping to make use of sub-headers to serve an area of process equipment or groups of drivers.

5.2 Steam Traps

a) Provide steam traps at low points and drip legs of steam lines.

b) Discharge steam traps to a lower pressure steam or condensate system.

c) Provide valves on each side of trap for trap removal on closed systems.

d) Install a strainer up-stream of each trap, if trap does not have a built in strainer.

5.3 Steamout Connections

a) Steamout connections are required for purging vessels and pipelines containing hydrocarbon and hazardous fluid.

b) Steamout connections shall not be less than 1-inch.

c) Where temporary type connections are used, the hose length for servicing connection shall not exceed 50 feet.

5.4 Steam Tracing and Winterizing

2 See Engineering Std. Drawing L-521 and Design Guide A-1(to be issued in Phase 1).

5.5 Utility Stations

5.5.1 Utility stations at grade, consisting of air, steam and water, shall be located throughout the operating area of each process unit, so that a 50-foot length of hose can service any point in the area. For detailed assembly of utility station see Eng. Std. Drawing L-531.

5.5.2 Additional utility hose connections for servicing equipment at elevated structures and platforms are shown on utility P&ID's.

5.5.3 Utility stations shall be installed in such a manner, so that they remain in operation during a unit shutdown.

5.6 Auxiliary Piping for Pumps and Turbines

2 Install piping to conform to Project Specification 14222-L-6.

6. INSTRUMENTS

Instrument requirements in this section apply to plant design and piping layout only. For detailed requirements affecting instrument locations and connections, see Specification 14222-J-1, Instruments - General.

6.1 Control Valve Manifolds

6.1.1 Preferred Types

See Engineering Std. Drawing L-538 for control valves manifold arrangements and block and bypass valve sizing.

6.1.2 Location

a) Control valves shall be located at grade or on conveniently accessible platforms. Their locations shall be consistent with their function and with convenience of plant operation. In general, they shall be located in sight of instruments or indicators showing variables they control.

b) Control valves in flashing service shall be located near the end of the piping.

6.1.3 High Pressure Drop at Control Valves

Where high pressure drop conditions exist across control valves, sonic harmonics along with extreme noise levels can be expected. Piping subjected to these conditions must be carefully analyzed and designed to insure that its size and configuration downstream of the valve prevents excessive vibration and noise.

6.2 Level Instruments

For miscellaneous details regarding level instruments see Specification 14222-J-1, Instruments-General.

6.2.1 Location

All level instruments shall be accessible from grade, platform or ladder Their location shall be consistent with function and with convenience of plant operation.

6.2.2 Strong Backs

Where strong backs are provided for external level instruments, their minimum pipe size will be 2". Block valves shall be provided at the vessel connections.

6.3 Orifice Runs

6.3.1 Location

Horizontal meter-runs are preferred. Determine the length of each meter run in accordance with Instrument Engineering Standard Drawings J-F-0101 thru J-F-0108. Provide sufficient clearance at orifice flanges for installation of instrument piping and seal pots where they are required. Refer to Engineering Standard Drawings L-504 & L-550.

6.4 Instrument Access

Operator access requirements for instruments are per the following table.

Type of Instrument	Access For Operation Required	Access from Grade And/Or Portable Ladder	Fixed Ladder	Fixed Platform
1. Thermocouples	No	Yes	**	**
2. Test Thermowells	Yes	Yes	**	**
3. Dial Thermometers	No*	Yes	**	**
4. Pressure Gage	Yes	Yes	**	**
5. Level Gages	Yes	No	Yes	**
6. Temperature Transmitter & Switches (indicating)	No*	Yes	**	**
7. Temperature Transmitter & Switches (blind/non-indicating)	No	Yes	**	**
8. Other Transmitters & Switches (blind/non-indicating)	Yes	Yes	**	**
9. Other Transmitters & Switches (indicating)	Yes	No	Yes	**
10. Recorders and Controllers	Yes	No	No	Yes
11. Control Valves and Other Finite Control Elements	Yes	No	No	Yes

* But must be able to read from platform or fixed ladder.
** To be used if available.

Yes=Required Minimum.

Maintenance access is required to all instruments but may be by portable ladder from grade or by platform.

7.0 MATERIALS

Materials in each piping line shall conform to job piping materials service classifications unless specified otherwise.

7.1 Junction of Different Services

Where two services of different classifications join, the more severe service will govern through the first valve or other means provided to separate the two services.

8. HYDROSTATIC TESTING

⚠2 Hydrostatic testing shall conform to Project Specification 14222-L-6.

9. PIPE SIZES

Piping 7" smaller than 3/4" shall be avoided. Pipe sizes $1\frac{1}{4}$", $2\frac{1}{2}$", $3\frac{1}{2}$", $4\frac{1}{2}$" and 5" shall not be used. Where equipment connections are those sizes, transition to other commerical pipe sizes shall be made as close to the equipment as practical. In pipeway runs, the minimum size for pipe headers shall be 2 inches or as otherwise goverened by the length of span.

10. PIPE SPANS

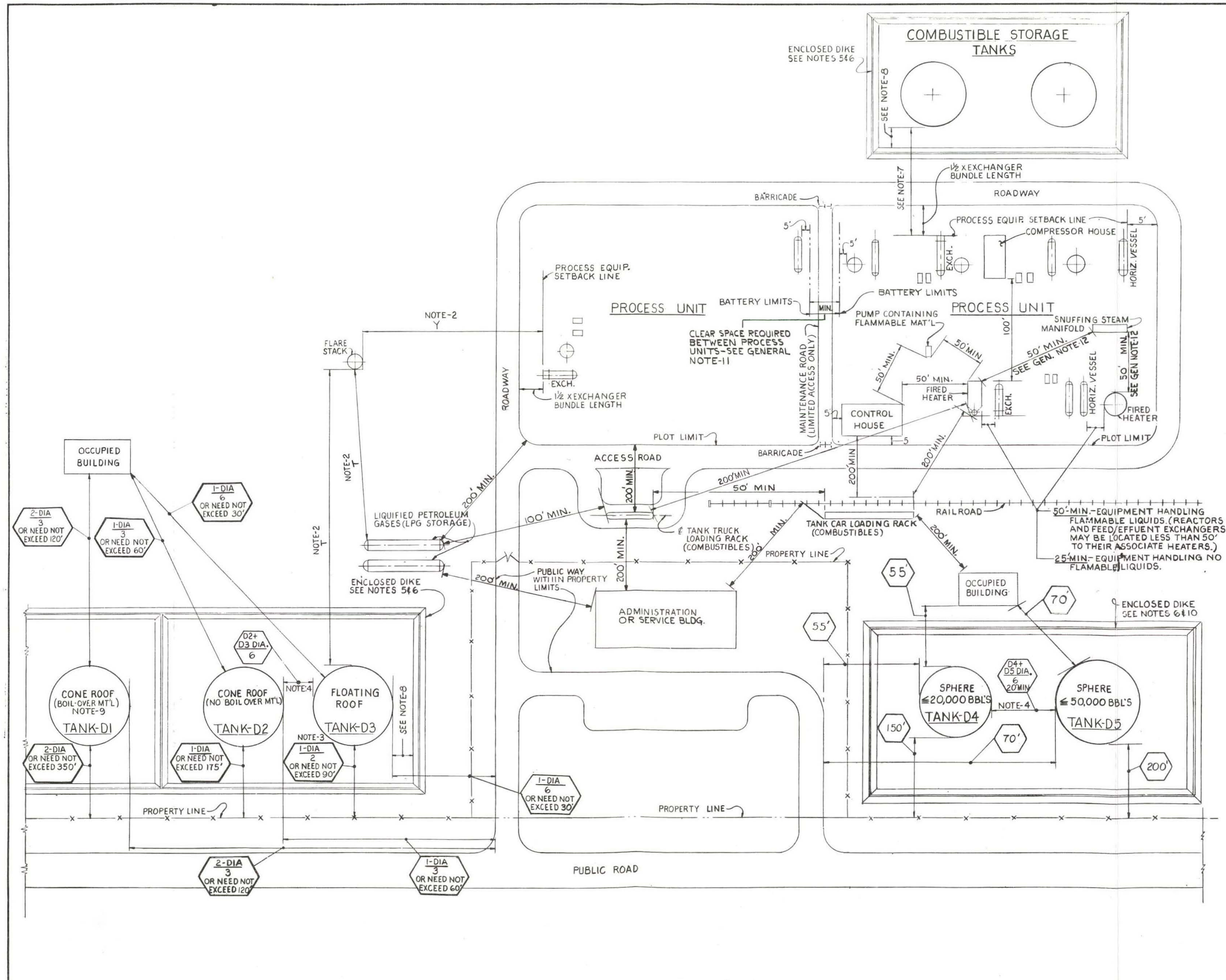
Pipe supports shall be so located as to provide the following maximum spans:

Up to $1\frac{1}{2}$" Pipe - 8 Ft
2" - 10 Ft.-12 Ft.
3" - 15 Ft.
4" - 18 Ft.
6" - 25 Ft.
8" - 30 Ft.

Size under 2" are not to be supported intermediately from larger lines.

2

FORM 11-293 7/66



SIZE D

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. $\frac{\text{1-DIA}}{2}$ – 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						

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

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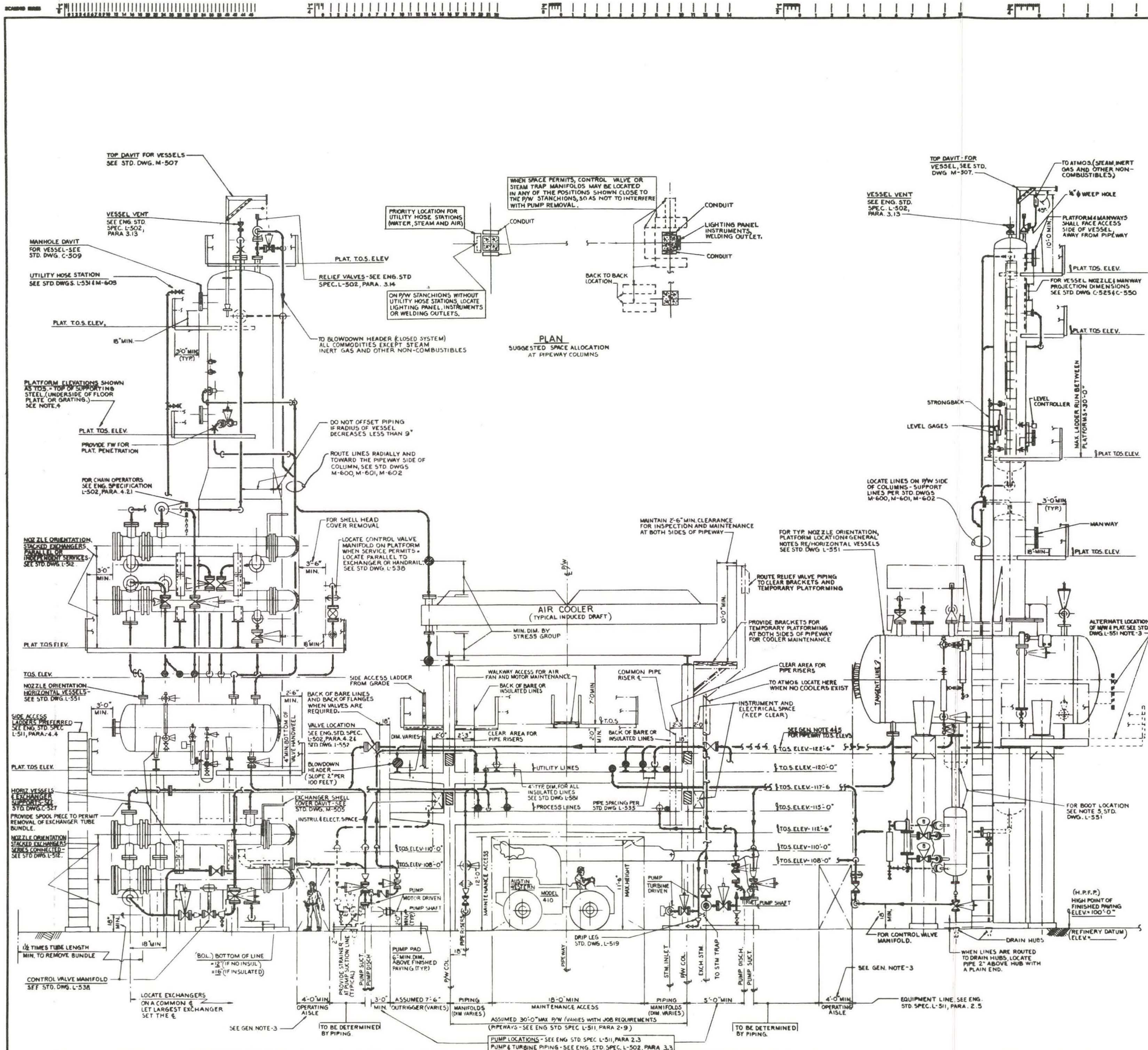
ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

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

JOB No.	DRAWING No.	REV.
STANDARD	A-521	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 WITH OUTRIGGERS.
   - PIPEWAYS WITHOUT OUTRIGGERS.
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.

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.

No.	DATE	REVISIONS	BY					
4	1/74	REVISED & REDRAWN	GF LS	H.G.				
3	6/6/63	GENERAL REVISION	GF					

SCALE NONE — DESIGNED HAG/GF — DRAWN L STUMPS

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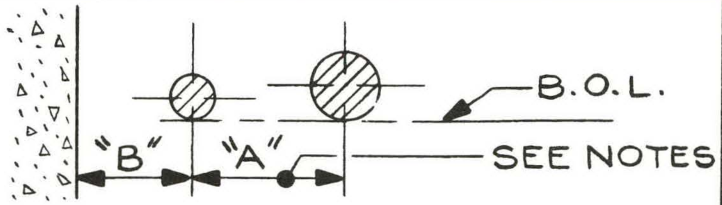
REFINERY & CHEMICAL DIVISION

CROSS SECTION
TYPICAL PROCESS UNIT

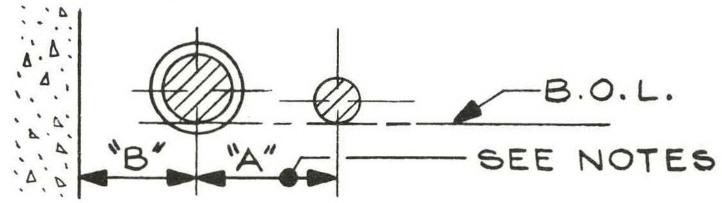
JOB No. STD — DRAWING No. A-522 — REV. 4



PIPE SIZE	DIM. "A" PIPE SPACING WITHOUT FLANGES													DIM "B"
	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	
2"	6	6	7	8	9	10	11	12	13	14	15	17	20	5
3"	6	7	7	9	10	11	12	12	13	14	15	17	20	5
4"	7	7	8	9	10	11	12	13	14	15	16	18	21	6
6"	8	9	9	10	11	12	13	14	15	16	17	19	22	7
8"	9	10	10	11	12	13	14	15	16	17	18	20	23	8
10"	10	11	11	12	13	14	15	16	17	18	19	21	24	9
12"	11	12	12	13	14	15	16	17	18	19	20	22	25	10
14"	12	12	13	14	15	16	17	17	18	19	20	22	25	10
16"	13	13	14	15	16	17	18	18	19	20	21	23	26	11
18"	14	14	15	16	17	18	19	19	20	21	22	24	27	12
20"	15	15	16	17	18	19	20	20	21	22	23	25	28	13
24"	17	17	18	19	20	21	22	22	23	24	25	27	30	15
30"	20	20	21	22	23	24	25	25	26	27	28	30	33	18

NOTES:

1. DIM. "A" IS BASED ON A CLEARANCE OF 3 TO 4 INCHES BETWEEN TWO BARE PIPE O.D'S.
2. DIM. "A" WITH A VARIANCE:
   a) BARE LINE TO INSULATED LINE = DIM. "A" PLUS INSULATION THICKNESS ROUNDED OFF TO THE NEAREST PLUS INCH.
   b) INSULATED LINE TO INSULATED LINE = DIM. "A" PLUS INSUL. THICKNESS OF EACH LINE ROUNDED OFF TO THE NEAREST PLUS INCH.
3. DIM. "B" IS BASED ON THE O.D. OF A BARE LINE HAVING A 3 AND 4 INCH CLEARANCE ADJACENT TO A WALL, VESSEL OR STEEL STRUCTURE. IF LINE IS INSULATED, ADD INSULATION THICKNESS TO DIM. "A" AND ROUND OFF TO THE NEAREST PLUS INCH.



DIM "B"	PIPE SIZE	DIM. "A" PIPE SPACING WITH FLANGES													DIM "B"
		2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	
5	2"	6	7	8	9	10	11	13	14	15	17	18	21	24	6
5	3"	7	7	8	9	11	12	13	15	16	17	18	21	25	7
6	4"	8	8	9	10	11	12	14	15	16	18	19	22	25	7
7	6"	9	9	10	11	12	14	15	16	18	19	20	23	26	9
8	8"	10	11	11	12	13	15	16	17	19	20	21	24	27	10
9	10"	11	12	12	14	15	16	17	18	20	21	22	25	28	11
10	12"	13	13	14	15	16	17	18	19	21	22	23	26	29	13
10	14"	14	15	15	16	17	18	19	20	21	22	24	26	30	14
11	16"	15	16	16	18	19	20	21	21	22	23	25	27	31	15
12	18"	17	17	18	19	20	21	22	22	23	24	26	28	32	16
13	20"	18	18	19	20	21	22	23	24	25	26	27	29	33	18
15	24"	21	21	22	23	24	25	26	26	27	28	29	31	35	20
18	30"	24	25	25	26	27	28	29	30	31	32	33	35	38	24

NOTES:

1. DIM. "A" IS BASED ON THE LARGER OF TWO LINES WITH A 300# UN-INSULATED FLANGE ADJACENT TO A BARE LINE. IT ALLOWS A CLEARANCE OF 1 TO 2 INCHES BETWEEN FLANGE O.D. AND BARE LINE. ALSO USE DIM. "A" FOR:-
   a) SMALL LINE FLANGED ADJACENT TO LARGE BARE LINE.
2. DIM. "A" WITH A VARIANCE:-
   a) INSULATED LINE ADJACENT TO FLANGED LINE = DIM. "A" PLUS INSULATION THICKNESS ROUNDED OFF TO THE NEAREST PLUS INCH.
   b) FLANGE RATING 400# AND ABOVE = DIM. "A" PLUS DIFFERENCE OF FLANGE O.D. ABOVE 300# ROUNDED OFF TO THE NEAREST PLUS INCH.
3. DIM. "B" IS BASED ON A 300# UNINSULATED FLANGE LINE HAVING A 2 TO 3 INCH CLEARANCE BETWEEN THE FLANGE O.D. AND THE ADJACENT WALL VESSEL OR STEEL STRUCTURE.
4. DIM. "B" WITH A VARIANCE:-
   APPLY SAME RULE AS PER NOTE 2-b) ABOVE.

GENERAL NOTES

1. PIPE SUPPORT SHOE HEIGHTS FOR HOT INSULATED LINES ARE PER STD. DRAWING L-581.
2. PIPE SUPPORT SHOE HEIGHTS FOR COLD INSULATED LINES ARE PER STD. DRAWING S4.
3. INSULATION THICKNESS
   a) HOT PIPING - SEE STD. SPECIFICATION N-501.
   b) COLD PIPING - SEE STD. SPECIFCATION N-502.

No	DATE	REVISIONS	BY	CHKD	DESIGN SUPV	ENGR	PROJ ENGR	APPR
6	7/75	ADDED GEN. NOTE-3, REMOVED WORD "HOT" FR. TITLE.	HG					
5	11/74	REVISED & REDRAWN SPLIT INTO TWO TABLES	GF	HG.				
4	12/73	REVISED TITLE NOTES & DETS	LS	G.E.				

SCALE NONE | DESIGNED | DRAWN WPP | CHIEF ENGR

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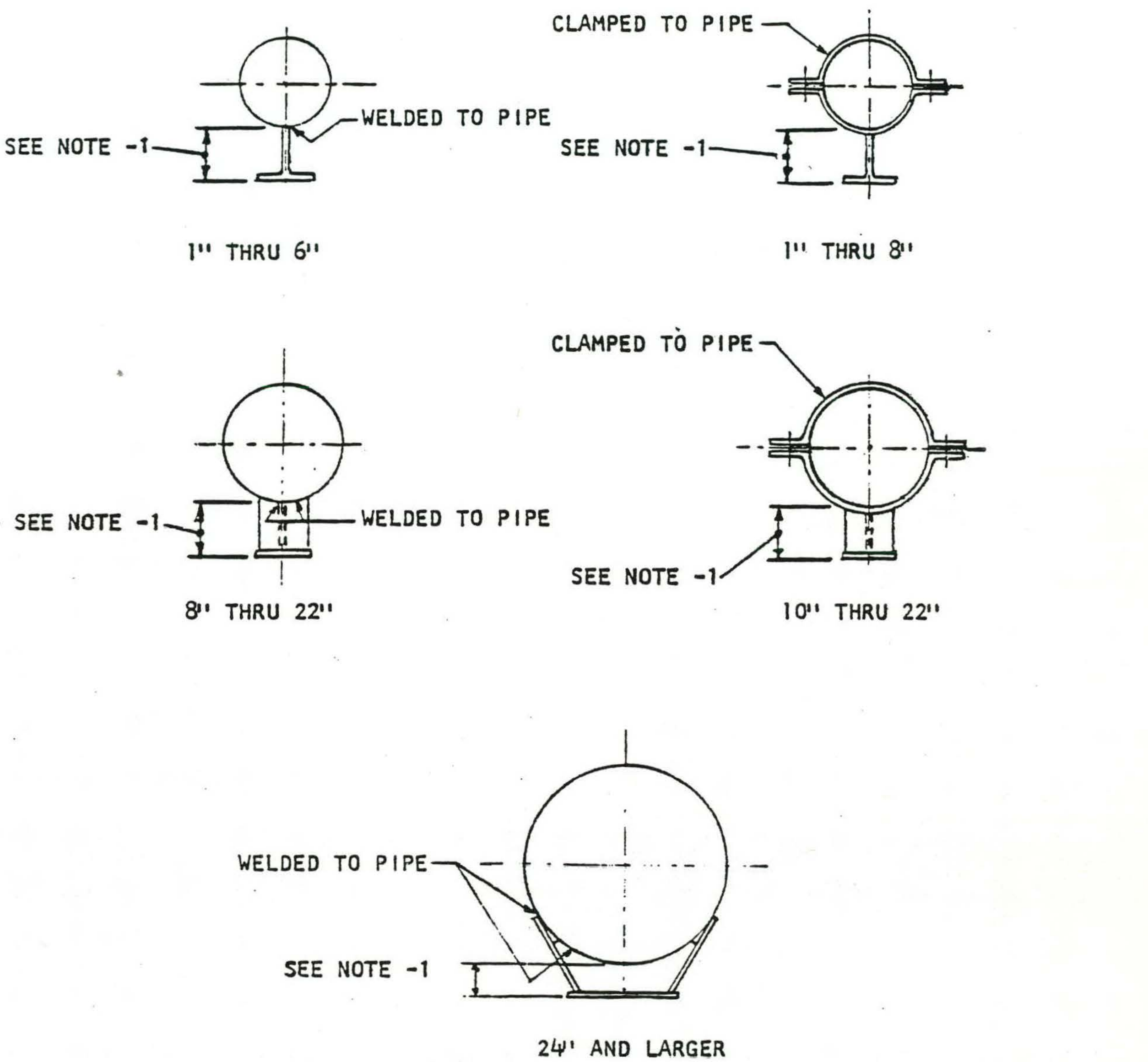
PIPE SPACING FOR BARE OR INSULATED LINES WITH OR WITHOUT FLANGES

JOB No.	DRAWING No.	REV.
STD	L-535	6



1. - SHOE HEIGHTS FOR HOT INSULATED LINES.
   a) 4"-SHOE HEIGHTS REQUIRED FOR LINES WITH INSULATION THICKNESS $3\frac{1}{2}$ INCHES AND LESS.
   b) 6"-SHOE HEIGHTS REQUIRED FOR LINES WITH INSULATION THICKNESS 4 THRU $5\frac{1}{2}$ INCHES.
2. - SHOE HEIGHTS SHOWN ARE TO BE USED FOR PIPING LAYOUT, ISOMETRIC AND ARRANGEMENT DRAWINGS.
3. - FOR EXACT DETAILS, SEE PIPE SUPPORT DRAWINGS.

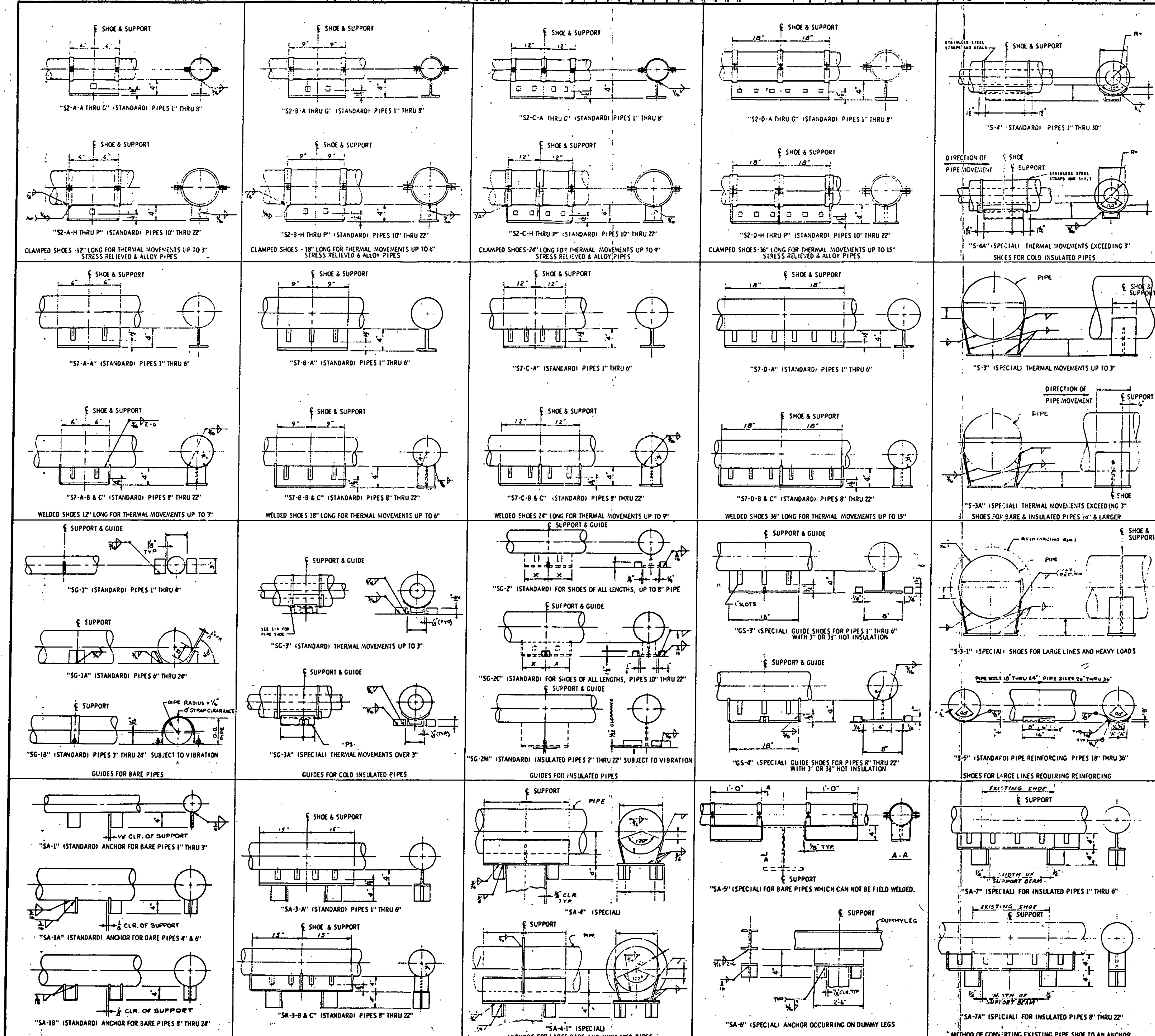
No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENG R	PROJ ENGR	APPR
2	12-74	DELETED 4" DIM. & ADDED NOTE-1	[illegible]	J.H	[illegible]	[illegible]		[illegible]
1	10-14-69	Redrawn. Reissued As Engineering Std.	JJH	JT	JJH	[illegible]		

SCALE	DESIGNED	DRAWN	CHIEF ENGR

ORIGIN			JOB No. STANDARD
R&C ENG (SF) PIPE SUPPORT 10/14/69	BECHTEL	BECHTEL ENGINEERING STANDARD PIPING DESIGN SHOE HEIGHTS FOR HOT INSULATED LINES	DRAWING No. L-581 — REV. 2

"A" SIZE

SIZE E



PIPING
(S7-B-B)SYMBOL FOR SHOE)

"STANDARD SHOES"

S7-B-B — FULL CODE AS IT APPEARS ON PIPING ISOMETRIC OR ORTHOGRAPHIC PIPING DRAWING.

S7-B-B
- SHOE FOR HOT INSULATED LINES.
- SERIAL NUMBER
- LENGTH-VARIABLE (*)
- PIPE SIZE RANGE-VARIABLE (*)
- COMPLETE SHOE NUMBER APPEARING ON LOWER RIGHT HAND CORNER OF PIPE SUPPORT STANDARD:

1. S7-A-A	5. S7-C-A
2. S7-A-B AND C	6. S7-C-B AND C
3. S7-B-A	7. S7-D-A
4. S7-B-B AND C	8. S7-D-B AND C

(*) SEE TABULATION ON PIPE SUPPORT STANDARD

STANDARD SHOES FOR HOT INSULATED LINES IN MAIN PIPEWAYS SHALL HAVE A MINIMUM LENGTH OF 18" INCHES

PIPING
SUPPORT BEAM
SG-1A (SYMBOL FOR GUIDE)

"STANDARD HORIZONTAL LINE GUIDES"

SG-1A — FULL CODE AS IT APPEARS ON PIPING ISOMETRIC OR ORTHOGRAPHIC PIPING DRAWINGS.

SG-1A
- GUIDE FOR HORIZONTAL LINES
- VARIABLE (*)
- SERIAL LETTER
- COMPLETE GUIDE NUMBER (APPEARS ON LOWER RIGHT HAND CORNER OF PIPE SUPPORT STANDARD)

1. FOR BARE LINES (NO SHOE).
(*) 2. HOT INSULATED LINE SHOE REQUIRED.
3. COLD INSULATED LINE SHOE REQUIRED.

PIPING
LOCATION NUMBER 2
SA-3-B (SYMBOL FOR ANCHOR)

"STANDARD ANCHORS"

SA-3-B — FULL CODE AS IT APPEARS ON PIPING ISOMETRIC OR ORTHOGRAPHIC PIPING DRAWINGS.

SA-3-B
- STANDARD ANCHOR
- SERIAL NUMBER
- PIPE SIZE RANGE (VARIABLE) SEE TABULATION ON PIPE SUPPORT STANDARD.
- COMPLETE ANCHOR NUMBER APPEARING ON LOWER RIGHT HAND CORNER OF PIPE SUPPORT STANDARDS ARE:

SA-1, SA-1A & SA-1B,	BARE LINE ANCHORS
SA-3-A	HOT INSULATED LINES (1" THRU 6")
SA-3-B AND C	HOT INSULATED LINES (8" THRU 22")

"SPECIAL SUPPORT"

(NON-STANDARD SHOE, GUIDE OR ANCHOR)

20-PS-12 — FULL CODE AS IT APPEARS ON PIPING ISOMETRIC OR ORTHOGRAPHIC PIPING DRAWING.

20-PS-12
- PROJECT PLANT NUMBER (IF ANY)
- PIPE SUPPORT
- SERIAL NUMBER
- DETAIL SHEET NUMBER (APPEARS ON LOWER RIGHT HAND CORNER OF PIPE SUPPORT DETAIL SHEET)

TRANSPARENCIES OF THE SPECIAL SUPPORTS SHOWN BY FORM NUMBER ARE AVAILABLE IN THE FILES. THESE REQUIRE THE ADDITION OF DESIGN AND SOME FABRICATION INFORMATION.

USE THIS DRAWING AS A SUPPORT SELECTION GUIDE ONLY. FOR DESIGN DETAILS AND LIMITATIONS SEE SUPPORT DETAIL DRAWING ISSUED FOR THE JOB OR THE PIPE SUPPORT STANDARDS.

No.	Date	Revision	By					
0	5/72	REISSUED AS ENGINEERING STANDARD. WAS L-624	JT	JJH	JJH			

SCALE NONE

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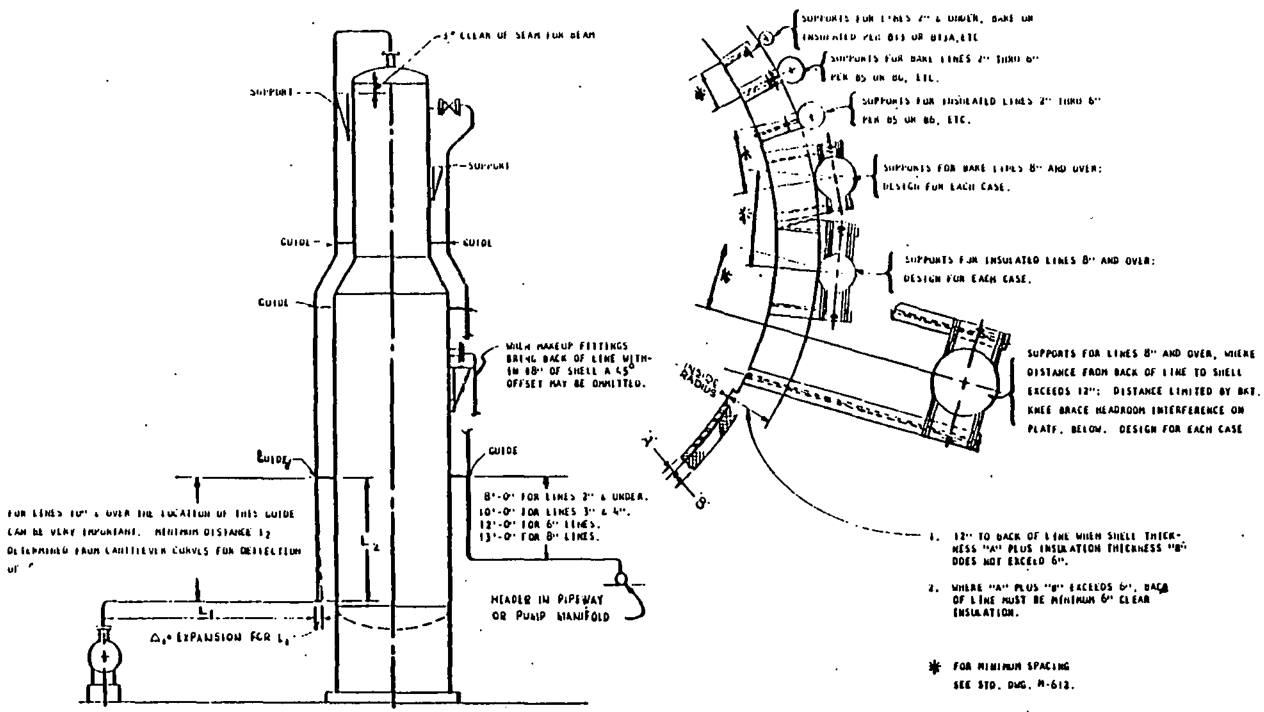
REFINERY AND CHEMICAL DIVISION

SUPPORT GUIDE
SHOES — GUIDES — ANCHORS

JOB No.	DRAWING No.	REV.
STD.	M — 624	0



LINES WHICH ARE RADIALLY LOCATED AROUND A VERTICAL VESSEL ARE PREFERRED TO THE TANGENTIALLY LOCATED ARRANGEMENT SHOWN ON M-601. RADIALLY LOCATED LINES REQUIRE LESS PIPE AND FEWER FITTINGS TO PROVIDE FLEXIBILITY BETWEEN SUPPORTS AND NOZZLES AND USE SIMPLER SUPPORTS OF STANDARD DESIGN. THE PIPES SHOULD BE LOCATED, IF POSSIBLE, ON PLATFORM-FREE SEGMENTS OF THE VESSEL PERIMETER. BY LOCATING PIPES CLOSER TO THE VESSEL SHELL, THE RESULTING VESSEL SHELL STRESSES ARE MINIMAL AND SMALL LINES CAN PENETRATE PLATFORMS WITHOUT BLOCKING THEM. THE MAXIMUM ALLOWABLE STRESSES PRODUCED MUST BE DETERMINED BY DESIGN GUIDE C-1, "LOCAL STRESSES IN CYLINDRICAL SHELLS DUE TO EXTERNAL LOADINGS." LINES AND SUPPORT ARRANGEMENT SHOWN ON M-601 ARE USED ON SMALLER DIAMETER VESSELS.

SUPPORTS ON STRESS RELIEVED VESSELS

PIPE SUPPORTS FOR VESSELS STRESS RELIEVED DUE TO SHELL THICKNESS ONLY CAN BE FIELD WELDED WHEN APPROVED BY THE PROJECT ENGINEER. VESSELS STRESS RELIEVED FOR PROCESS REASONS MUST HAVE ALL ATTACHMENTS TO THE SHELL WELDED IN PLACE BY THE VESSEL FABRICATOR BEFORE STRESS RELIEVING. ALL PIPING, INCLUDING UTILITY LINES, MUST BE COMPLETED AT THE EARLIEST POSSIBLE DATE TO PERMIT LOCATING AND DESIGNING THE SUPPORT ATTACHMENTS TO BE PROVIDED BY THE VESSEL FABRICATOR.

WHEN LOCATING SUPPORTS OR GUIDES ON A VESSEL, CARE SHOULD BE TAKEN TO ENSURE THAT THE ATTACHED MEMBER DOES NOT INTERFERE WITH A VESSEL WELD SEAM, INSULATION SUPPORT RING OR VESSEL VACUUM STIFFENER RINGS.

0	4/71	REISSUED AS ENGINEERING STD. WAS L-600

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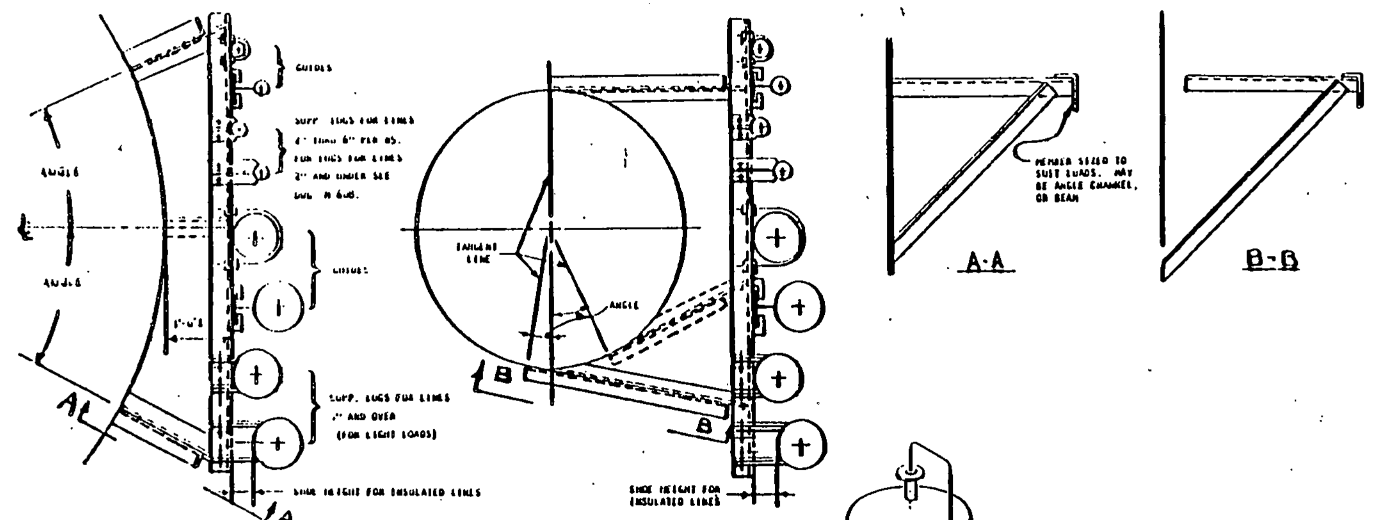
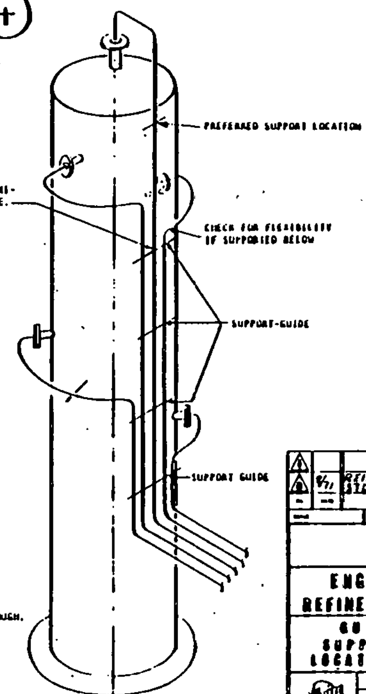
GUIDE FOR DESIGNING SUPPORTS FOR RADIALLY LOCATED LINES FROM COLUMNS

STD.	M-600	0



SUPPORT GUIDE #1 (ALTERNATE OR ADDITIONAL BRACKETS SHOWN DOTTED)

SUPPORT GUIDE #2



SUPPORT GUIDE #1

THIS TYPE OF SUPPORT USING RADIAL BRACKETS IS USED ON LARGE DIAMETER VESSELS AND HEATERS WITH PIPES LINED UP AS SHOWN. ITS MAIN DISADVANTAGE IS DUE TO THE SMALL LOADS THE VESSEL OR HEATER SHELL CAN TAKE WITH RADIALLY LOCATED BRACKETS. THE ALLOWABLE LOADS MUST FOLLOW THE TABLES SHOWN IN "LOCAL STRESSES IN CYLINDRICAL SHELLS". FOR VESSELS 9'-6" DIAMETER AND OVER, RING SEGMENTS ARE NORMALLY REQUIRED TO PREVENT OVERSTRESSING THE SHELL. THE OTHER DISADVANTAGES ARE SHARED WITH THE #2 SUPPORT. AMONG THEM ARE (1) THEY ARE LOCATED AT APPROXIMATELY EQUAL VERTICAL DISTANCES ON THE VESSEL AND THEREFORE, BECAUSE THEY MAY SUPPORT MORE THAN ONE LINE PER SUPPORT, THE SUPPORT LOCATION MAY NOT BE THE BEST FOR A PARTICULAR LINE. THIS COULD REQUIRE ADDITIONAL FLEXIBILITY IN THE LINE, WHICH MEANS ADDITIONAL PIPE ELBOWS. (2) THEY REQUIRE A CONSIDERABLE SEGMENT OF THE VESSEL PERIMETER ALLOTTED TO PIPING AND FREE OF PLATFORMS. THIS IS NOT A DISADVANTAGE, BUT SHOULD BE STANDARD PRACTICE EXCEPT THAT LINES LOCATED CONCENTRICALLY AND CLOSE TO VESSEL COULD PENETRATE THE PLATFORM.

SUPPORT GUIDE #2

THIS TYPE OF SUPPORT USING TANGENTIAL BRACKETS IS MOST ADAPTABLE TO SMALL DIAMETER VESSELS AND IS LIMITED IN LOADS BY THE SUPPORTING MEMBERS THEMSELVES AND THE WELDS ATTACHING THEM TO THE VESSEL.

CONCLUSIONS:

THESE SUPPORTS ARE SATISFACTORY FOR SMALL DIAMETER VESSELS WHERE TANGENTIAL BRACKETS MAY BE USED OR WHEN THE VESSEL SHELL IS THICK ENOUGH. FOR LARGE DIAMETER VESSELS OR WHERE LINES REQUIRE EXCESSIVE PIPING AND ELBOWS TO GAIN THE REQUIRED FLEXIBILITY, THE LINES SHOULD BE ROUTED CONCENTRICALLY AS SHOWN ON DWG. M-600.

NOTE:

SEE M-600 FOR WELDING TO STRESS RELIEVED VESSELS.

1	9/71	REISSUED AS ENGR'G. STD. WAS L-601	

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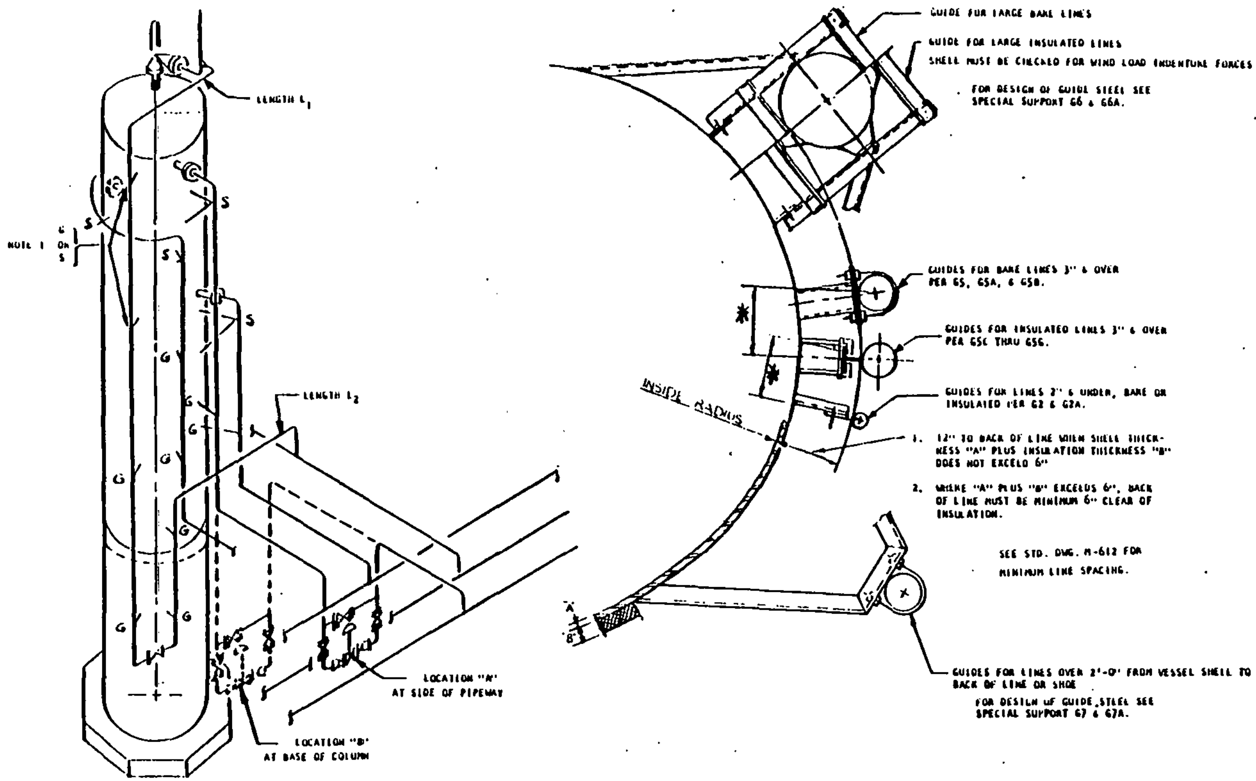
ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

GUIDE FOR DESIGNING SUPPORTS FOR TANGENTIALLY LOCATED LINES FROM COLUMNS

STD.	M-601	0



GUIDES SHOWN ARE TYPICAL FOR RADIALLY LOCATED LINES. STANDARD VERTICAL SPACINGS ARE SHOWN IN TABLE ON THE STANDARD GUIDE DETAILS EXCEPT FOR THE LOCATION OF THE BOTTOM GUIDE WHICH IS SHOWN ON DRAWING M-600.

NOTE 1

THE LOCATION OF THE SUPPORT FOR A RELIEF PURGE LINE IS ALMOST ALWAYS CRITICAL FOR THE FOLLOWING REASONS:

(1) THE RISER FROM THE VALVE NEAR GRADE IS USUALLY AT AMBIENT TEMPERATURE WHICH MEANS BELOW FREEZING IN SOME PLACES IN THE WINTER BECAUSE THE PURGING OPERATION IS NOT FREQUENT.

(2) THE VESSEL SHELL MAY BE HOT OVER MOST OF ITS LENGTH RESULTING IN CONSIDERABLE EXPANSION FROM SKIRT TO CONNECTION TO THE RELIEF VALVE.

THE LOCATION OF THE SUPPORT THEN MUST BE SELECTED SO THAT LENGTH L_1 WILL TAKE THE VESSEL GROWTH ABOVE THE SUPPORT AND LENGTH L_2 WILL TAKE THE VESSEL GROWTH BELOW THE SUPPORT. IF NO LOCATION CAN BE FOUND, EITHER OR BOTH LENGTHS L_1 AND L_2 MUST BE INCREASED TO SUIT OR AN EXPANSION LOOP PROVIDED.

CONTROL VALVE ASSEMBLY LOCATIONS

LOCATION "A" IS PREFERABLE BECAUSE THE HORIZONTAL LINE RUN FROM COLUMN TO THE VALVE ASSEMBLY IS USUALLY LONG ENOUGH TO MAKE SPRING SUPPORTS UNNECESSARY. IN POSITION "B" A DOUBLE SPRING SUPPORT IS USUALLY REQUIRED WHEN THE VESSEL IS HOT AND THE LINE AT THE LOW TEMPERATURES COMMON TO RELIEF LINES. THE DOUBLE SPRING REQUIRES A HEIGHT ABOVE GRADE TO CENTER OF CONTROL VALVE OF ABOUT 3'-0".

1/71	REISSUED AS ENG'G. STD. WAS L-602	

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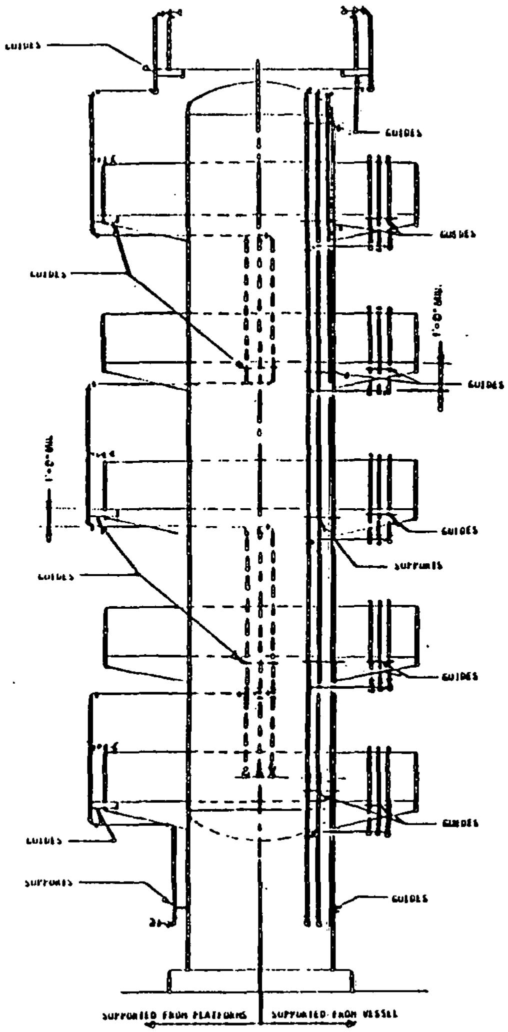
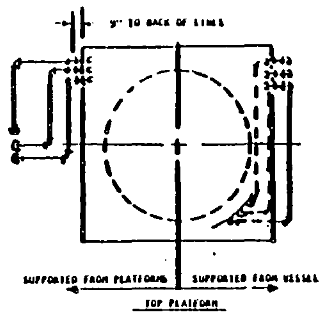
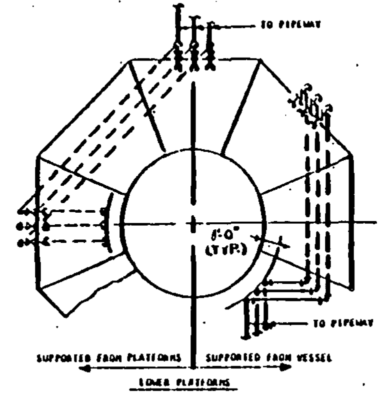
GUIDE FOR DESIGNING GUIDES FOR RADIALLY LOCATED LINES FROM COLUMNS

STD. M-602 0



FOR GUIDES. USE STANDARD DWGS. 62, 62A, OR 62B.
FOR SUPPORTS: USE STANDARD DWGS. 813 813A, or 813B.





SUPPORTING AND GUIDING LINES FROM VESSEL

THIS METHOD IS PREFERRED BECAUSE THE SUPPORTS CAN BE LOCATED ON THE VESSEL WHICH IS CAPABLE OF TAKING THE SUPPORT LOADS AND BY SUPPORTING ABOUT THE MID POINT OF THE VESSEL, THE BRANCHES TO THE PLATFORM OR RUNS TO THE PIPEWAY ONLY HAVE TO BE FLEXIBLE ENOUGH FOR HALF THE TOTAL VESSEL GROWTH. THE LINES ARE GUIDED ABOVE AND BELOW THE SUPPORT AT STANDARD INTERVALS. TO GIVE RIGIDITY TO THE HOSE CONNECTIONS THE FIELD FASTENS EACH HOSE CONNECTION TO THE PLATFORM HAND RAIL. BECAUSE OF THIS, GUIDES ONLY SHOULD BE PROVIDED FOR THE RISERS FROM THE UNDERSIDE OF THE PLATFORMS. UTILITY LINES BEING SMALL AND LOCATED CLOSE TO SHELL CAN PENETRATE PLATFORMS WITHOUT BLOCKING THEM.

SUPPORTING AND GUIDING LINES FROM PLATFORMS

THIS IS THE LEAST DESIRABLE METHOD OF SUPPORTING UTILITY LINES AND SHOULD BE EMPLOYED ONLY AS A LAST RESORT. BESIDES REQUIRING MORE PIPE AND FITTINGS IT MUST BE REMEMBERED THAT THE PLATFORMS ARE NOT DESIGNED FOR PIPE LOADS AND MAY REQUIRE STRENGTHENING.

1	1/71	REISSUED AS ENGINEERING STD. WAS L-503				

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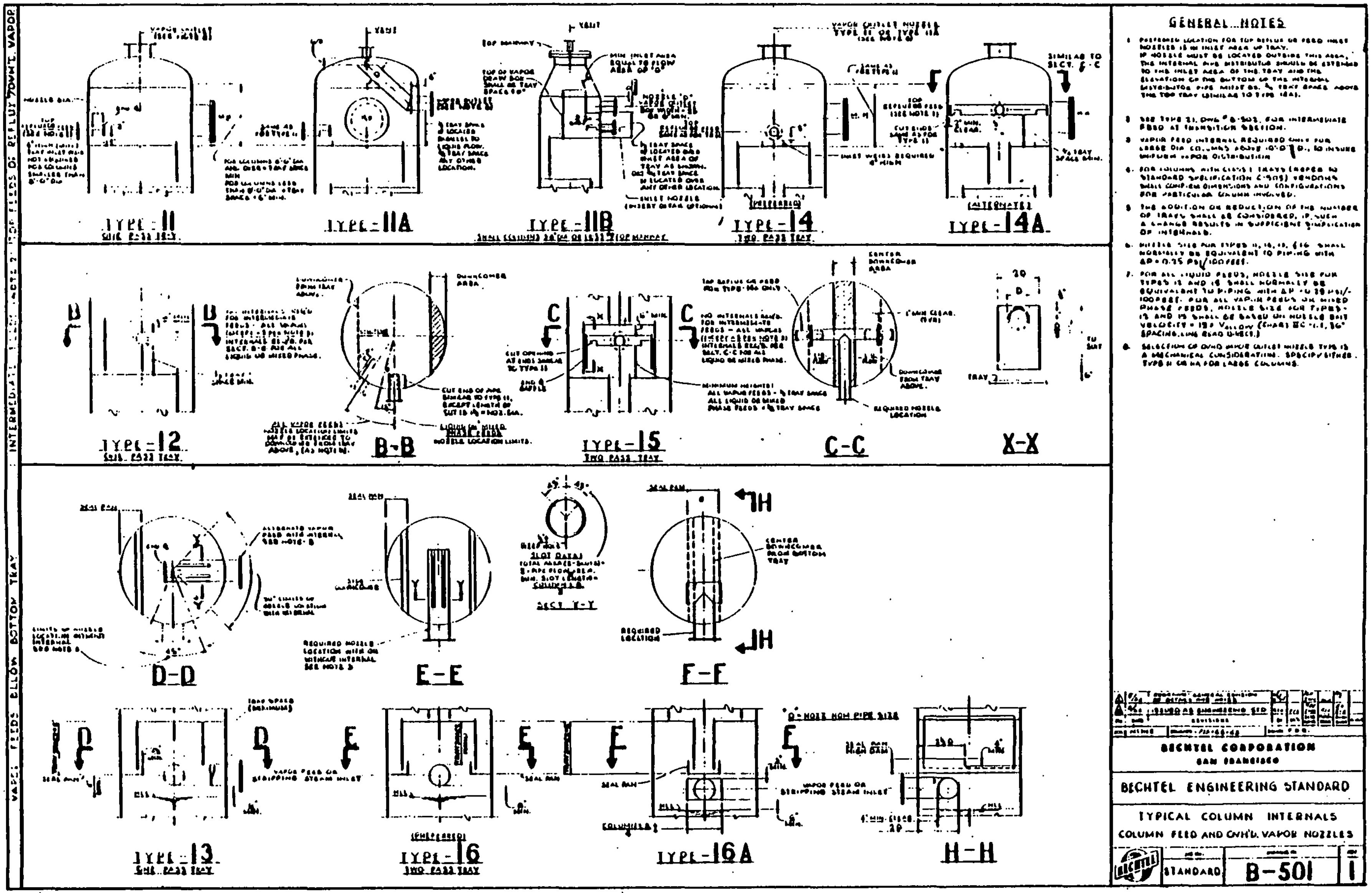
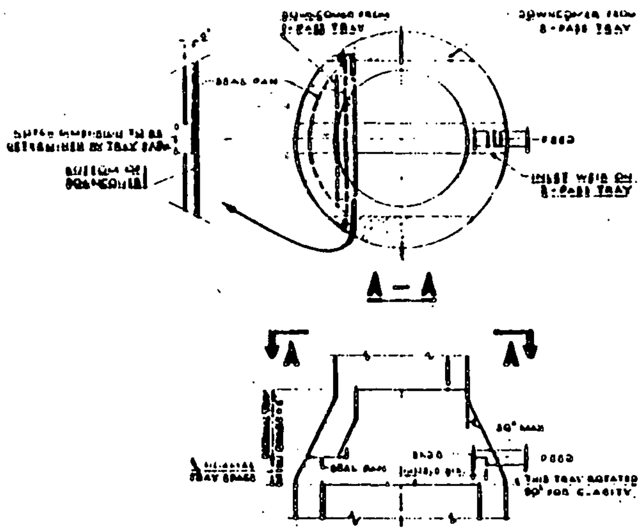
GUIDE FOR DESIGNING SUPPORTS FOR UTILITY LINES FROM VESSEL AND PLATFORMS

STD.	M-603	0

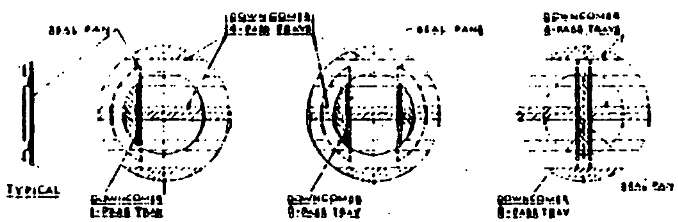
Specification No. 14222-L-4 Rev. 2 21 of 43





TYPE 21

ONE-PASS TO TWO-PASS TRAY
(WSIDE DOWNCOMERS)
(SEE NOTE 1)



TYPE 21-A
1-PASS TO
4-PASS (W/CENTER & SIDE D.C.)

TYPE 21-B
2-PASS (W/SIDE D.C.) TO
4-PASS (W/CENTER & SIDE D.C.)

TYPE 21-C
2-PASS (W/CENTER D.C.) TO
4-PASS (W/CENTER & SIDE D.C.)

GENERAL NOTES

1. TRANSITION FROM 1-PASS TO 2-PASS TRAY (WITH CENTER DOWNCOMER) CAN BE ACCOMPLISHED WITH THE ADDITION OF A TRANSITION TRAY, BUT SHOULD BE AVOIDED WHERE POSSIBLE.
2. FOR COLUMNS WITH CLASS 1 TRAYS (REFER STANDARD SPECIFICATION C-505), VENDORS SHALL CONFIRM DIMENSIONS AND CONFIGURATIONS FOR PARTICULAR COLUMN INVOLVED.

ISSUED AS ENGINEERING STANDARD

NONE

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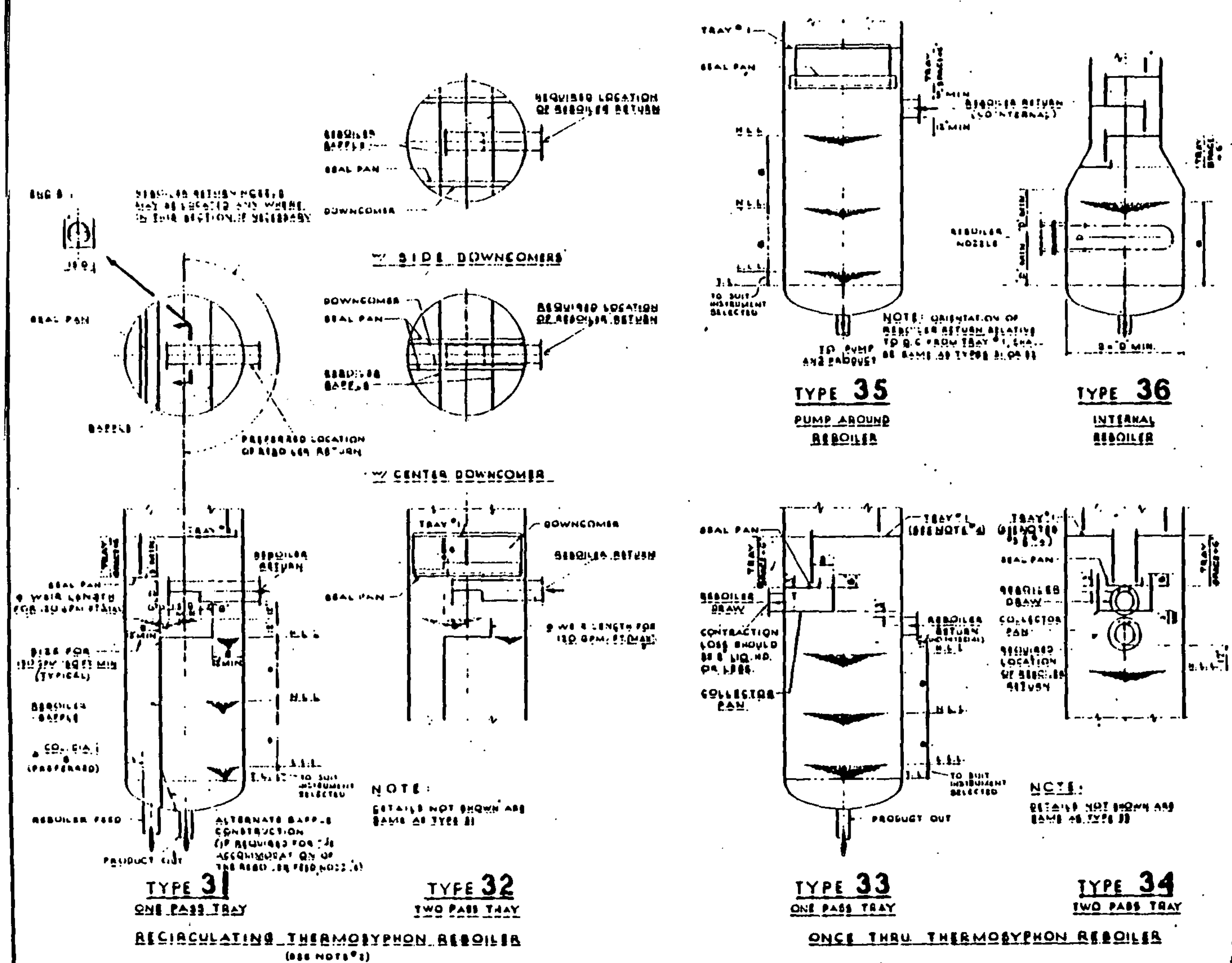
TYPICAL COLUMN INTERNALS
SHEET 2 (TRAY TRANSITION SECTIONS)

STANDARD B – 502



GENERAL NOTES

1. DIMENSION "a" TO BE PROVIDED ON PROCESS SKETCH FORM 80.
2. MIN. DIAMETER OF COLUMN FOR TYPES 31 AND 32 REBOILERS SHALL BE 4'-0".
3. TWO PASS TRAY WITH OUTSIDE DOWNCOMERS SHALL NOT BE USED ON TRAY #1 FOR TYPE 34, EXCEPT IN THE CASE WHERE TWO PARALLEL REBOILERS ARE REQUIRED.
4. CAPS FOR TRAY #1, TYPES 33 AND 34, SHALL BE NON-LEAKING TYPE.
5. FOR COLUMNS WITH GLASS I TRAYS (REFER STANDARD SPECIFICATION C-505), VENDORS SHALL CONFIRM DIMENSIONS AND CONFIGURATIONS FOR PARTICULAR COLUMN INVOLVED.

	ADDED ELL W/NOTE
	ISSUED AS ENGINEERING STANDARD
NONE	

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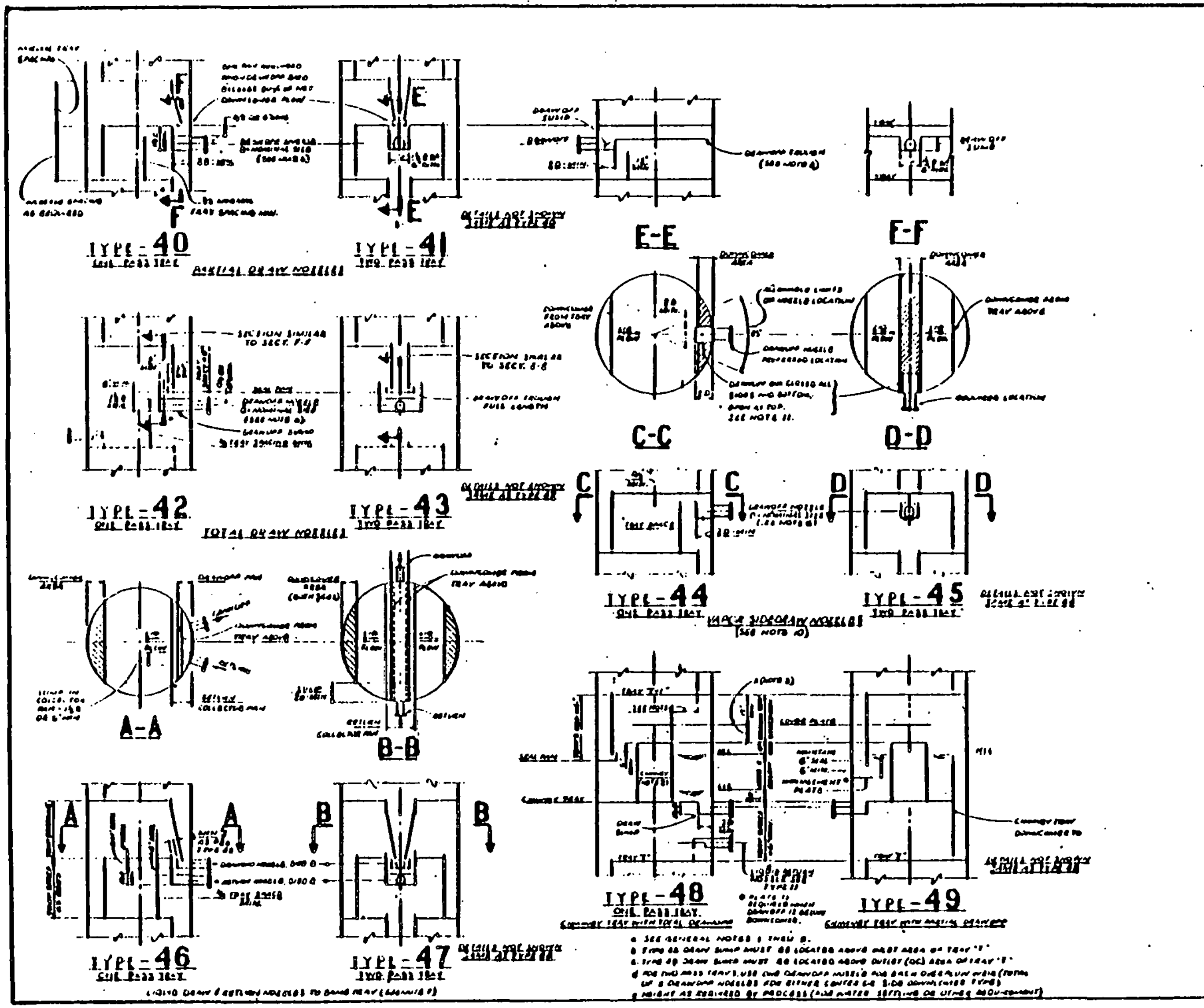
BECHTEL ENGINEERING STANDARD

TYPICAL COLUMN INTERNALS
SHEET #3 (REBOILER DETAILS)

STANDARD B-503 1



GENERAL NOTES

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BECHTEL ENGINEERING STANDARD

TYPICAL COLUMN INTERNALS
COLUMN DRAWOFF DETAILS

	STANDARD	B-504	0

FLANGES

TYPE	LIMITATIONS	SPECIFIC REQUIREMENTS
FORGED WELDING NECKS WITH INTEGRAL REINFORCING	NONE	NONE
LONG WELDING NECKS	NONE	ATTACHMENT TO VESSEL PER CODE FIG. UW-16.1 (g), (h), (m) OR (o)
WELDING NECK FLANGES	NONE	BORE SHALL MATCH I.D. OF NOZZLE NECK
SLIP-ON FLANGES	NOT ACCEPTABLE FOR : a. ANSI FLANGE RATINGS OF 400# AND HIGHER b. LOW TEMPERATURE SERVICE (MINUS 20° F. AND LOWER) c. LETHAL SERVICE	a. WELD PER CODE FIG. UA-48 (3) b. PROVIDE ¼" MAX. PIPE TAP TELL TALE HOLE IN FLANGE HUB. (SEE NOTE 6C)
PLATE FLANGES	NOT ACCEPTABLE FOR : a, b, c. SAME AS NOTED FOR SLIP-ON FLANGES d. NOZZLE SIZES 24" AND SMALLER	a. WELD PER CODE FIG. UA-48 (a) b. PROVIDE ¼" MAX. PIPE TAP TELL TALE HOLE IN FLANGE. (SEE NOTE 6C) c. COMPLETE DETAILS AND DESIGN CALCULATIONS TO BE SUBMITTED FOR APPROVAL PRIOR TO FABRICATION.

BLIND FLANGES

MINIMUM THICKNESS FOR BLIND FLANGES SHALL BE EQUAL TO THE SMALLER OF THE FOLLOWING :

a. STANDARD THICKNESS PER ANSI - B16.5

b. CALCULATED THICKNESS PER CODE PARA. UG-34 PLUS ONE HALF THE CORROSION ALLOWANCE SPECIFIED FOR THE VESSEL WALL.

(SELLER SHALL SUBMIT CALCULATIONS FOR REVIEW)

MINIMUM THICKNESS (t_n) FOR NOZZLE AND MANWAY NECKS (SEE NOTE 8a)

(A) NECK THICKNESSES PROVIDED SHALL NOT BE THINNER THAN THE SMALLER OF : a. THICKNESS OF ADJACENT VESSEL WALL. b. THICKNESS SHOWN IN TABLE BELOW.

(B) MINIMUM PIPE THICKNESSES SHOWN = NOMINAL PIPE THICKNESS LESS 12½ PERCENT (MILL TOLERANCE)
NECK CORROSION ALLOWANCE SHOWN = MINIMUM THICKNESS OF PIPE SCHEDULE LISTED MINUS THE MINIMUM THICKNESS OF STANDARD WALL PIPE.

(C) PLATE NECKS SHALL BE DOUBLE BUTT WELDED WITH RADIOGRAPHY AS SPECIFIED FOR ADJACENT VESSEL SECTION.

SPECIFIED VESSEL CORROSION ALLOWANCE	NECK TYPE		NOZZLE SIZE 24"	20"	18"	16"	14"	12"	10"	8"	6"	4"	3"	2"	1½"	1"
1/16"	PIPE	SCHEDULE	X.S.	30 - X.S.	30	40 - X.S.	40	X.S.	60 - X.S.	60	80 - X.S.	80 - X.S.	80 - X.S.	80 - X.S.	80 - X.S.	80 - X.S.
	PIPE	MINIMUM THICKNESS	.438"	.438"	.383"	.438"	.383"	.438"	.438"	.355"	.378"	.295"	.262"	.191"	.175"	.157"
	NECK CORROSION ALLOWANCE (MIN.)		.110"	.110"	.055"	.110"	.055"	.110"	.119"	.073"	.133"	.088"	.073"	.056"	.048"	.041"
1/8"	PIPE	SCHEDULE	X.S.	30 - X.S.	X.S.	40 - X.S.	X.S.	X.S.	60 - X.S.	80 - X.S.	80 - X.S.	120	160	160	160	160
	PIPE	MINIMUM THICKNESS	.438"	.438"	.438"	.438"	.438"	.438"	.438"	.438"	.378"	.383"	.383"	.300"	.246"	.219"
	NECK CORROSION ALLOWANCE (MIN.)		.110"	.110"	.110"	.110"	.110"	.110"	.119"	.156"	.133"	.176"	.194"	.165"	.119"	.103"
3/16"	PIPE	SCHEDULE	30	40	40	60	60	60	80	100	120	120	160	160	XXS	XXS
	PIPE	MINIMUM THICKNESS	.492"	.519"	.492"	.574"	.519"	.492"	.519"	.519"	.492"	.383"	.383"	.300"	.350"	.313"
	NECK CORROSION ALLOWANCE (MIN.)		.164"	.191"	.164"	.246"	.191"	.164"	.200"	.237"	.247"	.176"	.194"	.165"	.223"	.197"
1/4"	PIPE	SCHEDULE	40	60	60	60	80	80	100	100	120	160	XXS	XXS	XXS	XXS
	PIPE	MINIMUM THICKNESS	.601"	.710"	.656"	.574"	.656"	.601"	.629"	.519"	.492"	.465"	.525"	.382"	.350"	.313"
	NECK CORROSION ALLOWANCE (MIN.)		.273"	.382"	.328"	.246"	.328"	.273"	.310"	.237"	.247"	.258"	.336"	.247"	.223"	.197"
ALL	PLATE NECKS SEE NOTE (C) ABOVE		3/8" PLUS SPECIFIED VESSEL CORROSION ALLOWANCE						PLATE NECKS NOT ACCEPTABLE FOR NOZZLE SIZES 10" AND SMALLER							

REINFORCEMENT

(A) REINFORCING AREA PROVIDED EXCLUSIVE OF THAT INHERENT IN THE NOZZLE NECK AND VESSEL WALL SHALL NOT BE LESS THAN THAT PROVIDED BY PADS SIZED IN ACCORDANCE WITH TABLE BELOW.

(B) PAD SIZES SHOWN BELOW ARE BASED ON PIPE OR PLATE NOZZLE NECKS. THE SELLER SHALL SUBMIT DESIGN CALCULATIONS FOR NOZZLE NECKS WITH INTEGRAL REINFORCING FOR BUYER'S APPROVAL. DESIGN SHALL SATISFY THE FOLLOWING CONDITIONS :
1. CODE REQUIREMENTS
2. DESIGN FOR 65% OF THE HYDROSTATIC TEST PRESSURE AT NOZZLE WHEN NEW.

(C) PAD SIZES SHOWN FOR HEADS IN TABLE BELOW APPLY ONLY TO OPENINGS AND REINFORCEMENT LOCATED ENTIRELY WITHIN A CIRCLE THE CENTER OF WHICH COINCIDES WITH THE CENTER OF THE HEAD AND THE DIAMETER OF WHICH IS EQUAL TO 80 PER CENT OF THE SHELL DIAMETER.

REINFORCING PAD MINIMUM REQUIREMENTS

MAXIMUM NOZZLE SIZE	PAD
2"	NONE
3"	NONE WHEN t = 3/8" OR LESS; PER TABLE WHEN t IS MORE THAN 3/8"
4" & LARGER	PER TABLE

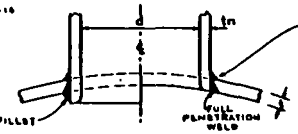
NOZZLE LOCATION	JOINT EFFICIENCY (E) OF VESSEL SECTION	OPTIONAL PAD SIZES: WITH t_r = t, R(MIN) = LARGER OF: a. O.D. OF NECK PLUS 2", b. FACTOR BELOW	OPTIONAL PAD SIZES: WITH R = 2d, t_r(MIN) = THICKER OF: a. 3/16", b. FACTOR BELOW
ALL SECTIONS OF VESSEL EXCEPT HEADS NOTED BELOW	1.00	1.9d	0.9t
	0.85	1.6d	0.6t
	0.70	1.3d	0.3t
2:1 ELLIPSOIDAL HEADS (SEE NOTE (C) ABOVE)	1.00	1.7d	0.7t
	0.85	1.5d	0.5t
	0.70	1.2d	0.2t
TORISPHERICAL HEADS WITH 6% (MIN) KNUCKLE RADIUS (SEE NOTE (C) ABOVE)	1.00	1.2d	0.2t
	0.85	PAD NOT REQUIRED	
	0.70	PAD NOT REQUIRED	
BLIND FLANGES	1.00	——	0.50t

R = OUTSIDE DIAMETER OF REINFORCING PAD
t = THICKNESS OF ADJACENT SHELL OR HEAD, NEW
t_r = THICKNESS OF REINFORCING PAD
d = INSIDE DIAMETER OF NOZZLE NECK, NEW.

ATTACHMENT TO VESSEL

ATTACHMENT - NOZZLES WITHOUT REINFORCING PADS

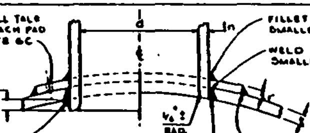
SEE CODE PAR. UW-14 FOR RADIOGRAPHIC REQUIREMENTS FOR NOZZLES LOCATED IN OR ADJACENT TO WELDED JOINTS.



REQUIREMENTS NOT SHOWN SAME AS FOR NOZZLES WITH REINFORCING PADS

OPTIONAL WELDING PER CODE FIG. UW 16.1 (c) OR (h) ACCEPTABLE

ATTACHMENT - NOZZLES WITH REINFORCING PADS



OPTIONAL WELDING PER CODE FIG. UW-16.1 (a) ACCEPTABLE

ALL DIMENSIONS ARE AS CONSTRUCTED NEW

FULL RADIOGRAPH IS REQUIRED FOR ALL VESSEL SEAMS THAT ARE COVERED BY REINFORCING PADS. LENGTH OF RADIOGRAPH EQUALS LENGTH UNDER PAD PLUS 3" AT EACH END.

FOR DEFINITIONS OF t & t_n FOR ALLOY LINED OR CLAD VESSELS SEE NOTE 8b

FLUSH TYPE CONSTRUCTION
A. ACCEPTABLE FOR ALL NOZZLES WITHOUT INTERNAL PIPING.
B. REQUIRED FOR :
1. NOZZLES LOCATED IN TOP AND BOTTOM HEADS OF VERTICAL VESSELS.
2. NOZZLES LOCATED ON OR NEAR BOTTOM ℄ OF HORIZONTAL VESSELS.
3. NOZZLES WHERE INTERNAL PROJECTION WOULD INTERFERE WITH REMOVAL OF INTERNALS.
4. VENT NOZZLES

NOTES

1. DESIGN AND FABRICATION OF ALL NOZZLES AND MANWAYS SHALL COMPLY WITH THE NOTES AND MINIMUM REQUIREMENTS OF THIS DRAWING WITH THE FOLLOWING EXCEPTIONS :
   a. WHEN OTHERWISE NOTED ON THE VESSEL DESIGN DRAWING.
   b. WHEN CODE OR JOB SPECIFICATIONS REQUIRE MORE STRINGENT MINIMUM REQUIREMENTS.
   c. WHEN WALL THICKNESS OF VESSEL (OR PORTION OF VESSEL) EXCEEDS 2", ATTACHMENT DETAILS SHALL BE AS SPECIFIED ON VESSEL DESIGN DRAWINGS.
2. THIS DRAWING APPLIES TO VESSELS CONSTRUCTED OF MATERIALS LISTED IN CODE TABLE UCS-23. IT MAY ALSO BE USED AS APPLICABLE, WHEN SPECIFIED ON VESSEL DESIGN DRAWINGS, FOR VESSELS CONSTRUCTED OF OTHER MATERIALS.
3. ALL REFERENCES TO CODE INDICATE THAT THE ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII, DIV."1" FOR PRESSURE VESSELS SHALL APPLY.
4. MATERIALS:
   a. ALL MATERIAL SHALL BE AS NOTED ON THE VESSEL DRAWING UNLESS APPROVED BY THE BUYER. IN WRITING,
   b. ALL MATERIALS (EXCEPT BOLTING) TO BE METALLURGICALLY EQUIVALENT AND MECHANICALLY COMPATIBLE WITH ADJ. VESSEL WALL.
   c. BOLTING : (STUDS REQUIRED - MACHINE BOLTS NOT ACCEPTABLE)
5. NOZZLE PROJECTIONS :
   PROJECTION FROM INSIDE OF VESSEL WALL TO FACE OF FLANGE SHALL BE :
   a. 8" FOR FLANGED CONNECTIONS 3" SIZE AND SMALLER.
   b. 10" FOR FLANGED CONNECTIONS 4" SIZE AND LARGER.
   c. PER DRAWING C-545 FOR STUB NOZZLES.
6. MISCELLANEOUS REQUIREMENTS
   a. CONTACT FACES FOR ALL FLANGES SHALL CONFORM TO THE RECOMMENDATIONS OF MSS SP-6.
   b. VESSEL FABRICATOR TO PROVIDE BLIND FLANGES AND BOLTING FOR MANWAYS AND BLINDED NOZZLES.
   c. TEST AT TELL TALE HOLES = 25 PSIG COMPRESSED AIR AND SOAP SUDS. DO NOT PLUG HOLES AFTER TEST.
7. GASKETS :
   GASKETS FOR MANWAY COVERS AND BLINDED NOZZLES WILL BE FURNISHED AND FIELD INSTALLED BY BUYER. THE SELLER'S TEST GASKETS SHALL BE REMOVED AFTER HYDROSTATIC TEST.
8. a. FOR MINIMUM THICKNESS OF NECKS (t_n) FOR SOLID ALLOY, CLAD OR LINED NOZZLES SEE SPEC. C-513.
   b. DIMENSIONS t AND t_n AS SHOWN ON THIS DRAWING SHALL INCLUDE THE THICKNESS OF INTEGRAL CLADDING BUT SHALL NOT INCLUDE THE THICKNESS OF LINING.

6	5/77	REVISED NOTE 4 AND EDITORIAL REVISIONS	E.O.					
5	2/70	DELETED A-201 & A-212 MATERIAL AT NOTE 4. REVISED NOTE 8a. ADDED NOTE FOR OUTER FILLET WELD FOR REINF. PAD. ADDED VENT NOZZLES TO FLUSH TYPE CONSTRUCTION.						

NONE

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ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

NOZZLES AND MANWAYS FOR PRESSURE VESSELS

STANDARD C-525 6

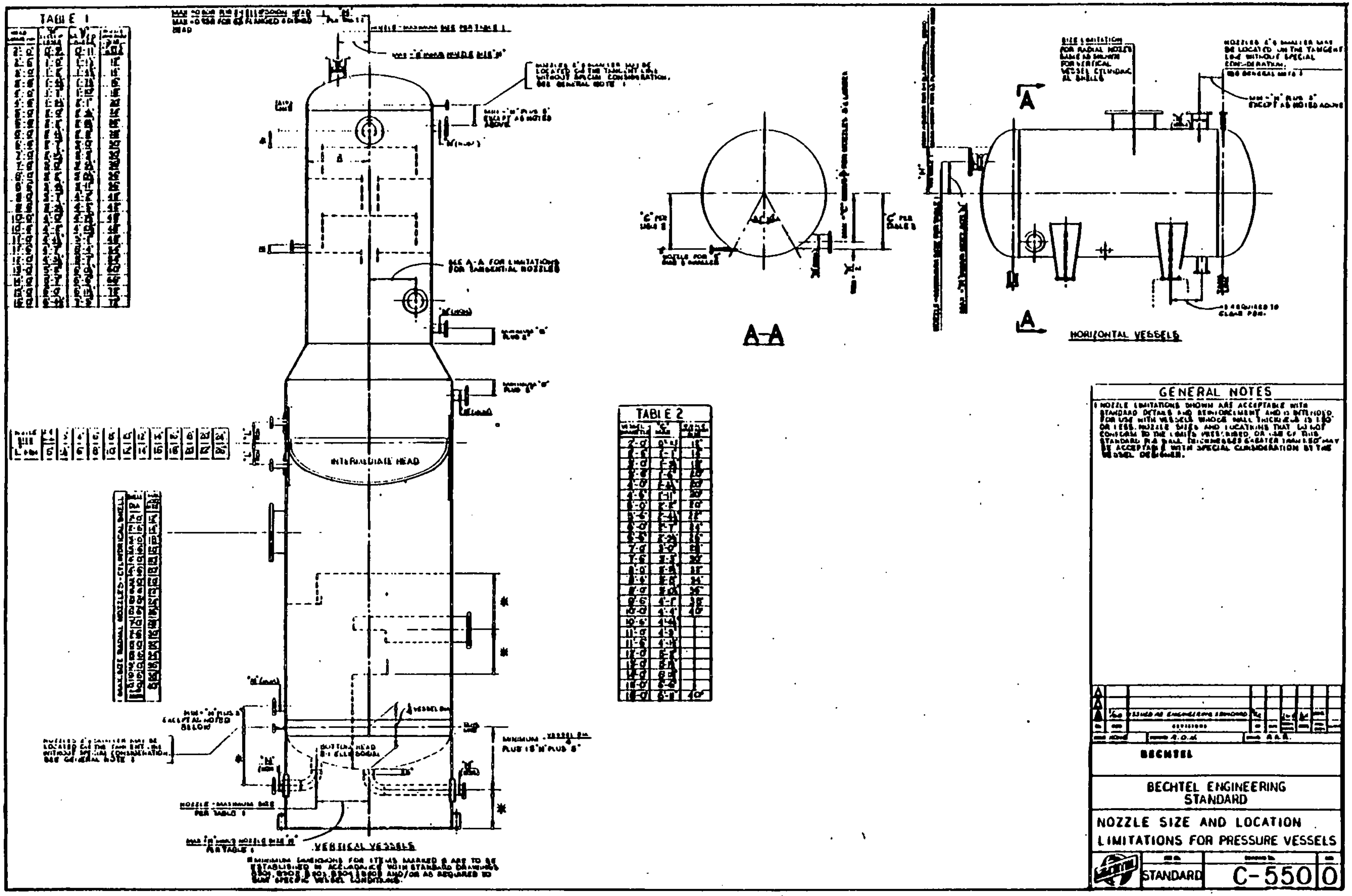
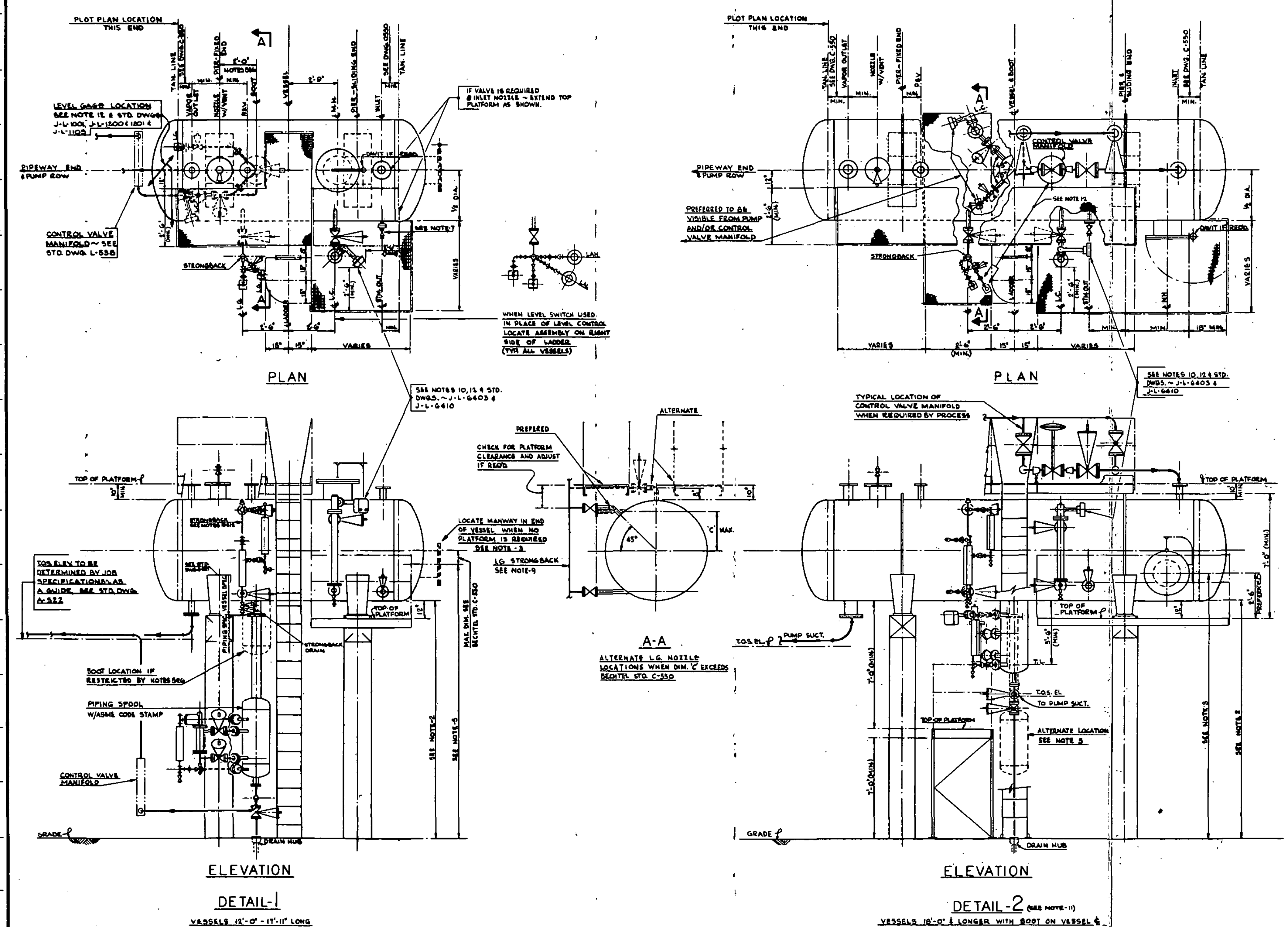


TABLE 1
TABLE 2
INTERMEDIATE HEAD
VERTICAL VESSELS
A-A
HORIZONTAL VESSELS
GENERAL NOTES
BECHTEL
BECHTEL ENGINEERING STANDARD
NOZZLE SIZE AND LOCATION LIMITATIONS FOR PRESSURE VESSELS
STANDARD
C-550
0



SIZE E

GENERAL NOTES

1. THE INTENT OF THIS DRAWING IS TO PROVIDE A GUIDE FOR STANDARD LAYOUT OF THE MORE COMMON TYPES OF HORIZONTAL DRUMS AND RELATED PIPING. ALL DIMENSIONS AND ARRANGEMENTS ARE SUBJECT TO REVIEW FOR SPECIFIC JOB REQUIREMENTS. MODIFICATIONS SHALL BE MADE TO SUIT.
2. MINIMUM VESSEL ELEVATION TO BE DETERMINED BY THE UNIT ENGINEER.
3. PLATFORMS ARE NOT REQUIRED FOR MANWAYS WHEN MANWAY CENTERLINE ELEVATION FROM GRADE IS:
   a) 15 FT. AND UNDER WITHOUT INTERNALS.
   b) 12 FT. AND UNDER WITH INTERNALS.
4. PLATFORM IS NOT REQUIRED FOR LEVEL CONTROLS WHEN CENTERLINE OF VESSEL IS 10FT. OR LESS ABOVE GRADE. PROVIDE LADDER ACCESS ONLY.
5. LOCATE BOOT AT GRADE WHEN BOTTOM OF VESSEL IS 20'-0" OR LESS ABOVE GRADE AND NOT RESTRICTED BY PUMP SUCTION HIGH WATER INTERFACE IN MAIN VESSEL OR OTHER PROCESS REQUIREMENTS.
6. DIMENSION BASED ON 18" DIAMETER BOOT.
7. INVESTIGATE ON EACH JOB, THE POSSIBILITY OF LOCATING THE VESSEL STEAM OUT NOZZLE ON THE PUMP SUCTION LINE @ THE PUMP, THERE-BY ELIMINATING A NOZZLE ON THE VESSEL AND UTILIZING GOOD ACCESSIBILITY TO STEAM OUT CONNECTION FROM GRADE.
8. SEE CROSS SECTION - TYPICAL PROCESS UNIT STD. A-522 FOR ADDITIONAL NOTES.
9. USE OF STRONG BACK SHALL BE DETERMINED FROM INDIVIDUAL JOB REQUIREMENTS.
10. TOP SIDE AND BOTTOM LEVEL CONTROLLER IS SHOWN FOR PURPOSES OF ILLUSTRATION ONLY. PREFERRED NOZZLE ARRANGEMENT TO BE DETERMINED BY INDIVIDUAL JOB REQUIREMENTS.
11. NOTES AND REFERENCES SHOWN ON DETAILS 1 AND 2 ARE THE SAME UNLESS OTHERWISE NOTED.
12. LEVEL GAGES, SHOULD BE LOCATED AS FOLLOWS:
   a) LEVEL GAGE SHOULD BE READABLE BY OPERATOR DURING MANUAL OPERATION OF RELATED CONTROL VALVE MANIFOLD.
   b) LEVEL GAGE SHOULD BE READABLE BY OPERATOR WHEN PERIODICAL ADJUSTMENTS OF LEVEL TRANSMITTER (OR CONTROLLER) ARE NECESSARY.

REFERENCE DRAWINGS

CROSS SECTION-TYPICAL PROCESS UNIT	A-522
NOZZLES AND MANWAYS FOR PRESSURE VESSELS	C-525
SADDLE SUPPORTS FOR HORIZ. VESSELS & EXCHANGERS	C-527
NOZ. SIZE & LOCATION LIMITATIONS FOR PRESS. VESSELS	C-550
SINGLE LEVEL GAGE-GEN. SERVICE-DIRECT VESSEL CONN.	J-L-1001
LEVEL GAGE-GEN. SERVICE-ON STRONGBACK	J-L-1102
LEVEL GAGE-GEN. SERVICE-ON STRONGBACK	J-L-1103
LEVEL TRANSMITTER OR CONTROLLER-TOP & BOTT. SIDE MOUNTED	J-L-6403
LEVEL TRANSMITTER OR CONTROLLER-TOP SIDE & BOTT. MOUNTED	J-L-6410
CONTROL VALVE MANIFOLDS	L-538

2		REVISED DWG. ... REFERENCES FOR LEVEL GAGES - PLAN VIEW OF DETAIL-1	
1	1/74	REVISED GEN. NOTE-3 ... REVISED TITLE BLOCK FORMAT.	
0		ISSUED AS ENG. STANDARD	

NONE | H.A. GIUSTI

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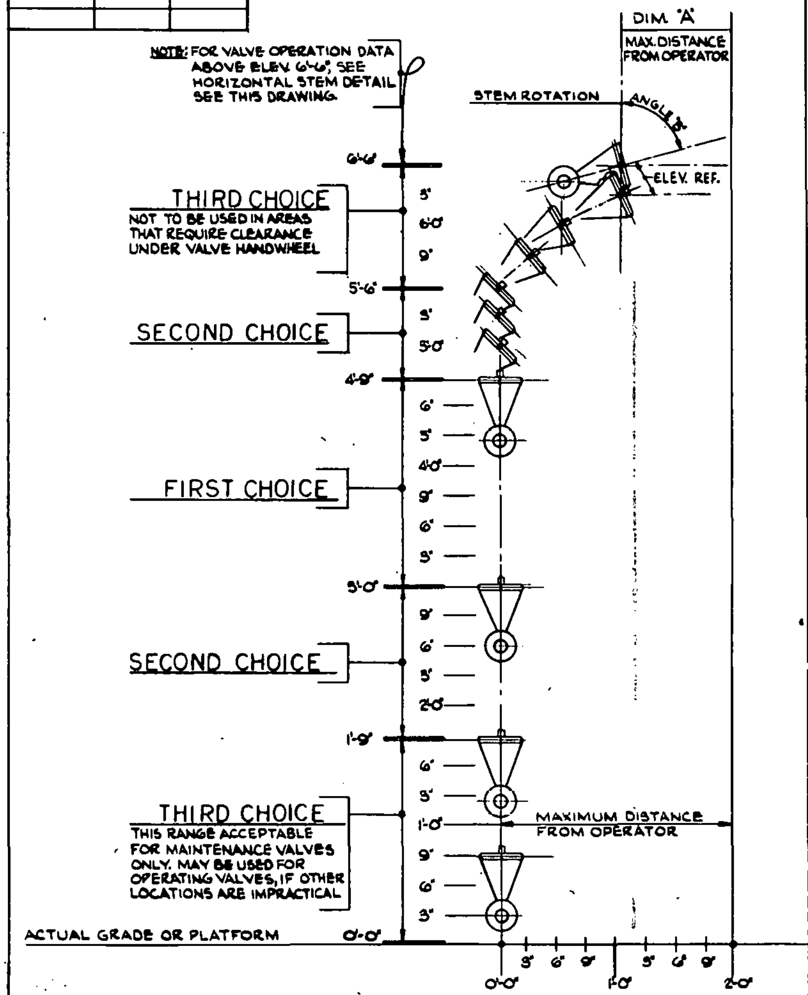
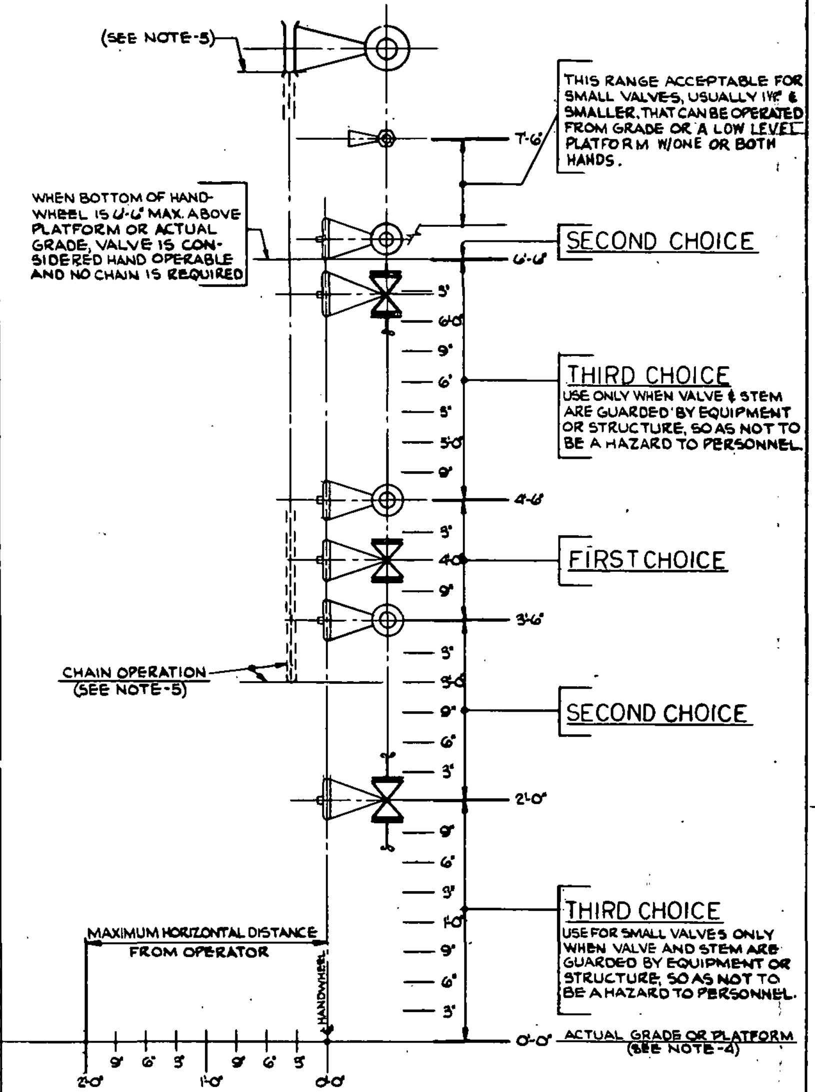
TYPICAL ORIENTATIONS FOR HORIZONTAL VESSELS

STANDARD | L-551 | 2

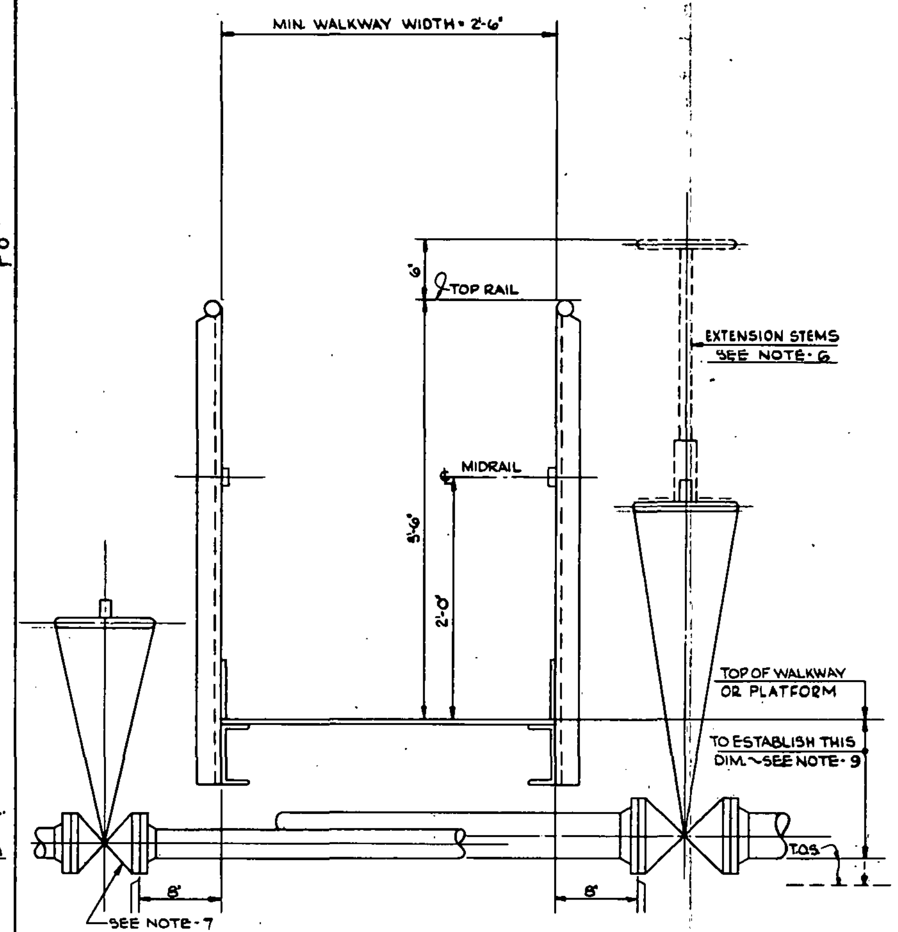
TED STEM		
ELEV	DIM 'A'	ANGLE 'B'
5'-0"	2'-0"	45°
5'-3"	2'-0"	45°
5'-6"	2'-0"	45°
5'-9"	1'-9"	50°
6'-0"	1'-6"	60°
6'-3"	1'-0	65°
6'-6"	1'-0"	75°



DETAIL-1
OPERATIONAL GUIDE FOR
VERTICAL AND TILTED VALVE STEMS



DETAIL-2
OPERATIONAL GUIDE FOR
HORIZONTAL VALVE STEMS



DETAIL-3
VALVE REQUIREMENTS
AT WALKWAYS

GENERAL NOTES

1. ALL VALVES REQUIRING ATTENTION DURING PLANT OPERATION SHALL BE OPERABLE FROM GRADE, PLATFORMS OR WALKWAYS.
2. VALVES IN CAUSTIC & ACID SERVICES SHALL BE LOCATED BELOW EYE LEVEL OR IN SUCH A MANNER, AS NOT TO PRESENT A HAZARD.
3. VALVES MAY BE ROTATED TO A HORIZONTAL POSITION WITH NO GREAT DECREASE IN MAINTENANCE CONVENIENCE, BUT SHOULD NOT BE INSTALLED WITH THE STEM DOWNWARD, SINCE THE BONNET ACTS AS A TRAP FOR ABRASIVE SEDIMENT AND WATER WHICH MAY FREEZE UNDER ADVERSE CLIMATIC CONDITIONS.
4. USE ACTUAL GRADE IN ESTABLISHING HEIGHTS OF VALVES, NOT HIGH POINT OF FINISHED GRADE OR NOMINAL GRADE.
5. WHEN BOTTOM OF VALVE HANDWHEEL ELEVATION IS GREATER THAN 6'-6" ABOVE GRADE OR PLATFORM, CHAIN OPERATION MAY BE USED. CHAIN MUST NOT HANG IN THE WALKWAY OR ACCESS AREA AND SHALL TERMINATE APPROX. 3'-0" ABOVE GRADE OR PLATFORM. CHAIN OPERATION SHALL NOT BE USED ON VALVES 1½" & SMALLER.
6. PROVIDE EXTENSION STEMS AT WALKWAYS AND PLATFORMS AS REQUIRED BY JOB INSTRUCTIONS. EXTENSION STEMS PER BECHTEL FORM Nº 107.
7. VALVES IN ADJACENT LINES, MUST BE STAGGERED ON EACH SIDE OF WALKWAY.
8. WALKWAY CLEARANCE OVER LINES SHOULD BE KEPT TO A MINIMUM. ONE SHOULD ANTICIPATE THE MAXIMUM LINE SIZE, THEN USING MINIMUM CLEARANCE FROM THIS POINT, ESTABLISH THE WALKWAY ELEVATION.
9. SAFETY REQUIRES THAT VALVES PLACED IN A HIGH POSITION (10FT. OR MORE); BE PLACED OVER A PLATFORM, RATHER THAN ADJACENT TO THEM.

No.	DATE	REVISIONS
2	12/74	DELETED ... EXTENSION STEM BRACING & NOTE BY STRESS GROUP
1	1/74	REVISED TITLE BLOCK FORMAT
0	7/69	ISSUED AS ENG. STANDARD

SCALE NONE DESIGNED H.A. GIUSTI

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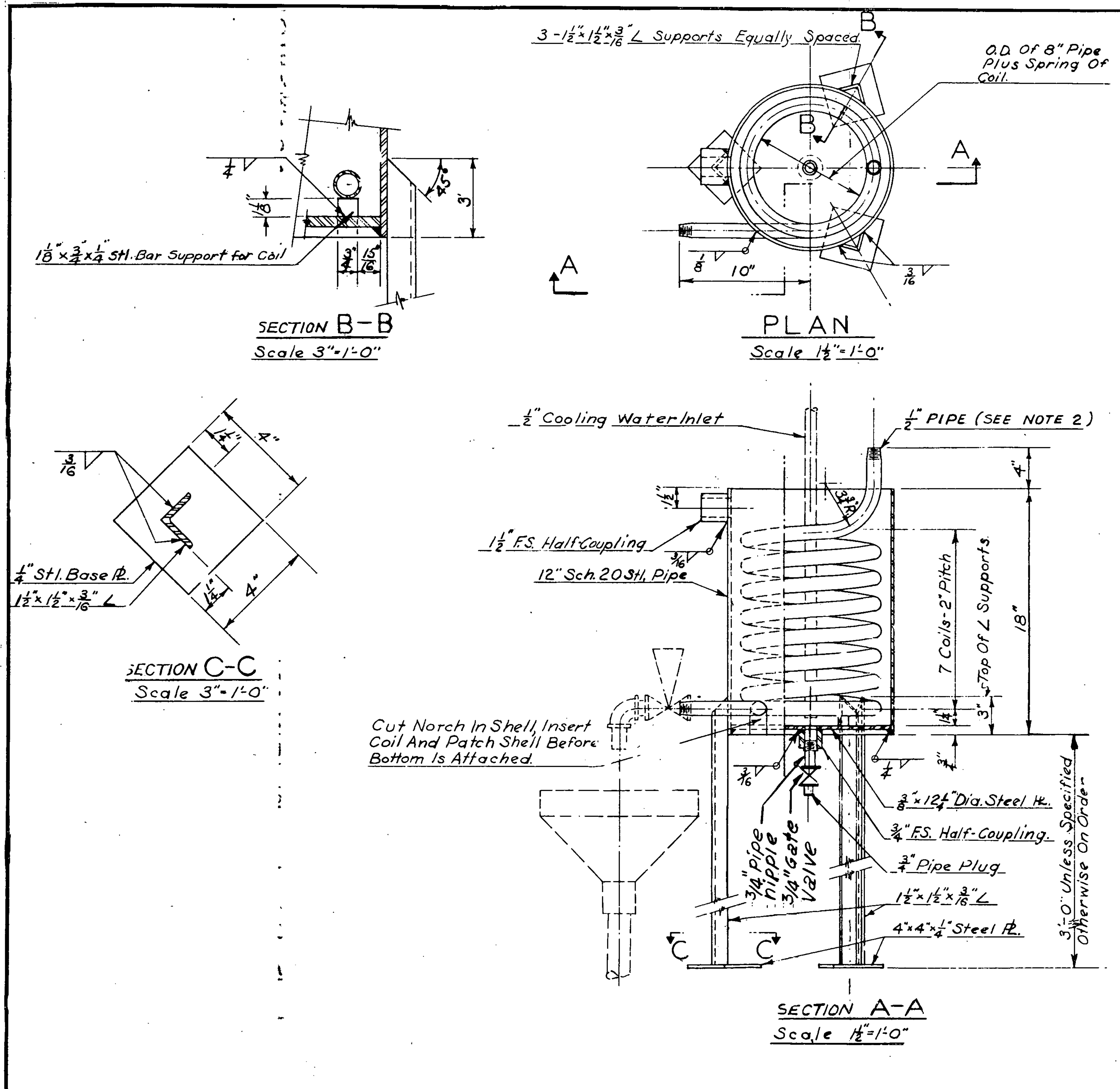
VALVE INSTALLATIONS

STANDARD L—552 REV. 2



CONSTRUCTION NOTES

1. HYDROTEST COIL TO INDIVIDUAL PIPING CLASSIFICATION HYDROSTATIC PRESSURE. HOLES MAY BE DRILLED IN BASE PLATES IN FIELD IF REQUIRED.
2. PIPE COIL AND MATERIAL TO BE SPECIFIED ON JOB M/R'S.

REFERENCE DRAWING

PIPING DETAILS FOR SAMPLE SYSTEMS L-515

No.	DATE	REVISIONS	BY	CH'K	DESIGN SUPV.	ENG'R	PROJ. ENGR.	APPR
3	8/74	REVISED TITLE & NOTE #1. ADDED PLUGGED VALVE CONN., ON BOTTOM OF SAMPLE COOLER	M.S.					RFS
2	10/29/65	NOTE 2 ADDED	SW	TAH				JL

SCALE As Noted | DESIGNED | DRAWN R.E.F. | CHIEF ENGR DWC

BECHTEL

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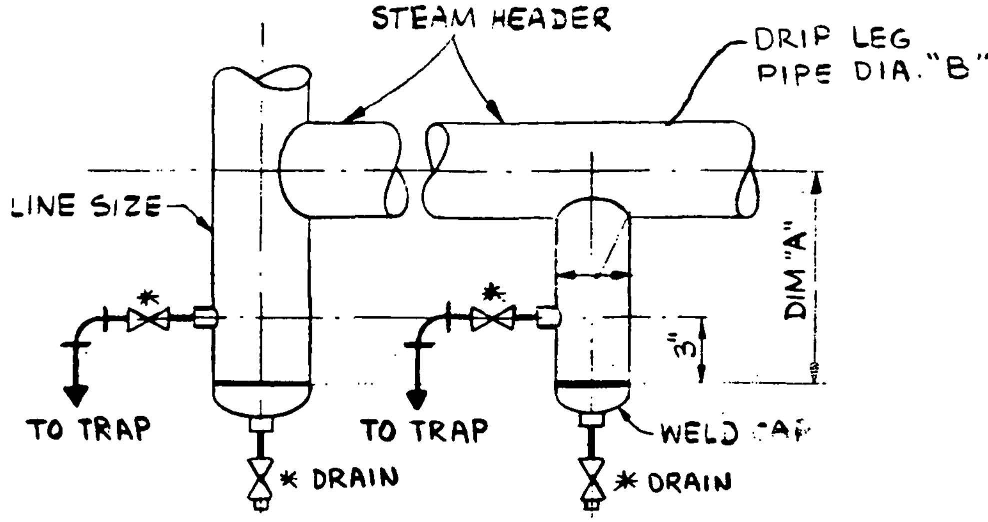
REFINERY & CHEMICAL DIVISION

STANDARD SAMPLE COOLER

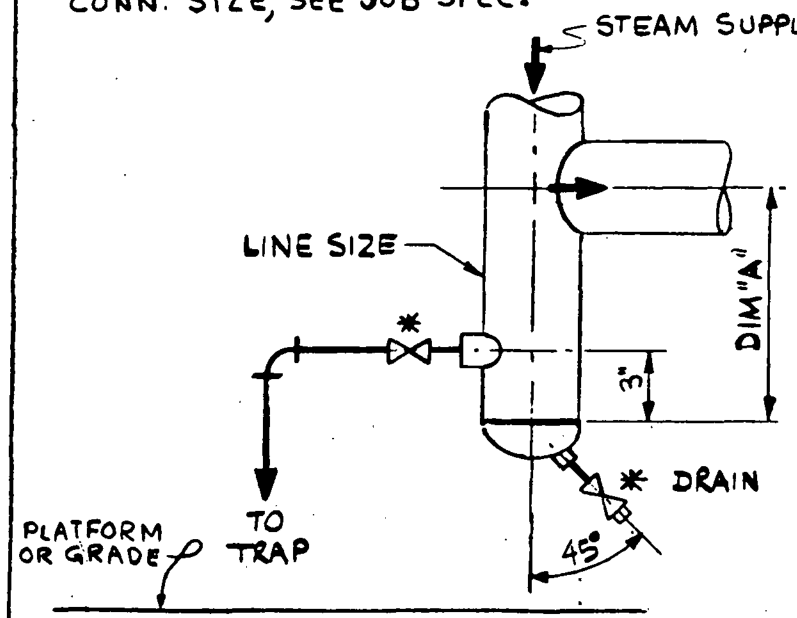
JOB No.	DRAWING No.	REV.
STD.	L-514	3

DRIP LEG DETAILS



DETAIL-1 STEAM HEADER (SEE NOTE-1)

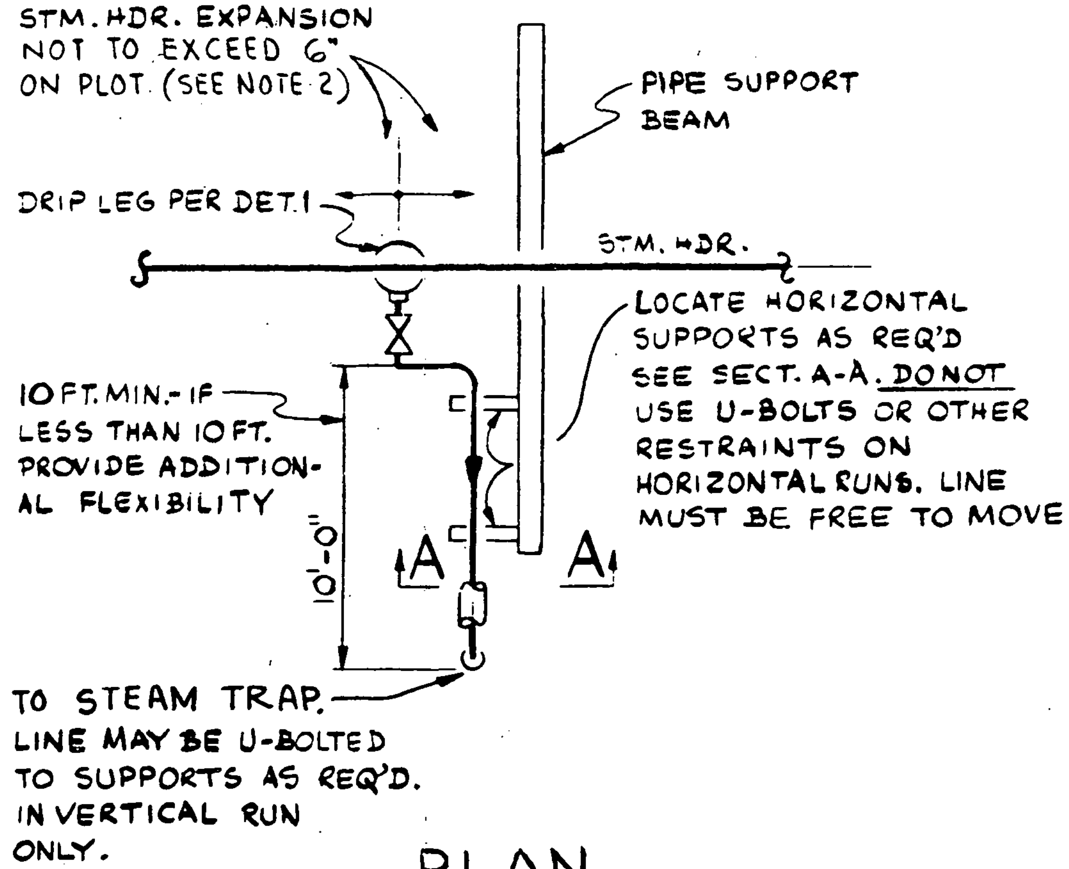
* FOR TRAP AND DRAIN CONN. SIZE, SEE JOB SPEC.



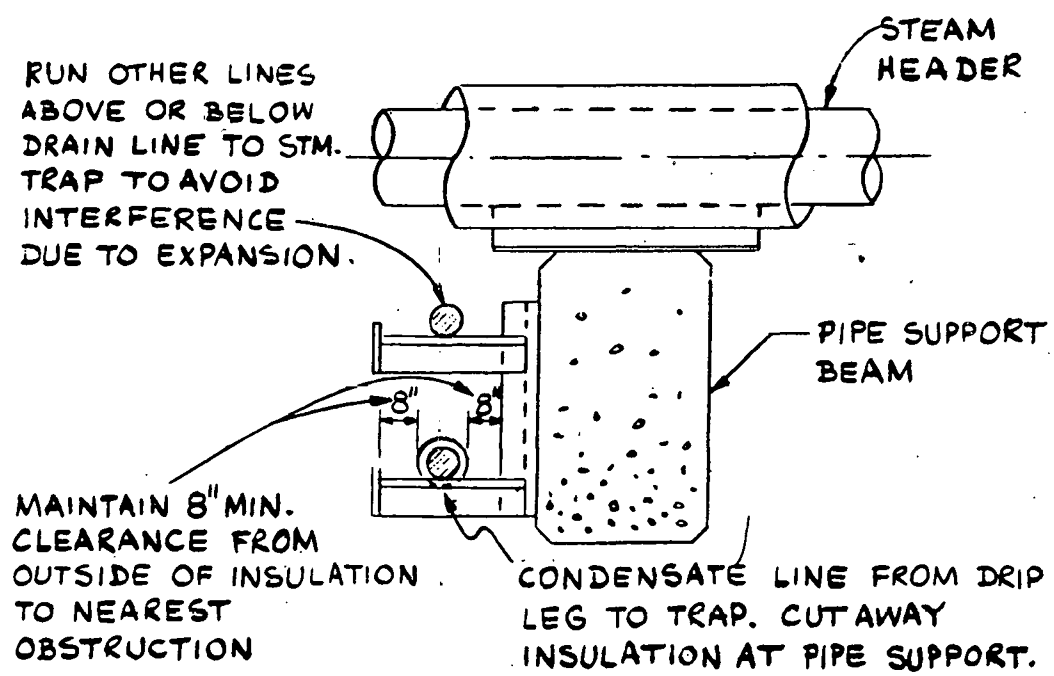
DETAIL-2 AT C.V. MANIFOLD OR STEAM INLET TO TURBINE

SIZE OF HEADER (MAIN)	DIM. "A"	DIA. "B"	SIZE OF HEADER (MAIN)	DIM. "A"	DIA. "B"
3"	12"	HDR.SIZE	14"	17"	8"
4"	13"	HDR.SIZE	16"	19"	8"
6"	14"	4"	18"	20"	10"
8"	15"	4"	20"	24"	10"
10"	16"	6"	24"	24"	12"
12"	17"	8"			

FIELD INSTALLATION GUIDE



PLAN



SECTION A-A

NOTES

1. STEAM HDRS. 2" AND SMALLER DO NOT REQUIRE DRIP LEGS AND AND SHALL DRAIN DIRECTLY TO TRAP.
2. OFFPLOT – FOR MOVEMENTS EXCEEDING 6", DETAILS WILL BE ADDED TO THE PIPING DRAWING.

No.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
6								
5	12/2/76	ADDED OWNERSHIP CLAUSE TO DWG.	L.S.	HG				
4	1/15/71	REDRAWN	T.L.	H.G.		JWS		

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

BECHTEL
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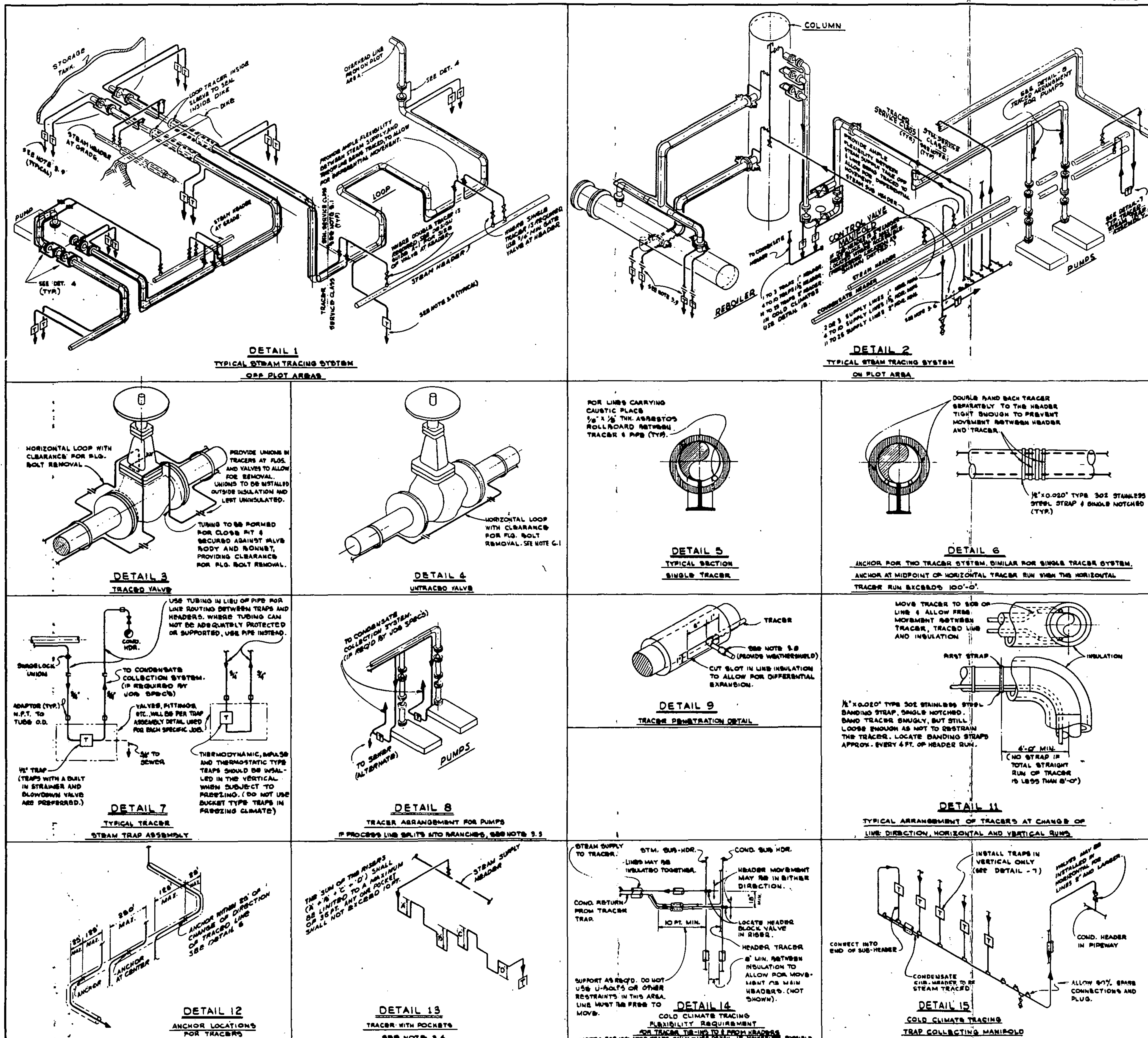
REFINERY & CHEMICAL DIVISION
ENGINEERING STANDARD

DRIP LEG DETAILS FOR STEAM LINES AND FIELD INSTALLATION GUIDE

JOB No.	DRAWING No.	REV.
STD.	L-519	5

SIZE E



GENERAL NOTES

1. MATERIALS

1.1 A SERVICE CLASS FOR STEAM TRACING MATERIALS WILL BE PREPARED INDIVIDUALLY FOR EACH PROJECT.
SEE ENGINEERING INSTRUCTION L-13 FOR PIPING MATERIAL REQUISITIONING TAKE-OFF AND CONTROL.

2. TRACER INFORMATION

2.1 INFORMATION FOR LINE AND INSTRUMENT TRACING IS CONTAINED IN THE FOLLOWING.

(A) GENERAL
D.G.-A1 - STEAM TRACING DESIGN CRITERIA (INCLUDES NUMBER OF TRACERS, TRACER SIZE, MAXIMUM LENGTH, ETC.)
E.I.-L-17 - STEAM TRACING SYSTEMS PROCEDURE.
J-5 - STEAM TRACING INSTRUMENTS
STD.DWG. L-513 - TYPICAL STEAM TRACING DETAILS USING HEAT TRANSFER CEMENT.

(B) PROJECT DOCUMENTS
LINE DESIGNATION TABLES
P&ID'S
INDEX FOR STEAM TRACED LINES
JOB INSTRUCTIONS

2.2 THE EXTENT OF TRACED LINES AND INSTRUMENTS WILL BE SHOWN ON THE MODEL, PIPING DRAWINGS AND ISOMETRICS.

3. TRACER ROUTING

3.1 THE MAXIMUM TRACER LENGTH AS SPECIFIED IN DESIGN GUIDE A-1 IS MEASURED FROM THE POINT WHERE THE TRACER FIRST CONTACTS THE LINE TO BE TRACED TO THE POINT THAT IT LEAVES AND DOES NOT INCLUDE THE STEAM SUPPLY HEADER OR THE CONDENSATE RETURN.

3.2 EACH INDIVIDUAL TRACER SHALL HAVE A SEPARATE CONNECTION TO THE STEAM SUPPLY PROGRESSING TO LOWER ELEVATIONS WITH NO BRANCH CONNECTIONS EXCEPT AS NOTED IN 3.3 AND WILL TERMINATE IN AN INDIVIDUAL TRAP.

3.3 A TRACER MAY BE SPLIT INTO TWO BRANCHES PROVIDING:

(A) THE BRANCHES DO NOT EXCEED 20 FEET EACH

(B) THE SUM OF THE MAIN TRACER AND THE BRANCH DOES NOT EXCEED THE MAXIMUM ALLOWABLE TRACER LENGTH.

(C) THE BRANCHES DO NOT CONTAIN POCKETS.

3.4 TRACER POCKETS SHOULD BE AVOIDED. HOWEVER, IF THAT IS NOT PRACTICAL, THEY SHOULD BE LIMITED TO THE EXTENT SHOWN IN DETAIL 13.

3.5 LINES REQUIRING TWO PARALLEL TRACERS MAY HAVE ONE STEAM SOURCE DIVIDED INTO TWO TRACERS TERMINATING IN ONE TRAP FOR EACH TRACER. SEE DETAIL 2 FOR MINIMUM SIZE OF LINE FOR MULTIPLE TRACERS.

3.6 HEADER AND SUB-HEADER BLOCK VALVES SHALL BE ACCESSIBLE FROM GRADE, PLATFORMS OR PORTABLE LADDERS. TRAPS SHALL BE ACCESSIBLE FROM GRADE AND PREFERABLY GROUPED IN CENTRAL LOCATIONS.

3.7 GAPS IN THE LINE TO BE TRACED SHOULD NOT EXCEED 18"

3.8 INSULATE ALL STEAM SUPPLY LINES AND ANY PORTION OF TRACER PROTRUDING OUTSIDE TRACED HEADER.

3.9 IN FREEZING CONDITIONS, THE TRAP DISCHARGE LINE RETURNING TO A CONDENSATE HEADER SHALL BE ROUTED ALONG AND INSULATED WITH A STEAM SUPPLY LINE. SEE DET. 14. STEAM TRAP MANIFOLDS ARE SYMBOLIZED BY A "T"

3.10 VALVES AND FLANGES SHALL NOT BE TRACED UNLESS SO INDICATED IN THE INDEX FOR TRACED LINES.

4. EXPANSION AND SUPPORTS

4.1 NORMALLY EXPANSION LOOPS IN TRACERS WILL NOT BE USED.

4.2 THE MAXIMUM LENGTH OF STRAIGHT TRACER RUN SHALL NOT EXCEED 250'-0"

4.3 ANY TRACER 100'-0" OR LONGER, WITHOUT CHANGE OF DIRECTION, SHALL BE ANCHORED AT ITS CENTER BY DOUBLE BANDING. SEE DETAILS 6 AND 12.

4.4 WHERE TRACED LINE CHANGES DIRECTION, THE TRACER SHALL BE ANCHORED WITHIN 25'-0" OF THE CHANGE OF DIRECTION. SEE DETAIL 12.

4.5 INSULATION SHALL BE SLOTTED AS SHOWN IN DETAIL 9 TO ALLOW FOR MOVEMENT OF TRACER.

5. TRACER LEADS

5.1 STEEL TUBING SHALL BE USED BETWEEN HEADER BLOCK AND TRACER UNLESS OTHERWISE STATED IN JOB SPECIFICATIONS. WHERE LEADS CANNOT BE ADEQUATELY PROTECTED OR SUPPORTED, PIPE SHALL BE USED INSTEAD.

6. TRACER UNIONS

6.1 WHERE UNIONS ARE PROVIDED IN TRACERS, INSTALL OUTSIDE OF INSULATION AND LEAVE UNION UNINSULATED. SEE DETAILS 3 AND 4.

NONE

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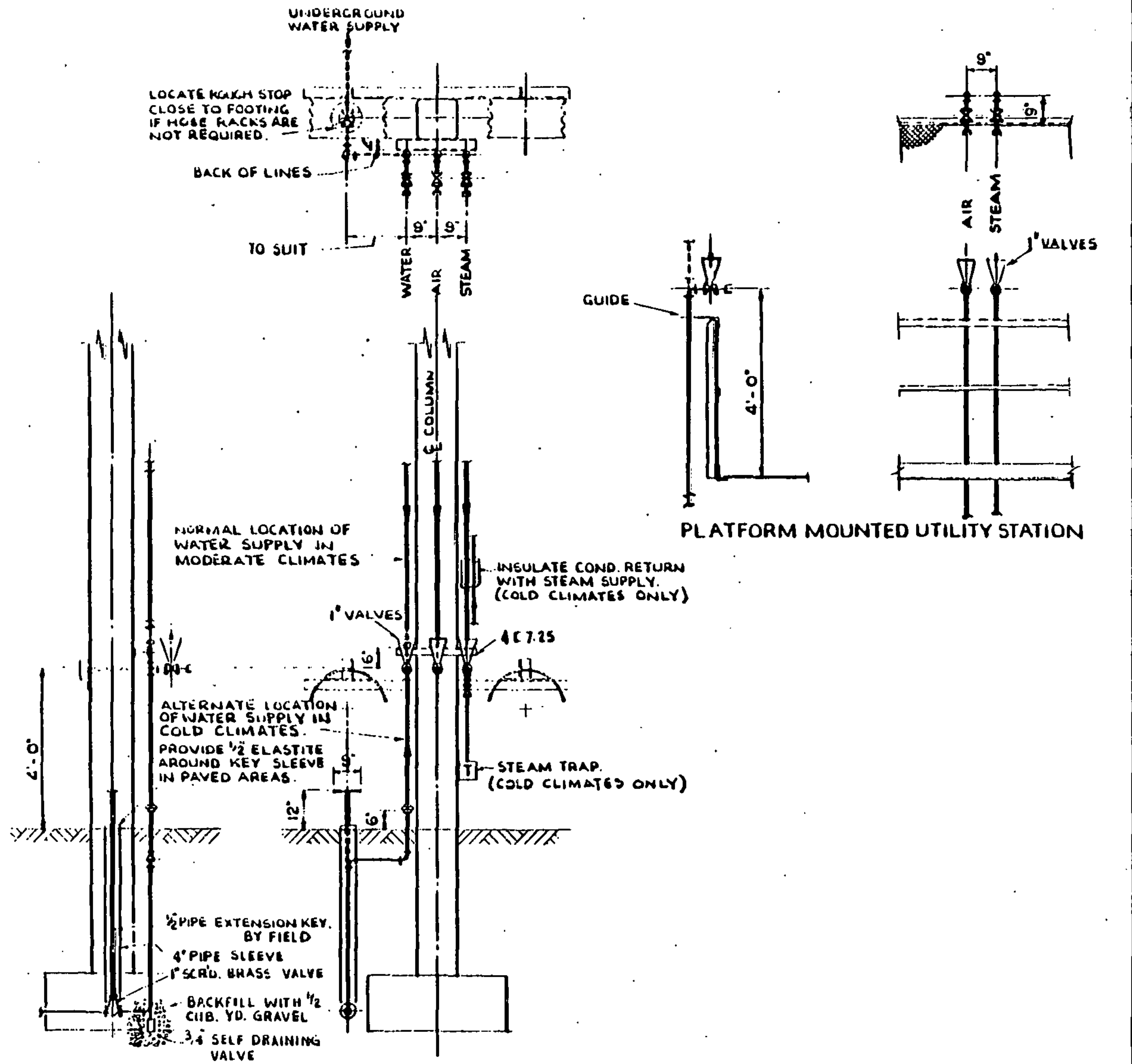
TYPICAL STEAM
TRACING DETAILS

STD. L-521 2



COLUMN MOUNTED UTILITY STATION AT GRADE.

PLATFORM MOUNTED UTILITY STATION

NOTES

1. FOR LOCATION OF HOSE STATIONS REFER TO PIPING PLANS OR MODEL
2. FOR HOSE RACK & MOUNTING DETAILS REFER TO M-541
3. FOR VALVE TYPE SEE PIPING SPECIFICATIONS

NO.	DATE	REVISIONS	BY	CH'K	DRFT. SUPV.	ENGR.	CHIEF ENGR.	CLIENT
2	11/1/65	3/4" SELF DRAINING VALVE ADD. TO UNDERGR. WATER LINE	S.W.				JL	
1	3/31/63	ISSUED AS ENG. STD.	WD					

SCALE	DESIGNED	DRAWN W. STANNARD

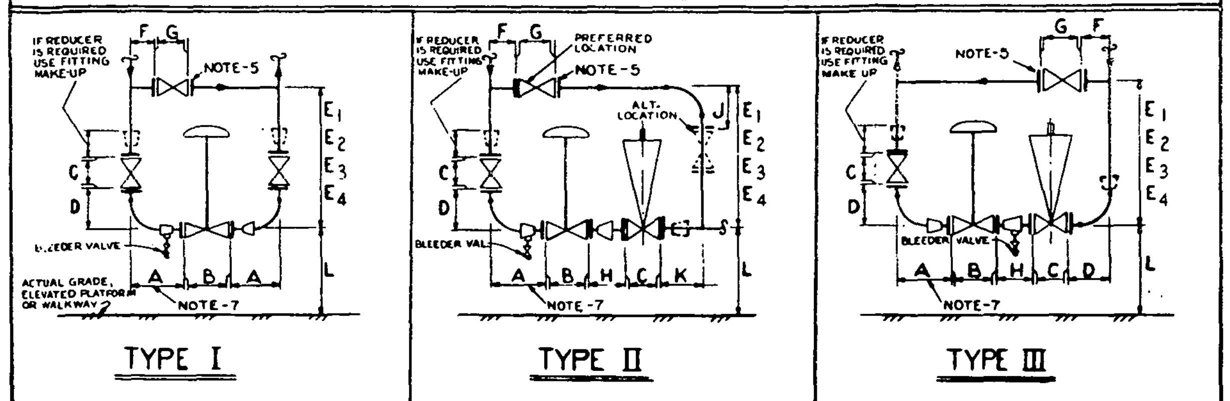
BECHTEL ENGINEERING STANDARD

UTILITY HOSE STATIONS

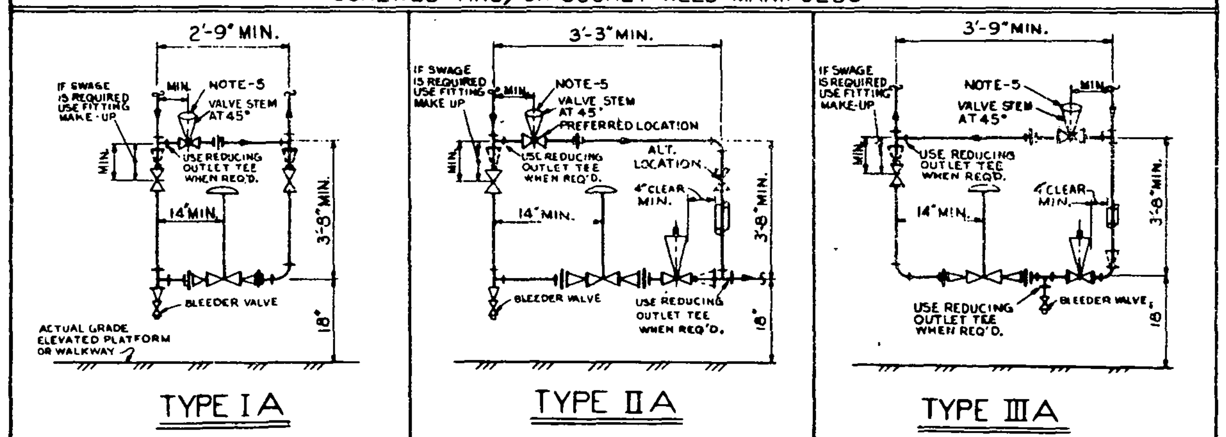
	JOB NO.	DRAWING NO.	REV.
BECHTEL	STD	L-531	2

LINE SIZE	BLOCK VA. SIZE	CONTROL VA. SIZE	BY-PASS VA. SIZE	A	B	C	D	E_1 REG.	E_2 C.FINS	E_3 HW	E_4 C.FINS HW	F	G	H	J	K	L
150# R.F. 300# CONTROL VALVE — GASKET THICKNESS WILL CONFORM WITH INDIVIDUAL PIPING CLASSIFICATION.																	
1½/2	1½	1	1½	7¾	7⅜	6½	4⅛	40½ *	43 *	45¼ *	47¾ *	6	6½	7⅜	4⅞	7⅞	18
2/3	2	1½	2	8⅞	9¼	7	5½	41½ *	44 *	46¼ *	48¾ *	7	8	8¾	5½	9⅜	18
3/4	3	2	2	10¾	10½	8	7¼	50¾ *	56¼ *	57 *	64 ▲	9	8	9	5½	10⅞	18
4/6	4	3	3	13⅜	12½	9	9	64½ ▲	64¼ ▲	64½ ▲	64½ ▲	10	9½	10⅜	7¼	14⅛	18
6/8	6	4	4	17⅞	14½	10½	12½	65 ▲	65 ▲	65 ▲	65½ ▲	12	11½	12⅜	9	16½	18
8/10	8	6	6	21⅞	18⅞	11½	16	61 ▲	64½ C.O.	67½ C.O.	71¼ C.O.	14	10½	13⅜	12½	19½	24
10/12	10	8	8	26⅜	22⅜	13	19	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	11½	15⅜	16	22	24
300# R.F. ALL VALVES — GASKET THICKNESS WILL CONFORM WITH INDIVIDUAL PIPING CLASSIFICATION.																	
1½/2	1½	1	1½	7¾	7¾	7¼	4⅜	40½ *	43 *	45¼ *	47¾ *	6	9½	7⅜	4⅞	8⅞	18
2/3	2	1½	2	8⅞	9¼	8½	5¾	41½ *	44 *	46¼ *	48¾ *	7	10½	8⅞	5¾	9⅜	18
3/4	3	2	2	10¾	10¼	11⅛	7⅝	50¾ *	56¼ *	57 *	65 ▲	9	10½	9⅜	5¾	11¼	18
4/6	4	3	3	13⅜	12½	12	9⅜	66 ▲	66 ▲	66 ▲	66 ▲	10	12½	10½	7⅜	14½	18
6/8	6	4	4	17⅞	14½	15⅞	12⅜	67 ▲	67 ▲	67 ▲	69½ C.O.	12	14	12¾	9⅜	16⅞	18
8/10	8	6	6	21⅞	18⅞	16⅛	16⅜	62 ▲	67½ C.O.	70½ C.O.	74¼ C.O.	14	15⅞	14¼	12⅝	19⅞	24
10/12	10	8	8	26⅞	22¾	18	19⅞	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	16½	16	16⅞	22¾	24
600# R.F. ALL VALVES — GASKET THICKNESS																	
1½/2	1½	1	1½	7⅞	8¼	9½	5¼	40½ *	43 *	45¼ *	47¾ *	7	9½	8⅜	5¼	8½	18
2/3	2	1½	2	9	9⅞	11½	6⅛	41½ *	44 *	46¼ *	48¾ *	7	11½	9⅞	6⅛	10	18
3/4	3	2	2	11⅛	11¼	14	8	50¾ *	56¼ *	57 *	66 ▲	9	11½	10⅛	6⅛	11⅞	18
4/6	4	3	3	13½	13¼	17	10¼	67 ▲	67 ▲	67 ▲	67 ▲	10	14	11¾	8	15⅜	18
6/8	6	4	4	18¾	15½	22	13⅜	69 ▲	69 ▲	69 ▲	69½ C.O.	12	17	14⅞	10¼	17⅞	18
8/10	8	6	6	22⅞	20	26	17½	65 ▲	68¾ C.O.	71½ C.O.	75¼ C.O.	14	22	16⅞	13⅞	21	24
10/12	10	8	8	27¼	24	31	21¼	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	26	18⅞	17½	24¼	24
300# R.J. ALL VALVES — RING JOINT GAP VARIES																	
1½/2	1½	1	1½	7⅛	8¼	8	5⅜	40½ *	43 *	45¼ *	47¾ *	7	10	8⅞	5⅜	8⅞	18
2/3	2	1½	2	8¾	9¾	9⅞	6¼	41¼ *	44 *	46¼ *	48¾ *	7	11⅞	9	6¼	9⅞	18
3/4	3	2	2	11⅛	11⅛	11¾	7⅝	50¾ *	56¼ *	57 *	65 ▲	9	11⅞	10	6¼	11⅞	18
4/6	4	3	3	13¾	13⅛	12⅞	9¼	66 ▲	66 ▲	66 ▲	66 ▲	10	13⅛	11⅛	7⅛	14¾	18
6/8	6	4	4	18¾	15⅞	16½	13¾	67 ▲	67 ▲	67 ▲	69½ C.O.	12	14⅞	13⅜	9⅞	17¾	18
8/10	8	6	6	22¾	19¼	17⅞	16¼	62 ▲	67½ C.O.	70½ C.O.	74¼ C.O.	14	16½	14⅞	13⅞	20⅞	24
10/12	10	8	8	26¾	23	18⅜	19⅞	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	17⅞	16⅞	16⅞	22⅞	24
600# R.J. ALL VALVES — RING JOINT GAP VARIES																	
1½/2	1½	1	1½	7 7/16	8¼	9½	5¼	40½ *	43 *	45¼ *	47¾ *	7	9½	8 3/16	5¼	8½	18
2/3	2	1½	2	9	9⅞	11⅝	6 3/16	41½ *	44 *	46¼ *	48¾ *	7	11⅝	9 3/16	6 3/16	10 1/16	18
3/4	3	2	2	11 3/16	11⅜	14⅛	8 1/16	50¾ *	56¼ *	57 *	66 ▲	9	11⅝	10¼	6 3/16	11 11/16	18
4/6	4	3	3	13 9/16	13⅜	17⅛	10 9/16	67 ▲	67 ▲	67 ▲	67 ▲	10	14⅛	11⅞	8 1/16	15 7/16	18
6/8	6	4	4	18 15/16	15⅝	22⅛	13 13/16	69 ▲	69 ▲	69 ▲	69½ C.O.	12	17⅛	14¾	10 9/16	17 13/16	18
8/10	8	6	6	22¼	20⅛	26⅛	17 9/16	65 ▲	68¾ C.O.	71½ C.O.	75¼ C.O.	14	22⅛	16½	13 15/16	21 1/16	24
10/12	10	8	8	27 3/16	24⅛	31⅛	21 5/16	76¾ C.O.	81 C.O.	88 C.O.	92¼ C.O.	16	26⅛	18⅞	17 9/16	24 5/16	24

FLANGED CONTROL VALVE MANIFOLDS



SCREWED AND/OR SOCKET WELD MANIFOLDS



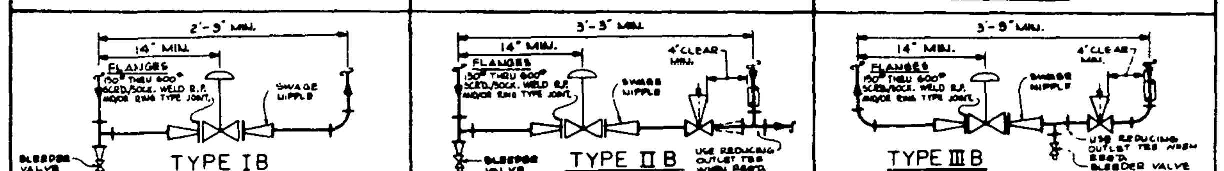


TABLE OF VALVE SIZES FOR MANIFOLDS SCREWED AND/OR SOCKET WELD

NOTE: TYPES IB, IIB & IIIB ALSO REQUIRE SAME VALVING AND BY PASSES AS SHOWN FOR TYPES IA, IIA, IIIA

CONTROL VA. SIZE ¾" REDUCED PORT			CONTROL VA. SIZE ¾" BODY			CONTROL VA. SIZE 1" REDUCED PORT			CONTROL VA. SIZE 1" BODY			CONTROL VA. SIZE 1¼" PORT 1½" BODY			CONTROL VA. SIZE 1½" BODY		
LINE SIZE	BLOCK VA. SIZE	BY-PASS VA. SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA. SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA. SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA. SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA. SIZE	LINE SIZE	BLOCK VA. SIZE	BY-PASS VA. SIZE
¾/1	¾	¾	¾/1	¾	¾	¾/1	—	—	¾/1	—	—	¾/1	—	—	¾/1	—	—
1/1½	1	¾	1/1½	1	1	1/1½	1	1	1/1½	1	1	1/1½	—	—	1/1½	—	—
1½/2	1½	¾	1½/2	1	1	1½/2	1½	1	1½/2	1½	1½	1½/2	1½	1½	1½/2	1½	1½

GENERAL NOTES

1. THIS DRAWING IS TO BE USED FOR SELECTING CONTROL VALVE MANIFOLDS USING GATES AND GLOBES FOR BLOCK AND BY-PASS VALVES. MANIFOLDS ARE TO BE CONSIDERED SPECIAL WHEN PIPING CLASSIFICATIONS SPECIFY OTHER TYPE VALVES OR WHEN THE PROJECT CONTROL SYSTEMS ENGINEER INDICATES THAT THE CONTROL VALVE APPLICATION IS SPECIAL, SUCH AS: NOISE REQUIREMENTS, PRESSURE DROP MAY BE TOO HIGH THROUGH VALVE, FLASHING OR CAVITATING MAY BE OCCURING OR EROSION PROBLEMS MAY EXIST.
2. CONTROL VALVE TYPE, SIZE RATING, ETC., SHALL BE CHECKED AGAINST THE INSTRUMENT DATA SHEET AND THE CERTIFIED VENDOR DRAWING.
3. CONTROL VALVE MANIFOLD ACCESSIBILITY AND LOCATION.
   - 3.1 ACCESSIBILITY
     - a) ALL CONTROL VALVES SHALL BE INSTALLED SO THAT THEY ARE READILY ACCESSIBLE FOR MAINTENANCE.
     - b) THEY SHALL BE LOCATED AT GRADE UNLESS PRESSURE OR OTHER DESIGN CONDITIONS MAKE SUCH AN ARRANGEMENT IMPRACTICABLE. WHEN LOCATED ABOVE GRADE, THEY SHALL BE INSTALLED SO THAT THEY ARE READILY ACCESSIBLE FROM A PERMANENT PLATFORM OR WALKWAY WITH AMPLE CLEARANCES FOR MAINTENANCE.
   - 3.2 LOCATION

     PREFERABLY THE CONTROL VALVE SHALL BE INSTALLED NEAR THE OPERATING EQUIPMENT TO BE OBSERVED WHILE ON LOCAL MANUAL CONTROL.
     - a) CONTROL VALVES SHALL BE INSTALLED IN HORIZONTAL LINES WITH THE DIAPHRAGM (ACTUATOR) OPERATORS LOCATED DIRECTLY ABOVE THE VALVE BODY. ANY DEVIATION SHOULD BE CHECKED WITH THE PROJECT CONTROL SYSTEMS ENGINEER.
4. BLOCK VALVES LOCATED UPSTREAM AND DOWNSTREAM OF THE CONTROL VALVE ARE GATES AND ARE NORMALLY LINE SIZE. WHERE THE CONTROL VALVE IS TWO OR MORE SIZES SMALLER THAN LINE SIZE, THE BLOCK VALVES MAY BE ONE SIZE SMALLER THAN LINE SIZE.
5. BY-PASS VALVES AND PIPING SHALL BE SAME SIZE AS CONTROL VALVE. TYPE OF VALVES ARE AS FOLLOWS:
   - a) SIZES 6" AND LARGER SHALL BE GATES.
   - b) SIZES 4" AND SMALLER SHALL BE GLOBES.
6. BLEEDER VALVES ARE NORMALLY LOCATED UPSTREAM OF CONTROL VALVES UNLESS JOB REQUIREMENTS DICTATE OTHERWISE.
7. FOR FLANGED CONTROL VALVES SIZES 1", 1 1/2" AND 2" - INCREASE DIMENSION "A" BY 3", ADDING A PIECE OF MAKE-UP PIPE BETWEEN THE REDUCER AND ELBOW ONLY WHEN LINE IS ONE SIZE LARGER THAN BLOCK VALVE AND TWO SIZES LARGER THAN CONTROL VALVE.
8. REDUCERS AND SWAGES UPSTREAM AND DOWNSTREAM OF CONTROL VALVE ARE CONCENTRIC UNLESS OTHERWISE SPECIFIED.
9. ANGLE AND 3-WAY CONTROL VALVES ARE CONSIDERED SPECIAL AND ARE NOT SHOWN ON THIS DRAWING. HOWEVER WHEN USING THESE VALVES, CAUTION MUST BE EXERCISED TO ALWAYS INSTALL VALVES IN THE PROPER DIRECTION OF FLOW. CHECK WITH CONTROL SYSTEMS ENGINEER.
10. SUPPORTS AT CONTROL VALVE MANIFOLDS SHALL BE LOCATED IN A WAY, SO THAT THE ASSEMBLY IS SELF-SUPPORTING WITH THE CONTROL VALVE REMOVED.

LEGEND

E_1 REG	REGULAR CONTROL VALVE
E_2 C.FINS	CONTROL VALVE WITH COOLING FINS
E_3 HW	CONTROL VALVE WITH TOP MOUNTED HANDWHEEL
E_4 C.FINS HW	CONTROL VALVE WITH COOLING FINS AND TOP MOUNTED HANDWHEEL.
C.O.	CHAIN OPERATED BY-PASS VALVE
*	BY-PASS VALVE STEM ORIENTATION AT 45° UP FROM HORIZONTAL ℄
▲	BY-PASS VALVE SHALL NOT EXCEED 6'-6" TO BOTTOM OF HANDWHEEL FROM ACTUAL GRADE, ELEVATED PLATFORM OR WALKWAY.

NOTE:

THIS DRAWING IS BASED ON AMERICAN PETROLEUM INSTITUTE STANDARD (API) RP 550-PART 1 SECTION 6, CONTROL VALVES AND POSITIONERS.

4	4/74	ADDED DETS. TYPE IB, IIB & IIIB
3	9/70	REVISED & REDRAWN
2		RELOCATED DRAIN VALVE AT DRIP LEG & ADDED NOTE

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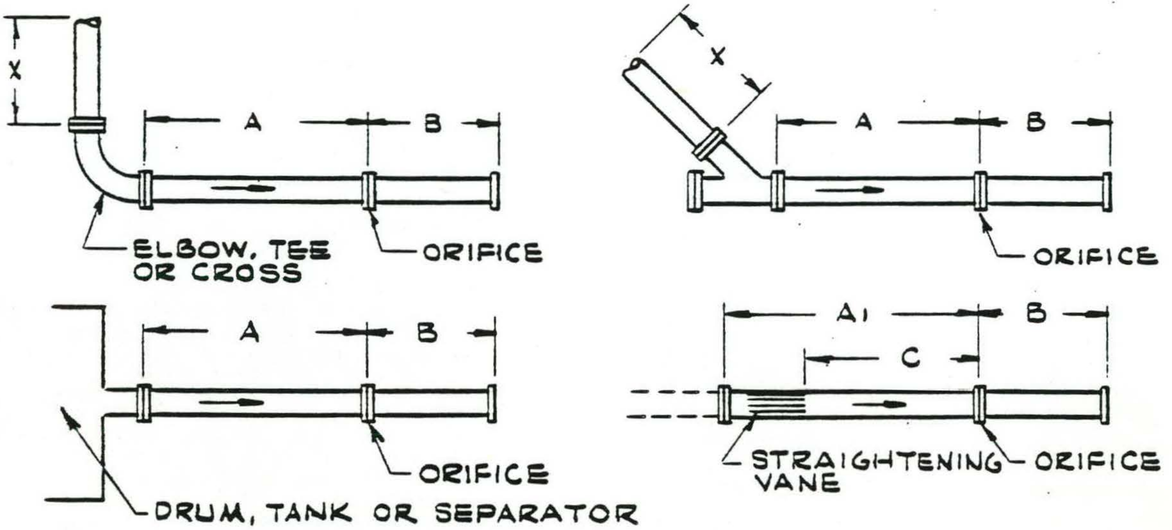
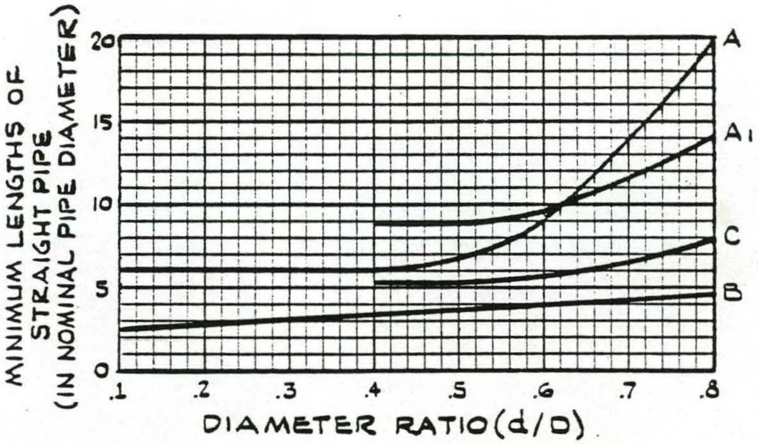
ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

CONTROL VALVE MANIFOLDS

STD. L-538 Rev. 4

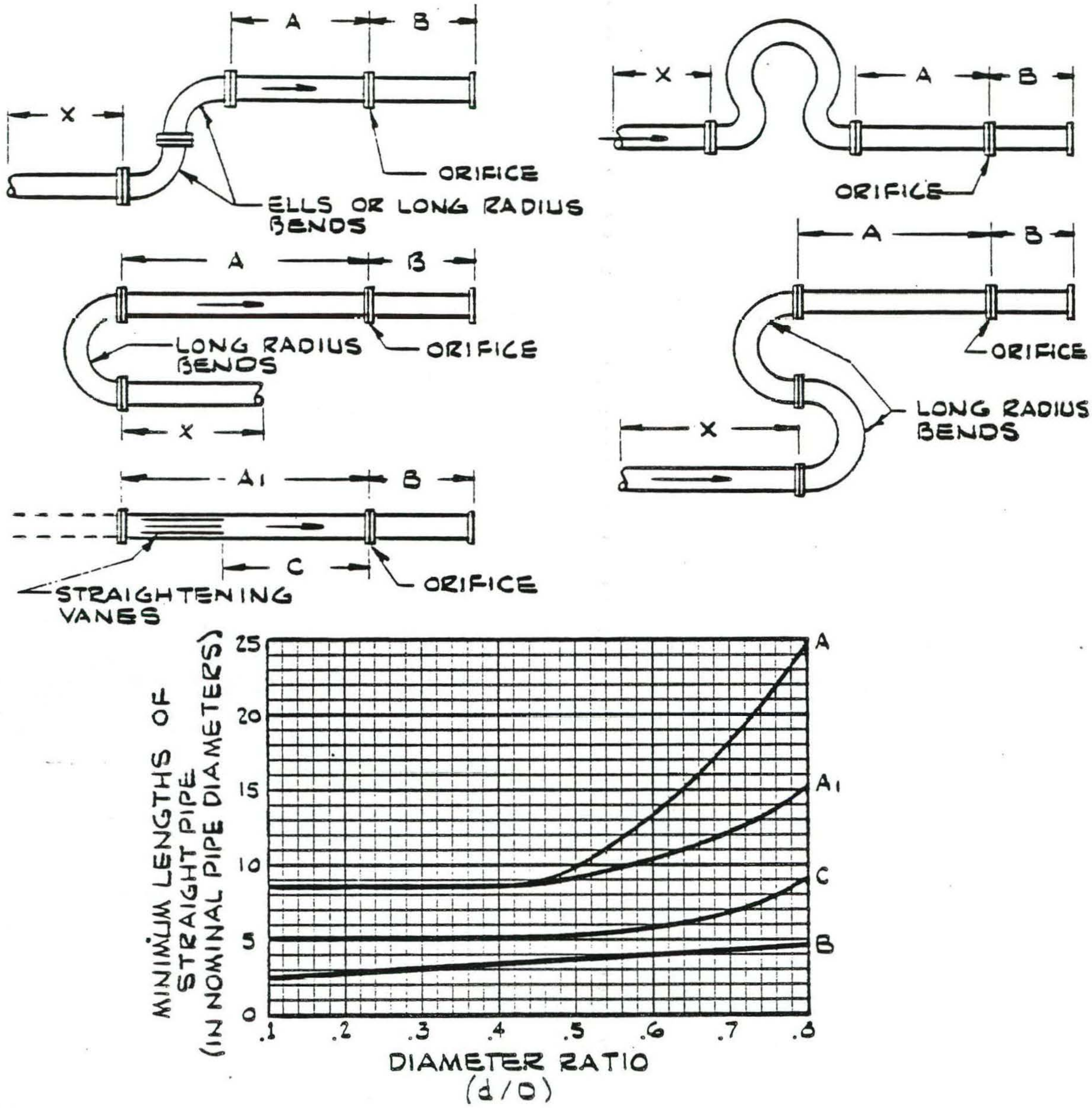




NOTES:

1. THIS SCHEDULE SHALL BE USED FOR TEES, CROSSES OR LATERALS ONLY IF THEY ARE SINGLE ENTRANCE FITTINGS W/OTHER OPENINGS BLANKED OR PLUGGED
2. IF A TEE, CROSS OR LATERAL IS USED FOR MULTIPLE INLET, OR INLET AND OUTLET, REFER TO STD. DWG. J-F-0103
3. TEES, CROSSES AND LATERALS SHALL BE CONSIDERED AS DISTURBING FITTINGS REGARDLESS OF WHAT ENTRANCE IS USED.
4. STRAIGHT PIPE "X" SHALL BE A MINIMUM OF 6 PIPE DIAMETERS IF PRECEDED BY OTHER FITTINGS IN THE SAME PLANE. IF THIS LENGTH IS NOT AVAILABLE REFER TO STD. DWG. J-F-0102
5. IF STRAIGHT PIPE "X" IS PRECEDED BY FITTINGS IN A DIFFERENT PLANE, USE STD. DWG. J-F-0103
6. IF STRAIGHT PIPE "X" IS PRECEDED BY A VALVE COVERED BY STD. DWG. J-F-0106, THE MINIMUM TOTAL DIMENSION "X" + "A" SHALL BE EQUAL TO DIMENSION "A" PER STD. DWG. J-F-0106

2	DATE 11-73	Redrawn & Issued for Eng. Standard	DR.	CHK.	DES. SUP.	ENG.	PROJ. ENG.	APPR
ORIGIN R&C ENG.	BECHTEL	INSTRUMENT ENGINEERING STANDARD	JOB NO.	DRAWING NO.				REV.
		PIPING REQUIREMENTS FOR METER RUNS	STD	J-F-0101				2

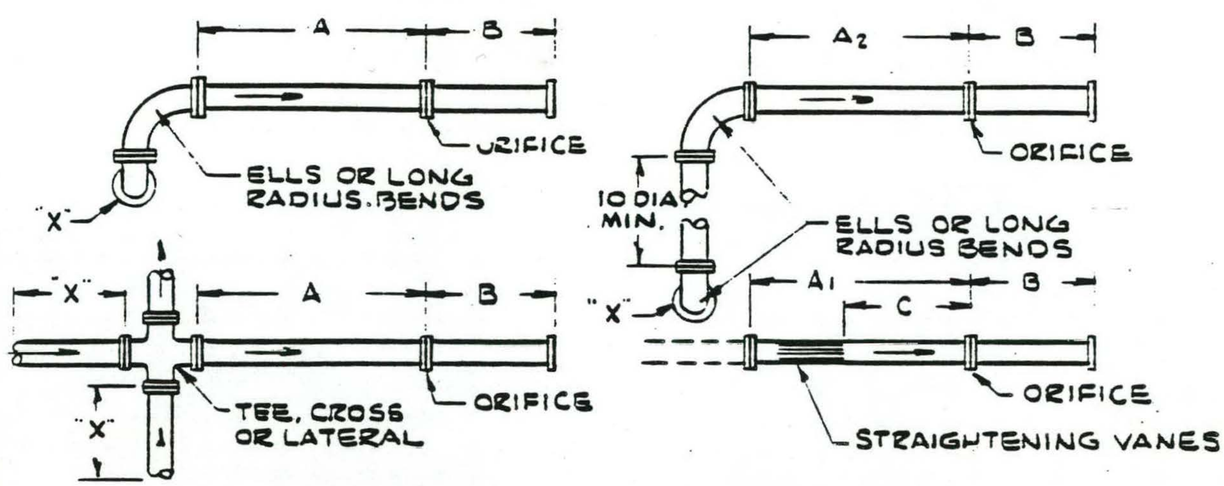


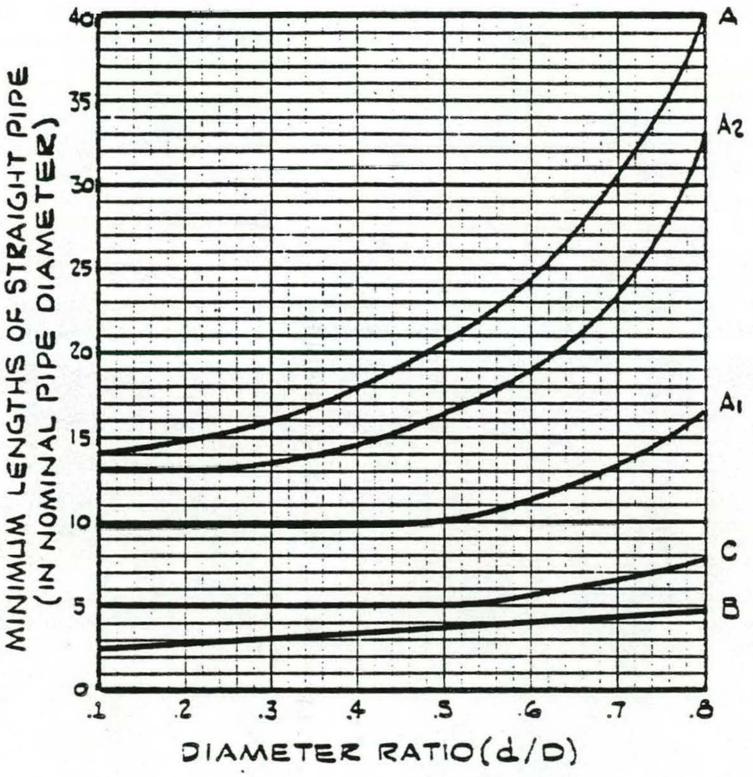
NOTES:

1. IF STRAIGHT PIPE "X" IS PRECEDED BY FITTINGS IN A DIFFERENT PLANE, REFER TO STD. DWG. Nº. J-F-0103

2. IF STRAIGHT PIPE "X" IS PRECEDED BY A VALVE COVERED BY STD. DWG. Nº J-F-0106, THE MINIMUM TOTAL DIMENSION "X"+"A" SHALL BE EQUAL TO DIMENSION "A" FROM STD. DWG. Nº J-F-0106.

2	DATE 7-73	Redrawn & Issued For Eng. Standard	DR.	CHK.	DES. SUP.	ENG.	PROJ. ENG.	APPR
ORIGIN R&C ENG.	BECHTEL	INSTRUMENT ENGINEERING STANDARD PIPING REQUIREMENTS FOR METER RUNS	JOB NO.		DRAWING NO.			REV.
			STD		J-F-0102			2

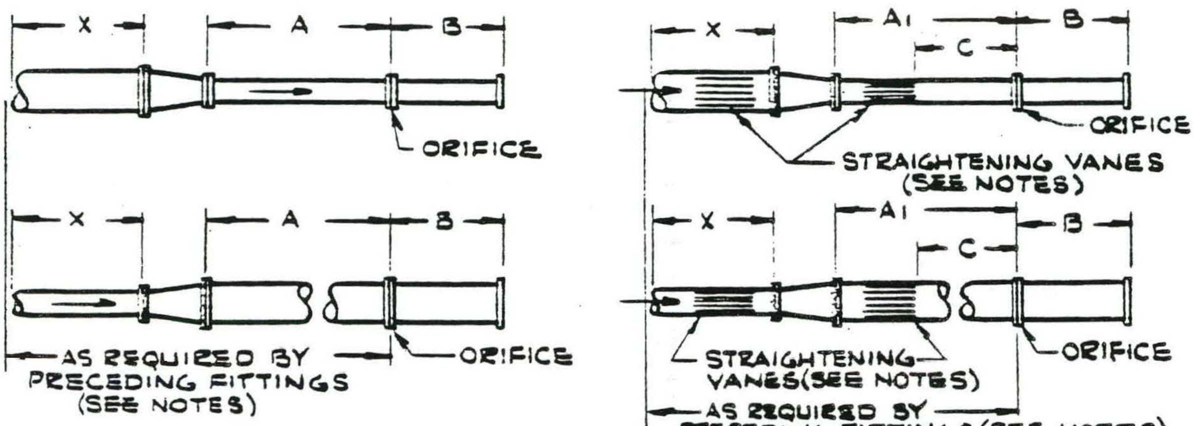


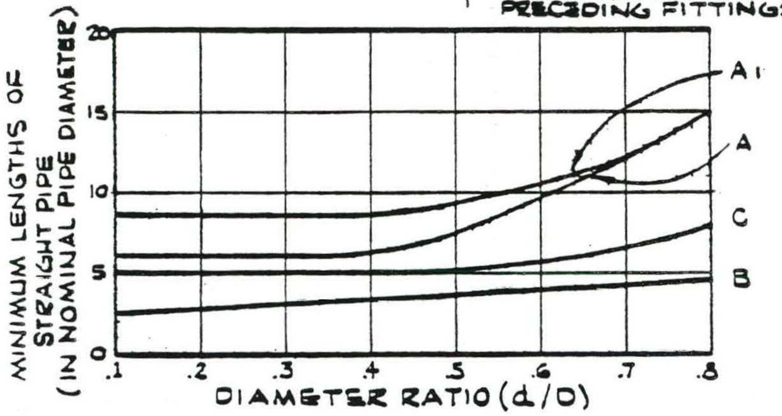


NOTES:

1. TEES, CROSSES OR LATERALS HAVING MULTIPLE INLETS OR INLET AND OUTLET, SHALL BE CONSIDERED AS DISTURBING FITTINGS REGARDLESS OF HOW ENTRANCES AND EXITS ARE ARRANGED.
2. IF STRAIGHT PIPE "X" IS PRECEDED BY A VALVE COVERED BY STD. DWG. J-F-0106, THE MINIMUM TOTAL DIMENSION "X" PLUS "A" SHALL BE EQUAL TO DIMENSION "A" PER STD. DWG. J-F-0106.

2	DATE 11-73	Redrawn & Issued for Eng. Standard	DR	CHK	DES. SUP	ENG.	PROJ. ENG.	APPR
ORIGIN R&C ENG.	BECHTEL	INSTRUMENT ENGINEERING STANDARD PIPING REQUIREMENTS FOR METER RUNS		JOB NO.	DRAWING NO.			REV
				STD	J-F-0103			2





NOTES:

1. IF STRAIGHT PIPE "X" IS PRECEDED BY FITTINGS, THE MINIMUM TOTAL DIMENSION "X"+"A" SHALL BE EQUAL TO DIMENSION "A" FROM THE SCHEDULE APPROPRIATE TO THE FITTINGS.

2. IF STRAIGHT PIPE "X" IS PRECEDED BY A VALVE COVERED BY STD. DWG. J-F-0106, THE MINIMUM TOTAL DIMENSION "X"+"A" SHALL BE EQUAL TO DIMENSION "A" PER STD. DWG. J-F-0106.

3. STRAIGHTENING VANES WILL NOT REDUCE LENGTHS OF STRAIGHT PIPE "A", AND SHOULD BE USED ONLY BECAUSE OF OTHER FITTINGS PRECEDING REDUCERS OR INCREASERS, IF THE CONDITIONS DETERMINED BY NOTES 1 OR 2 CANNOT BE MET.

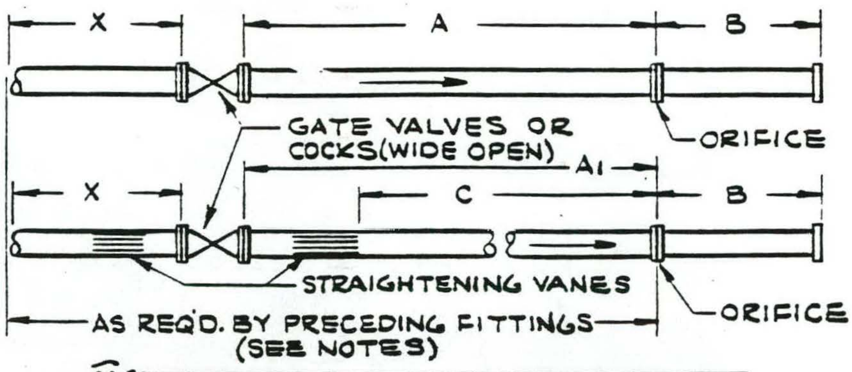
4. STRAIGHTENING VANES, IF USED, MAY BE INSTALLED EITHER BEFORE OR AFTER THE REDUCER OR INCREASER. IF VANES ARE INSTALLED DOWNSTREAM OF THE REDUCER OR INCREASER, CURVE "A1" MUST BE USED. IF VANES ARE INSTALLED UPSTREAM OF THE REDUCER OR INCREASER, CURVE "A" MAY BE USED. THE STRAIGHT RUN OF PIPE PRECEDING THE STRAIGHTENING VANES OR REDUCER OR INCREASER (WHICHEVER IS UPSTREAM) SHALL BE EQUAL TO "A1" MINUS "C" TAKEN FROM THE SCHEDULE CHOSEN UNDER NOTES 1 OR 2.

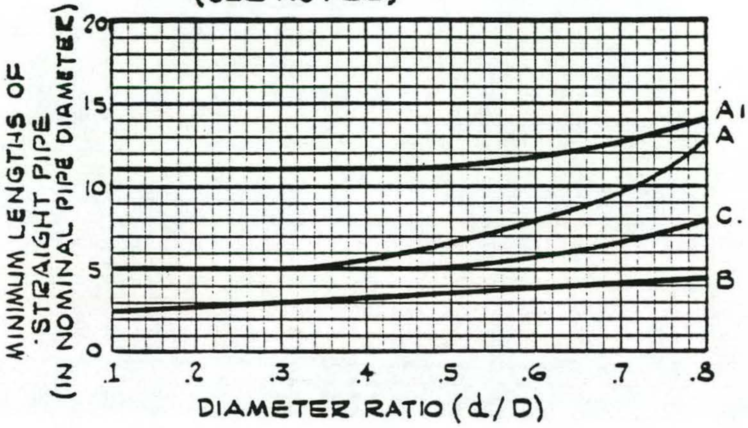
DATE 7-73	Redrawn & Issued for Eng. Standard	DR	CHK.	DES SUP	ENG.	PROJ ENG.	APPR	

ORIGIN

INSTRUMENT ENGINEERING STANDARD
PIPING REQUIREMENTS FOR METER RUNS

JOB NO.	DRAWING NO.	REV.
STD	J-F-0104	2





NOTES:

1. THIS SCHEDULE SHALL BE USED ONLY IF THE GATE VALVES OR COCKS ARE WIDE OPEN. IF THIS IS NOT THE CASE, REFER TO STD. DWG. J-F-0106.

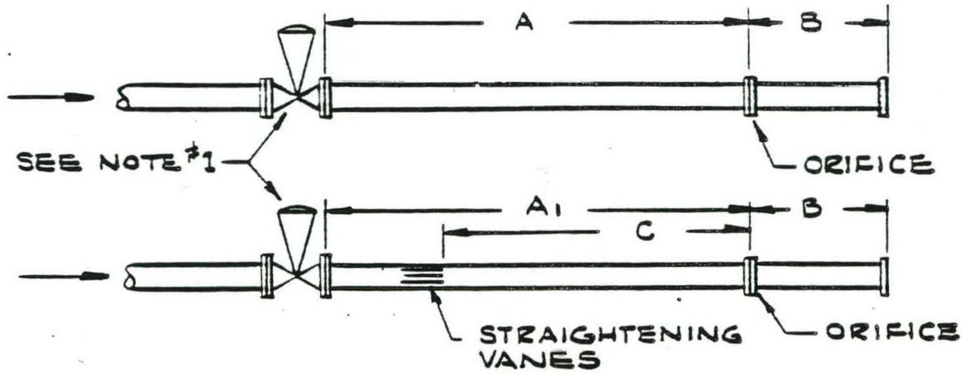
2. IF STRAIGHT PIPE "X" IS PRECEDED BY FITTINGS, THE MINIMUM TOTAL DIMENSION X+A SHALL BE EQUAL TO DIMENSION "A" FROM THE SCHEDULE APPROPRIATE TO THE FITTINGS.

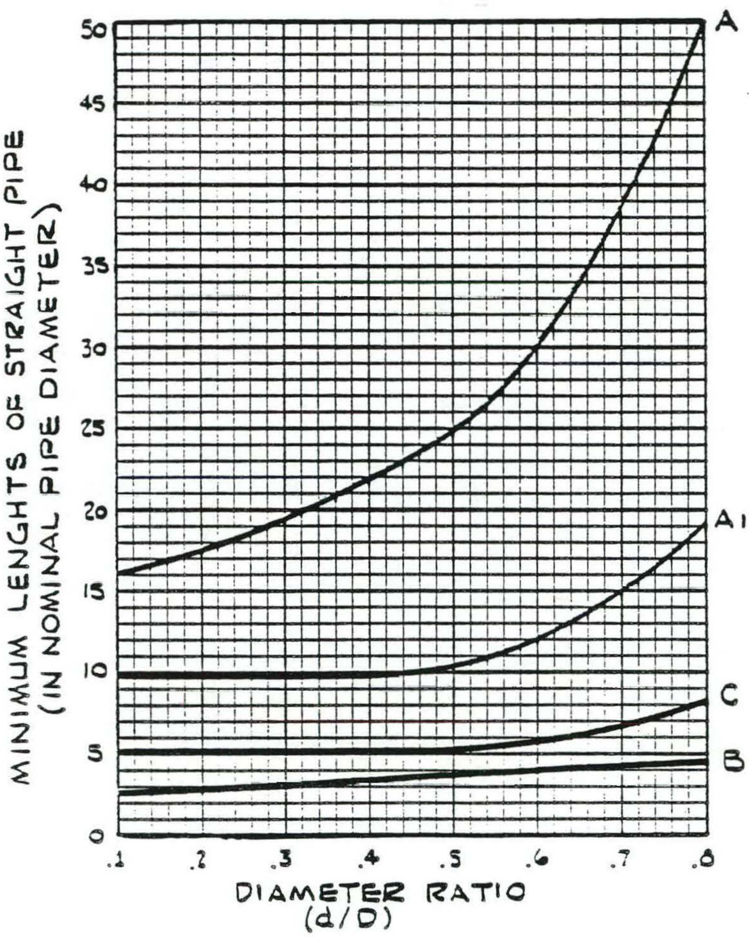
3. IF STRAIGHT PIPE "X" IS PRECEDED BY A VALVE, COVERED BY STD. DWG. J-F-0106, THE MINIMUM TOTAL DIMENSION "X"+"A" SHALL BE EQUAL TO DIMENSION "A" PER STD. DWG. J-F-0106.

4. STRAIGHTENING VANES WILL NOT REDUCE LENGTHS OF STRAIGHT PIPE "A", & SHOULD BE USED ONLY BECAUSE OF OTHER FITTINGS PRECEDING THE GATE VALVES OR COCKS, IF THE CONDITIONS DETERMINED BY NOTES 2 OR 3 CANNOT BE MET.

5. STRAIGHTENING VANES, IF USED, MAY BE INSTALLED EITHER BEFORE OR AFTER THE GATE VALVE OR COCK. IF VANES ARE INSTALLED DOWN-STREAM OF THE GATE VALVE OR COCK, CURVE A1 MUST BE USED. IF VANES ARE INSTALLED UPSTREAM OF THE GATE VALVE OR COCK, CURVE "A" MAY BE USED. THE STRAIGHT RUN OF PIPE PRECEDING THE STRAIGHTENING VANES OR GATE VALVE OR COCK (WHICHEVER IS UPSTREAM) SHALL BE EQUAL TO "A1"-"C" TAKEN FROM THE SCHEDULE CHOSEN UNDER NOTES 2 OR 3.

2	DATE 11-73	Redrawn & Issued for Eng. Standard	DR.	CHK.	DES. SUP.	ENGR.	PROJ. ENG.	APPR
ORIGIN R&C ENG.	BECHTEL	INSTRUMENT ENGINEERING STANDARD PIPING REQUIREMENTS FOR METER RUNS	JOB NO.	DRAWING NO.				REV
			STD	J-F-0105				2





NOTE:

1. THIS SCHEDULE SHALL BE USED FOR CHECK & GLOBE VALVES, CONTROL, REGULATOR & REDUCING VALVES, & COCKS OR GATE VALVES PARTIALLY OPEN

2 DATE 7-73	Redrawn & Issued for Eng. Standard	DR.	CHK.	DES. / SUP.	ENG.	PROJ. ENG.	APPR

ORIGIN
R&C
ENG.

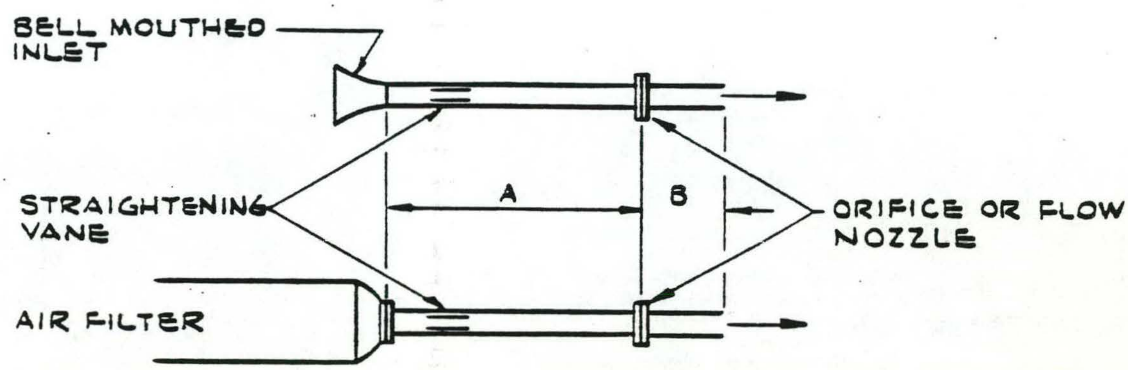
INSTRUMENT ENGINEERING STANDARD
PIPING REQUIREMENTS FOR METER RUNS

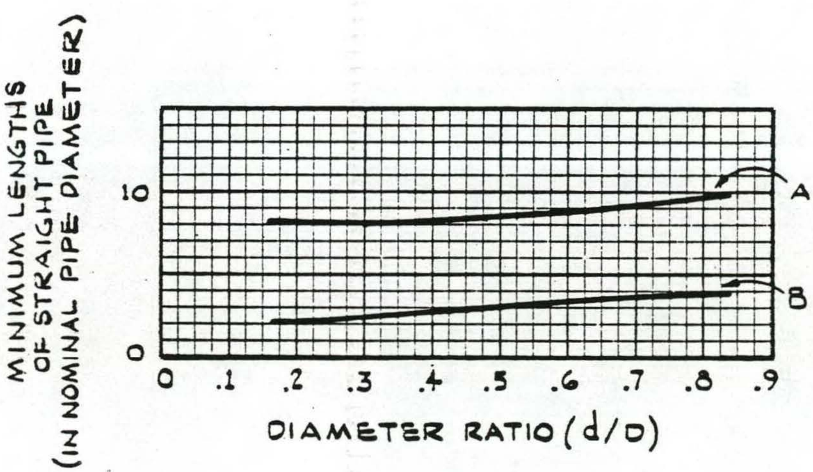
JOB NO.

STD

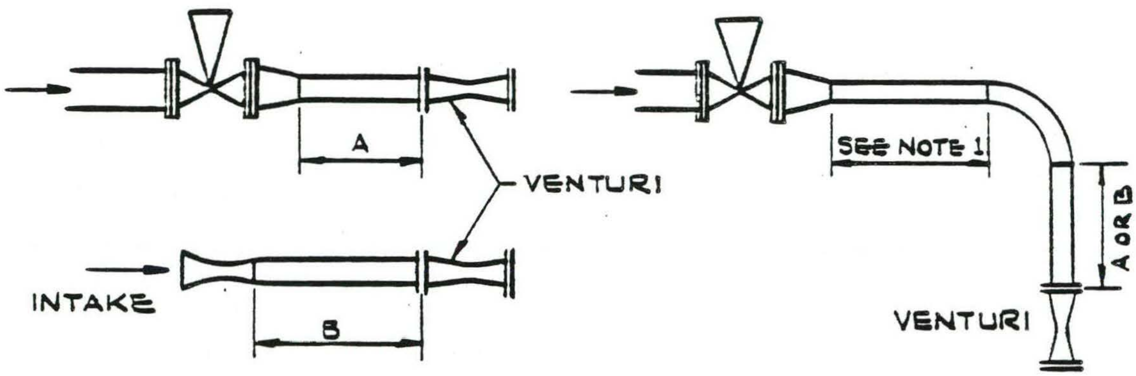
DRAWING NO. J-F-0106

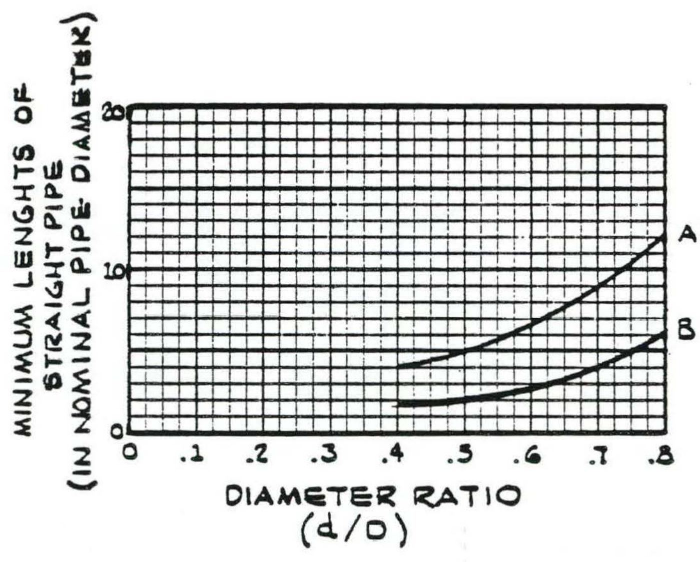
REV. 2





△								
2	DATE 7-73	Redrawn & Issued for Eng. Standard	DR.	CHK.	DES. SUP.	ENG.	PROJ. ENG.	APPR
ORIGIN R&C ENG.	BECHTEL	INSTRUMENT ENGINEERING STANDARD PIPING REQUIREMENTS FOR METER RUNS	JOB NO.	DRAWING NO.				REV.
			STD	J-F-0107				2

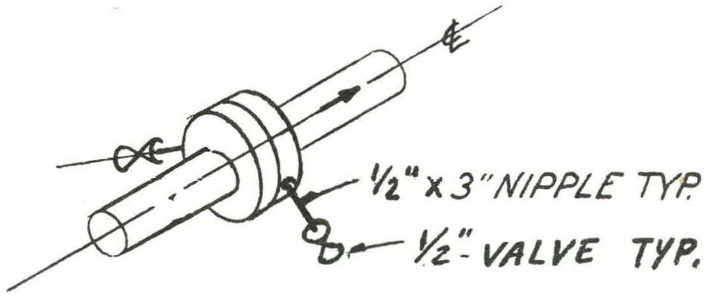




NOTE:

1. IF STRAIGHT RUN BEFORE ELBOW IS LESS THAN 12 DIAMETERS, USE A VALUE IN PLACE OF B.
2. BASED ON DATA FROM W. S. PARDOE

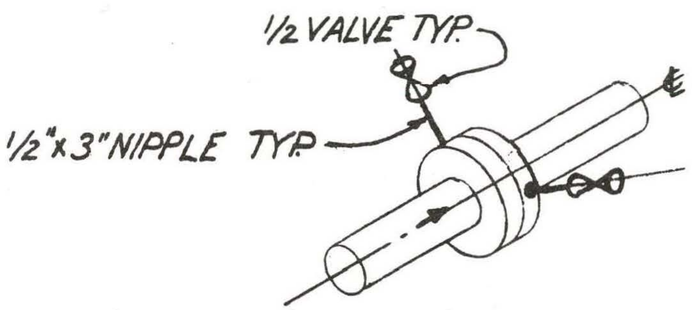
DATE 11-73	Redrawn & Issued for Eng. Standard	DR.	CHK.	DES. SUP.	ENG.	PROJ. ENG.	APPR.	
ORIGIN R&C ENG.	INSTRUMENT ENGINEERING STANDARD PIPING REQUIREMENTS FOR METER RUNS	JOB NO.		DRAWING NO.				REV.
		STD		J-F-0108				2

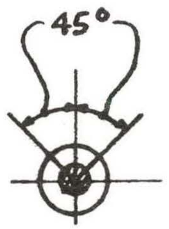


SEE NOTE-3

DETAIL A

LIQUID OR STEAM FLOW

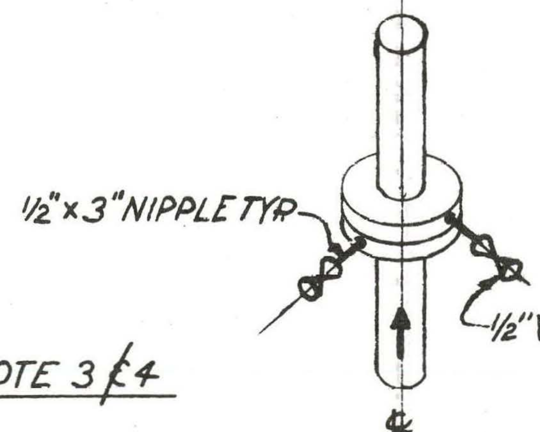


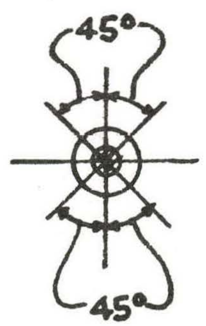


SEE NOTE-3

DETAIL B

GAS FLOW



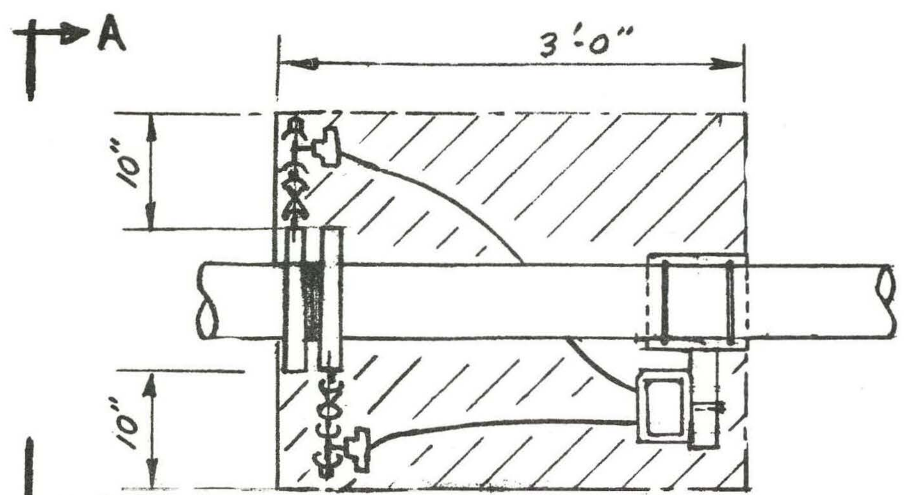


SEE NOTE 3 & 4

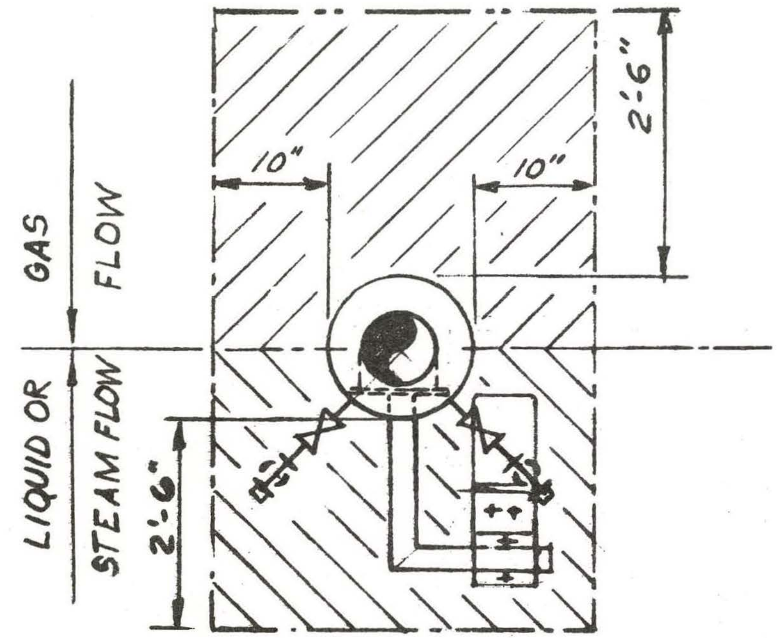
DETAIL C

ORIFICE IN VERTICAL LINE

MINIMUM CLEARANCES FOR ORIFICE INSTALLATION



PLAN



SECT. A-A

LEAVE SHADED AREAS CLEAR FOR MOUNTING OF SEAL POTS, INSTRUMENT ETC.

GENERALLY SEAL POTS ARE INSTALLED WHEN THE INSTRUMENT IS MOUNTED BELOW THE LINE. SEAL POTS ARE NOT USUALLY INSTALLED WHEN THE INSTRUMENT IS MOUNTED ON THE LINE.

45° ORIFICE TAPS MAY BE USED IN LIEU OF 90° TAPS (STD. DWG. L-550) ONLY WHEN SPECIFIED BY JOB SPECIFICATIONS.

NOTES

1. VALVES AND NIPPLES ARE TO CONFORM TO THE JOB PIPING SPECIFICATION FOR RATING AND MATERIAL.
2. ORIFICE GAP: (A) UP TO 12-INCH LINE SIZE, 1/8-INCH PLUS TWO GASKETS. (B) 12-INCH AND LARGER LINE SIZE, 1/4-INCH PLUS TWO GASKETS.
3. ORIFICE FLANGES WITH 900 LB OR HIGHER RATING ARE PROVIDED WITH 3/4-INCH ORIFICE TAPS. USE 3/4" NIPPLES AND BLOCK VALVES.
4. WHEN ORIFICE FLANGES ARE INSTALLED IN VERTICAL LINES, THE FLOW SHALL BE UPWARD: HOWEVER, THIS TYPE OF INSTALLATION SHOULD BE AVOIDED.

REFERENCE DRAWINGS	
PRIMARY CONNECTIONS FOR ORIFICE FLANGES WITH 90° TAPS.	L-550

No.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
0	1/74	ISSUED AS STD.	H.G.S.					

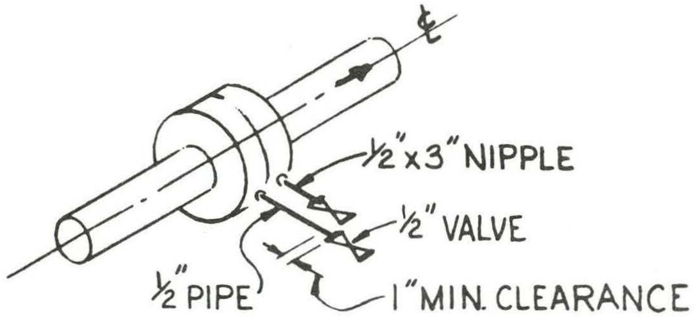
SCALE NONE | DESIGNED | DRAWN | CHIEF ENGR

BECHTEL

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

PRIMARY CONNECTIONS FOR ORIFICE FLANGES WITH 45° TAPS

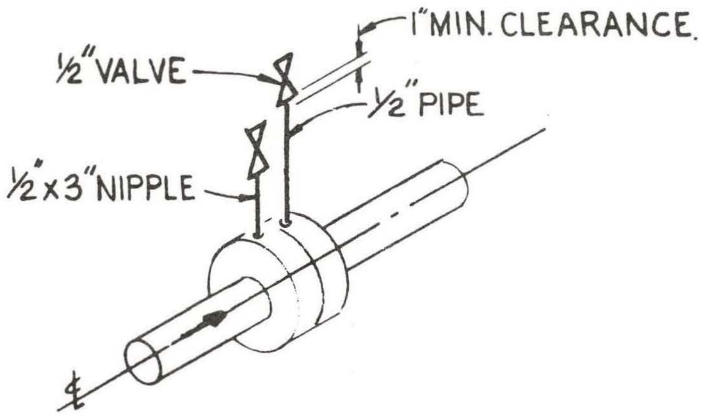
JOB No.	DRAWING No.	REV.
STD	L-504	0



SEE NOTE 3

DETAIL A

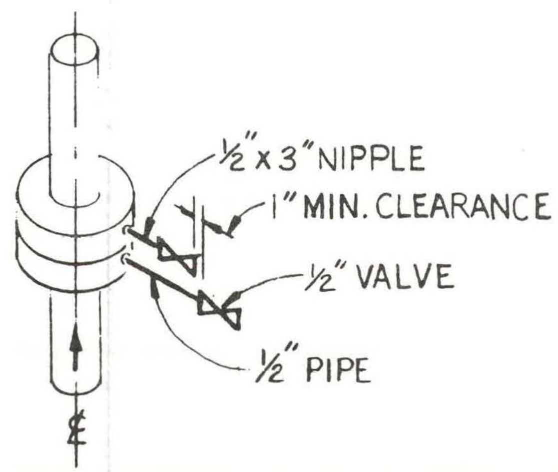
LIQUID OR STEAM FLOW



SEE NOTE 3

DETAIL B

GAS FLOW

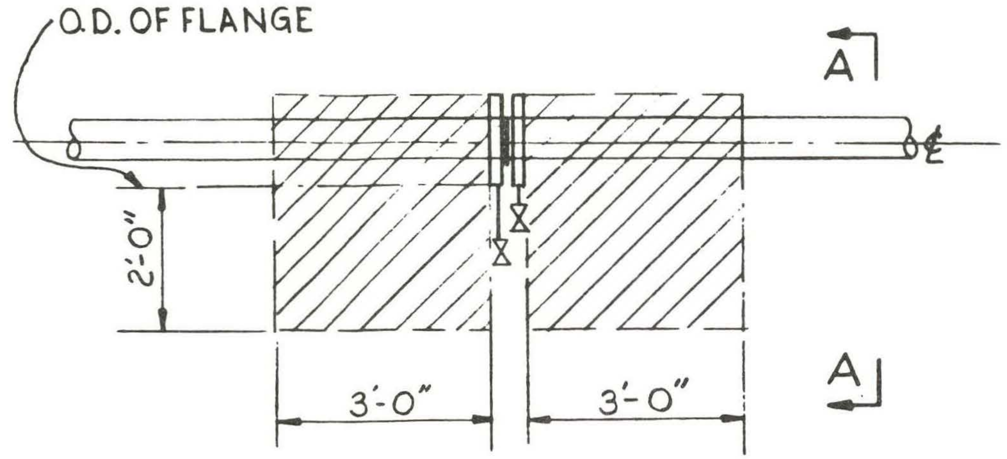


SEE NOTE 3 & 4

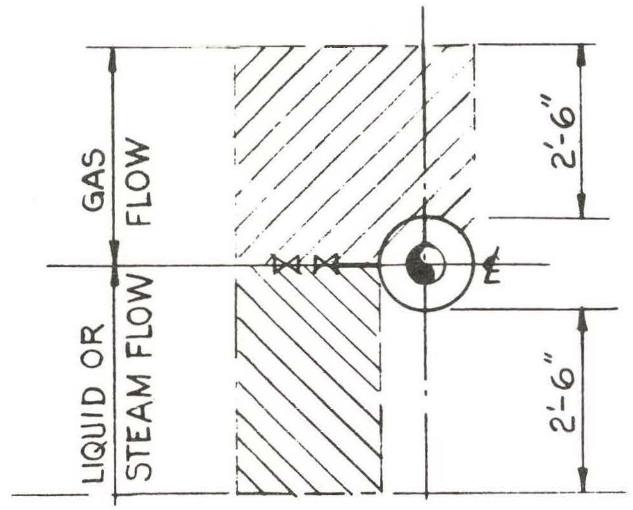
DETAIL C

ORIFICE IN VERTICAL LINE

MINIMUM CLEARANCES FOR ORIFICE INSTALLATIONS



PLAN



SECT. A-A

LEAVE SHADED AREAS CLEAR FOR MOUNTING OF SEAL POTS, INSTRUMENT ETC.

SEAL POTS ARE SOMETIMES INSTALLED WHEN THE INSTRUMENT IS MOUNTED BELOW THE LINE. SEAL POTS ARE NOT USUALLY INSTALLED WHEN THE INSTRUMENT IS MOUNTED ON THE LINE.

184

NOTES

1. VALVES AND NIPPLES ARE TO CONFORM TO THE JOB PIPING SPECIFICATION FOR RATING AND MATERIAL.
2. ORIFICE GAP: (a) UP TO 12-INCH LINE SIZE 1/8-INCH PLUS TWO GASKETS. (b) 12-INCH AND LARGER LINE SIZE, 1/4-INCH PLUS TWO GASKETS.
3. ORIFICE FLANGES WITH 900 LB OR HIGHER RATING ARE PROVIDED WITH 3/4-INCH ORIFICE TAPS. USE 3/4" NIPPLES AND BLOCK VALVES.
4. WHEN ORIFICE FLANGES ARE INSTALLED IN VERTICAL LINES, THE FLOW SHALL BE UPWARD; HOWEVER, THIS TYPE OF INSTALLATION SHOULD BE AVOIDED WHEREVER POSSIBLE.

REFERENCE DRAWING	
PRIMARY CONNECTIONS FOR ORIFICE FLANGES WITH 45° TAPS.	L-504

No.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
3	1/74	REVISED TITLE & TITLE BLOCK FORMAT, ADDED REF. DWG.	L.C.	[illegible]	[illegible]	[illegible]		[illegible]
2	10/4/63	REVISED NOTE 3.	[illegible]	[illegible]	[illegible]	[illegible]		

SCALE	DESIGNED	DRAWN	CHIEF ENGR

BECHTEL

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

PRIMARY CONNECTIONS FOR ORIFICE FLANGES WITH 90° TAPS

JOB No.	DRAWING No.	REV.
STD	L-550	3

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7.0 SHOP DETAIL DRAWINGS AND SPOOL IDENTIFICATION

8.0 RECORDS AND REPORTS

9.0 SHIPPING PREPARATION

10.0 SCHEDULING AND EXPEDITING

2 11.0 DELETE

FORM H-292 7-66

3					
2	10-21-81	STANDARD FORMS & DRAWINGS ADDED	AP	TS	
1	11/10/80	ISSUED FOR PHASE ZERO	JK	HS	
0	2/21/80	ISSUED FOR APPROVAL	TWA	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
PROJECT SPECIFICATIONS
PIPING FABRICATION

JOB NO. 14222

SPECIFICATION	REV
14222-L-5	2

1. GENERAL

1.1 Application

This specification applies to above grade process and utility piping lines, and those lines extending below grade in the same service using the same materials. Requirements herein shall govern shop and field fabrication unless where obviously not applicable. Additional requirements, such as treating and wrapping, may apply to buried piping.

1.2 Intent

Process and utility piping will be fabricated in strict accordance with codes, drawings, purchase order, and other requirements specified herein. Where conflicts exists between the aforementioned documents, this specification shall govern except where code requirements legally apply. No requirements herein shall have the effect of waiving the applicable code unless more stringent than the code.

2. CODES

2.1 Local Codes or Regulations

Where local regulations, ordinances, statutes or codes take precedence over ASME or ANSI codes, such regulations, ordinances. statutes or codes shall govern.

2.2 Refinery Piping Code

Except where specified otherwise, the fabrication of piping shall be in accordance with the Code for Petroleum Refinery Piping, ANSI B31.3, latest edition.

2.3 Boiler Code Piping

Piping external to power boilers and steam generating equipment that falls under jurisdiction of Section I, Power Boilers, of the ASME Boiler and Pressure Vessel Code, shall be fabricated in accordance with the Code for Power Piping, ANSI B31.1, latest edition. The extent of such piping shall be indicated on the drawings as Boiler Code Piping.

2.4 Other Requirements

Other codes, such as refrigeration or plumbing, may govern some parts of the piping. Drawings will indicate the applicable codes in such cases.

3. INFORMATION SOURCES

In addition to the above-mentioned codes and their sub-references, the following sources contain information affecting detailing and fabrication of piping.

2 3.1 Piping Material Specification 14222-L-1

The Piping Material Specification specifies by Service Class, the material requirements for pipe, fittings, flanges, etc., and design details for branch, vent, drain and temperature connections.

2 3.2 Supplementary Table of Wall Thickness and Branch Reinforcement (Specification 14222-L-1

The Supplementary Table of Wall Thickness and Branch Reinforcement is a supplement to the Piping Material Specification and will specify by individual pipe line number the requirements of wall thickness and branch reinforcement not specified in the Piping Material Specification. This supplement will be provided during Phase 1.

3.3 Piping Stock Code Book

The Piping Stock Code Book, and supplements if any, identify and describe all piping material item codes in the Piping Material Specification, piping drawings, or other documents related to piping material.

3.4 Piping Drawings

The piping drawings may be orthographic arrangements and/or line isometrics. Appropriate standard detail drawings and other drawings showing typical details will be included.

3.5 Schedule of Welding, Heat Treatment and Non-Destructive Testing of Piping (Form 167 attached)

The Schedule of Welding, Heat Treatment and Non-Destructive Testing of Piping will specify, by individual Service Class, the requirements for welding, heat treatment and non-destructive testing.

Shop fabricator shall complete Form 167 by filling in his procedure identification and return this form with the required procedures to Buyer for approval.

3.6 Where conflict exists between the aforementioned documents and this specification, Fabricators shall contact the Buyer for clarification. No requirement of this specification shall have the effect of waiving the applicable code unless more stringent than the code.

4. EXTENT OF SHOP FABRICATION

Shop fabrication shall include all piping as specified in the Material Requisition/Purchase Order. Piping indicated on drawings as field run shall be excluded. Fabrication shall be in strict accordance with Buyer's drawings.

5. MATERIALS AND FABRICATION REQUIREMENTS

5.1 Materials

5.1.1 General requirements for materials used for piping fabrication:

5.1.1.1 Materials shall be in accordance with the Piping Material Specification Service Class specified on the piping drawings.

5.1.1.2 Materials not in accordance with the Piping Material Specification Service Class for the specific pipe line involved will be identified on the piping drawings with the appropriate material stock code number or description.

5.1.2 Material Commitment

When requested, Shop Fabricator shall submit to the Buyer complete itemized lists of all materials committed to the shop, at times of commitment. The report must show the mill-test reports or certifications required by applicable codes, job specifications or other applicable requirements.

5.1.3 Material Identification

5.1.3.1 All materials shall be marked with the information required by the applicable material manufacturing specification.

5.1.3.2 Marking shall be done by any permanent method that will not result in harmful contamination or sharp discontinuities, nor shall it infringe upon the minimum wall thickness. Low chloride markers shall be used for marking austenitic stainless steel materials.

5.2 General Fabrication Requirements

5.2.1 Threaded Connections

All threaded connections shall be gage-checked or chased after welding or heat treating. Openings for thermowells and other inserts shall be drilled through the connection and be free from obstruction.

5.2.2 Socket Welding

Care shall be taken to ensure that a clearance of 1/16" remains between the male and female ends at the bottom of the socket.

5.2.3 Galvanized Piping

Piping required to be galvanized shall be galvanized after fabrication.

5.2.4 Bolt Holes

Unless otherwise noted, flange bolt holes shall straddle vertical centerline of the flange.

5.2.5 Orifice Runs

Orifice runs shall be fabricated in accordance with the requirements of the American Gas Association (AGA), Report No. 3 and API RP 550 Part I, Section I.

Welding neck orifice flanges shall have same bore as the pipe. Orifice runs shall not contain welds except at the flanges. Pipe ends and bevels at orifice flanges shall be machine cut and shall be perpendicular to the axis of the pipe. Welds at orifice flanges shall be ground smooth and flush inside. Pipe tap connections on slip-on orifice flanges and directly on the pipe, where so specified, shall be drilled through the pipe wall and shall be finished smooth and flush inside.

Taps shall be oriented as shown on the piping drawings.

5.2.6 Welded Attachments

Welded attachments such as supports and guides shall normally not be furnished by Shop Fabricator. Dummy legs for welded lines shall be fabricated with the spool. Where attachments are required for shop fabricated piping it will be so noted on the piping drawings. Attachment material and welding requirements shall be in accordance with Form 167. Dummy legs, where required, shall be in accordance with Drawing L-539.

5.2.7 Branch Connections

5.2.7.1 Branch connections on shop fabricated piping shall include appropriate fittings, or groups of fittings (i.e., flanged thermowell connections) or pipe stubs for smaller field-fabricated branch connections. Two inch pipe stubs shall extend to the first natural weld but not more than 12 inches from the outside surface of the header. Three inch and larger pipe stubs and branches shall extend to the first flange or to the field weld point as indicated on the piping drawings or as required for reasonable spool piece size.

5.2.7.2 Reinforcing pads for field stub-ins shall be fabricated by shop fabricator and tack welded to branch spool for shipment.

5.2.8 Dimensional tolerances shall be in accordance with the Pipe Fabrication Institute Standard ES-3.

5.3 Weld Joint Preparation

Preparation for shop and field welds shall be by mechanical means where practical. Flame cut surfaces shall be ground to provide fit-up equivalent to machining. End preparation for butt welding shall be in accordance with ANSI B16.25.

2 5.4 Welding

All welding shall be in accordance with Project Specification 14222-W-2 167 unless otherwise specified.

FORM 283

5.5 Heat Treatment

5.5.1 All heat treatment shall be in accordance with Specification W-501 and Form 167 unless otherwise noted.

5.6 Bends

5.6.1 Pipe may be bent by hot or cold method in accordance with the Piping Code ANSI B31.3 Para. 329.2. Bending shall be followed by heat treatment in accordance with the Code for Refinery Piping ANSI B31.3 and Form 167. Hot bending shall not be performed in the field without Engineering approval.

5.6.2 Bending shall not reduce the pipe wall thickness below the minimum wall thickness specified.

5.6.3 Unless otherwise noted, the centerline radius of bends shall be five (5) nominal pipe diameters. Buttwelds in the arcs of bends or for the addition of pulling legs shall not be permitted without written approval from the Buyer.

5.6.4 When bending welded pipe, the longitudinal weld shall be located in the neutral axis of the bend.

5.6.5 All bends shall be smooth, free from cracks and surface defects, without buckles, and they shall be within tolerance limits allowed by the applicable code to which piping is fabricated.

5.7 Surface and Weld Defects

5.7.1 Unless otherwise specified, surface defects will be considered injurious if the defect extends below the specified minimum wall thickness or is more than 1/16" in depth.

5.7.2 Injurious surface defects shall be completely removed by grinding. The ground out area shall be repaired by welding if defect removal results in reduction of pipe wall below minimum thickness. The repaired area shall be ground smooth to the pipe contour. Fabricator shall not repair any injurious defect without Buyer's written approval.

5.7.3 Weld defects shall be repaired in accordance with the Code for Pressure Piping ANSI B31.3, Para. 327.7.

5.8 Cleaning

5.8.1 All shop fabricated piping assemblies shall be cleaned after all fabrication and welding.

5.8.2 If water is used in cleaning austenitic stainless steel piping assemblies, it shall not contain more than 30 ppm chlorides.

5.8.3 Any special requirements for cleaning of shop fabricated piping will be specified in the individual Service Classes of the Piping Material Specification.

FORM 283

6. EXAMINATIONS AND INSPECTION

6.1 The Buyer's representative shall at all reasonable times have access to the work wherever it is in preparation or progress, and Seller shall provide proper facilities for such access and inspection. The Buyer's representative shall have the authority to reject any materials, procedures or work which, in his opinion, fail to meet the requirements of this specification or the documents referenced to in this specification.

6.2 Fabricators shall be responsible for non-destructive examination of fabricated piping.

2 The extent and procedures for nondestructive examination (radiography, liquid penetrant, ultrasonic, magnetic particle, etc.) of fabricated piping shall be as specified in Project Spec. 14222-W-2 and Form 167.

6.4 Unless specified otherwise on drawings, shop hydrostatic testing of pipe spools is not required.

After installation, all fabricated assemblies will be hydrostatically tested by the Buyer in accordance with the applicable Code. Seller shall guarantee his work to be capable of withstanding the initial hydrostatic test, and he shall consent to repair or replace, at his expense, any item which fails to pass such test.

6.5 The Buyer's approval of the following Shop Fabricator's procedures and activities is required prior to the use of such procedures and start of such activities.

6.5.1 Procedures and details of welding processes to be used with each class of piping.

6.5.2 Weld repair procedures.

6.5.3 Heat treating operations.

6.5.4 Non-destructive examination procedures.

6.5.5 All requests for substitutions, modifications, or relaxations of this specification or of the documents referenced to in this specification shall be fully stated in writing for the consideration of the Buyer whose decision will be final.

6.5.6 Approval by the Buyer of Shop Fabricator's procedures, substitutions, major repairs, fabrication details, drawings, etc., shall not relieve Shop Fabricator of the responsibility for correctness of details, and compliance with all codes, legal requirements and this specification.

7. SHOP DETAIL DRAWINGS AND SPOOL IDENTIFICATION

7.1 Shop Fabricator shall make shop detail drawings for all piping he fabricates. Shop detail drawings shall show the spool number, materials, dimensions, fabrication details and the applicable code and procedures.

Buyer's isometric drawings may be used for this purpose. The piping drawing supplied by the Buyer and from which the shop detail drawing is made shall be shown as a reference.

7.2 A number, consisting of the plant or unit number, commodity symbol, line number, and spool piece number, shall identify each pipe spool. Piece numbers shall be shown on the Buyer's piping drawings. Each spool shall be detailed on a separate sheet bearing the purchase order number and pipe spool number.

7.3 Shop Fabricator shall prepare a complete index of all piping spool drawings, referencing each piping spool drawing to the Buyer's piping drawing from which it was prepared.

7.4 Location of field weld between shop fabricated spool pieces will be shown on the Buyer's piping drawings.

7.5 In general, the Buyer will neither check nor approve the Shop Fabricator's individual piping spool drawings. Fabricators shall be completely responsible that fabricated piping conforms to code, specification, drawing and purchase order requirements. If, during or after erection in the field, there are any dimensional errors, incorrect materials or other defects in shop fabricated piping beyond those permitted in Pipe Fabrication Institute Bulletin ES-3, such errors and/or defects will be rectified by the Buyer. All costs incidental to the rectification and/or repairs of such initial errors and/or defects shall be back-charged to the Shop Fabricator (methods and procedures for back-charging will be specified in the Purchase Order.)

8. RECORDS AND REPORTS

8.1 Shop Fabricator shall maintain shop detail drawings and records on all materials, mill-test reports, fabrication, heat treatment, welding repairs and non-destructive examination for all shop-fabricated piping specified herein. All such drawings, certificates, test data and reports shall be on file with the Seller and shall be sent to the Buyer upon request.

8.2 For piping under jurisdiction of Section I, Power Boilers, of the ASME Boiler and Pressure Vessel Code, Shop Fabricator shall furnish 6 copies each of the completed Form P4-A, Manufacturer's Data Report.

8.3 All records and reports required by the Buyer shall be furnished upon, or prior to, the arrival of the piping at the Buyer's jobsite. The record package shall be specifically identified as to the shipment it represents.

9. SHIPPING PREPARATION

9.1 Immediately after cleaning and inspection, fabricated piping spools shall be suitably protected for shipment as follows:

9.1.1 Flange faces, machined surfaces and threads shall be cleaned of all mill scale, rust, etc., and coated with a corrosion preventative such as Rust Ban 324 or waterproof grease.

9.1.2 Small branches and small header attachments shall be adequately braced or otherwise protected to prevent damage during handling, shipping and storage.

9.1.3 Threaded couplings and other internally threaded connections shall be closed and protected by wrapping with plastic tape.

9.1.4 Threaded nipples and other externally threaded connections shall be closed and protected by wrapping with plastic tape.

9.1.5 Weld end preparations shall be protected with securely fastened plastic or wood covers.

9.1.6 Flange faces shall be protected with securely fastened plastic or wood covers.

9.1.7 Ring type joint flanges shall have groove packed with grease prior to attaching flange protective covers.

9.2 Painting of shop-fabricated piping shall be in accordance with Project Specification 14222-X-3

9.3 All small loose pieces shall be boxed for protection during shipment. Each box shall be identified with a securely fastened metal tag bearing the purchase order number along with appropriate spool detail number (see Paragraph 7.2) to indicate its place in the final installed assembly.

9.4 Each section of fabricated pipe, pipe assembly or separate fitting shall be clearly marked in a durable manner with appropriate spool detail number (see Paragraph 7.2) to indicate its place in the final installed assembly. This marking shall be repeated at opposite sides and ends of each fabricated spool to facilitate identification. Low chloride markers shall be used for marking austenitic stainless steel fabricated pipe.

9.5 Fabricated pipe spools shall be adequately blocked, strapped, or otherwise held in position during shipment and shall be further separated by dunnage as may be necessary to prevent damage.

9.6 All shipments of fabricated pipe spools shall include with the packing list a complete listing of the spools shipped.

10. SCHEDULING AND EXPEDITING

10.1 Delivery of fabricated pipe spools and/or material to the Buyer's jobsite shall be in accordance with the delivery schedule given in the Purchase Order. Within the general requirements of the delivery schedule, the Seller shall, insofar as is practical, fabricate the piping systems in the sequence requested by the Buyer, in order to meet the installation schedule.

10.2 The Seller shall submit to the Buyer on the first and fifteenth of each month a report of his progress in accordance with Form 389 (attached.)

2

FORM 283

R&C SFE Form 389 (4/71) Attachment to Std. Spec. L-503

SHOP FABRICATION OF PIPING — PROGRESS REPORT

BECHTEL

JOB NO. 5678 REV. NO. 4 SHEET NO. 50 - 103

PLANT NO. 50 DATE 4-12-71

PLANT NUMBER SHALL BE USED AS PREFIX TO SHEET NUMBERS

SHEETS SHALL BE NUMBERED SEPARATELY FOR EACH PLANT - IN SEQUENCE STARTING WITH 1, 2, 3 ETC.

DRAWING NO. LISTED SHALL BE BECHTEL ISOMETRIC, ORTHOGRAPHIC OR DETAIL DRAWING

LATEST REVISION RECEIVED

SPOOL NUMBERS LISTED SHALL BE BECHTEL PIPE SPOOL NUMBERS

BECHTEL PIPING DRAWING				BECHTEL PIPE SPOOL NUMBER	SHOP DETAIL DRAWING				MATERIAL		FABRICATION				REMARKS
DRAWING NUMBER	PRIOR	REV.	DATE		DRAWING NUMBER	REV.	DATE START	DATE REL	DATE ORD	DATE REC	DATE START	DATE COMP	DATE INSP REL	DATE SHIP	
50-P-10-1	6	2	1-5-71	50-P-10-1A	T-342	1	1-7-71	1-14-71	1-20-71	1-27-71	2-8-71	3-1-71	3-2-71	3-5-71	
"	"	"	"	50-P-10-1B	T-343	1	1-7-71	1-14-71	1-20-71	1-27-71	2-8-71	2-26-71	2-26-71	3-5-71	
				50-P-10-1C	T-344	1	1-8-71	1-14-71	1-20-71	1-27-71	2-8-71	2-26-71	2-26-71	3-5-71	
50-EL-102	3	1	2-8-71	50-P-142-A	T-345	0	1-12-71	1-15-71	1-22-71	2-3-71	2-12-71	3-5-71	3-6-71	3-9-71	
"	"	"	"	50-P-142-B	T-346	1	2-15-71	2-18-71	1-22-71	2-3-71	2-18-71				HOLD PLACED ON SPOOL
				50-P-143-A	T-347	0	1-13-71	1-18-71	1-22-71	2-3-71	2-18-71	3-4-71	3-6-71	3-9-71	
				50-P-143-B	T-348	0	1-13-71	1-18-71	1-22-71	2-3-71	2-18-71	3-5-71	3-6-71	3-9-71	
			2	7				7			7	6	6	6	TOTAL FOR THIS SHEET ONLY
			62	206				206			206	189	174	163	TOTAL FOR PLANT 50 ONLY

SPOOLS SHALL BE FABRICATED IN GIVEN PRIORITY WHEN SPECIFIED

INDICATE PLANT TOTALS ON LAST SHEET OF SPECIFIC PLANT LISTINGS

INDICATE TOTALS FOR THIS SHEET ONLY

PIPING CLASS OR SERVICE	CODE DESIGN CRITERIA	MATERIAL ASME SECT. IX		NOMINAL PIPE SIZE (INCH)	MAX. WALL THK. (INCH)	PREHEAT TEMP.(1)	POST WELD HEAT TREAT TEMP. (1)	WELDING (1) PROCEDURES	REV.	NON DESTRUCTIVE EXAMINATION RT, UT, MT OR PT (2)		NON PRESSURE ATTACHMENT MATERIAL	NON PRESSURE ATTACHMENT WELDING PROCEDURE (3)	REMARKS
		P-NO.	TYPE							SPECIFICATION	AMOUNT			

NOTES

1. FOR GENERAL REQUIREMENTS ON SHOP WELDING AND HEAT TREATMENT SEE SPEC. W-501 FOR GENERAL REQUIREMENTS ON FIELD WELDING AND HEAT TREATMENT SEE BECHTEL WELDING PROCEDURES PHT-500 AND PHT-501.
2. RT- RADIOGRAPHIC TESTING, MT- MAGNETIC PARTICLE TESTING, PT- LIQUID PENETRANT TESTING AND UT- ULTRASONIC TESTING.
3. PREHEAT AND POST WELD HEAT TREATMENT FOR NON PRESSURE ATTACHMENTS SHALL BE THE SAME AS FOR OTHER WELDS UNLESS OTHERWISE SPECIFIED IN THE "REMARKS" COLUMN.
4. POST WELD HEAT TREATMENT OF CARBON STEEL AT 1100°F MINIMUM IS REQUIRED WHEN THE WALL THICKNESS IS 0.75 INCH OR GREATER UNLESS OTHERWISE SPECIFIED IN THE "REMARKS" COLUMN.

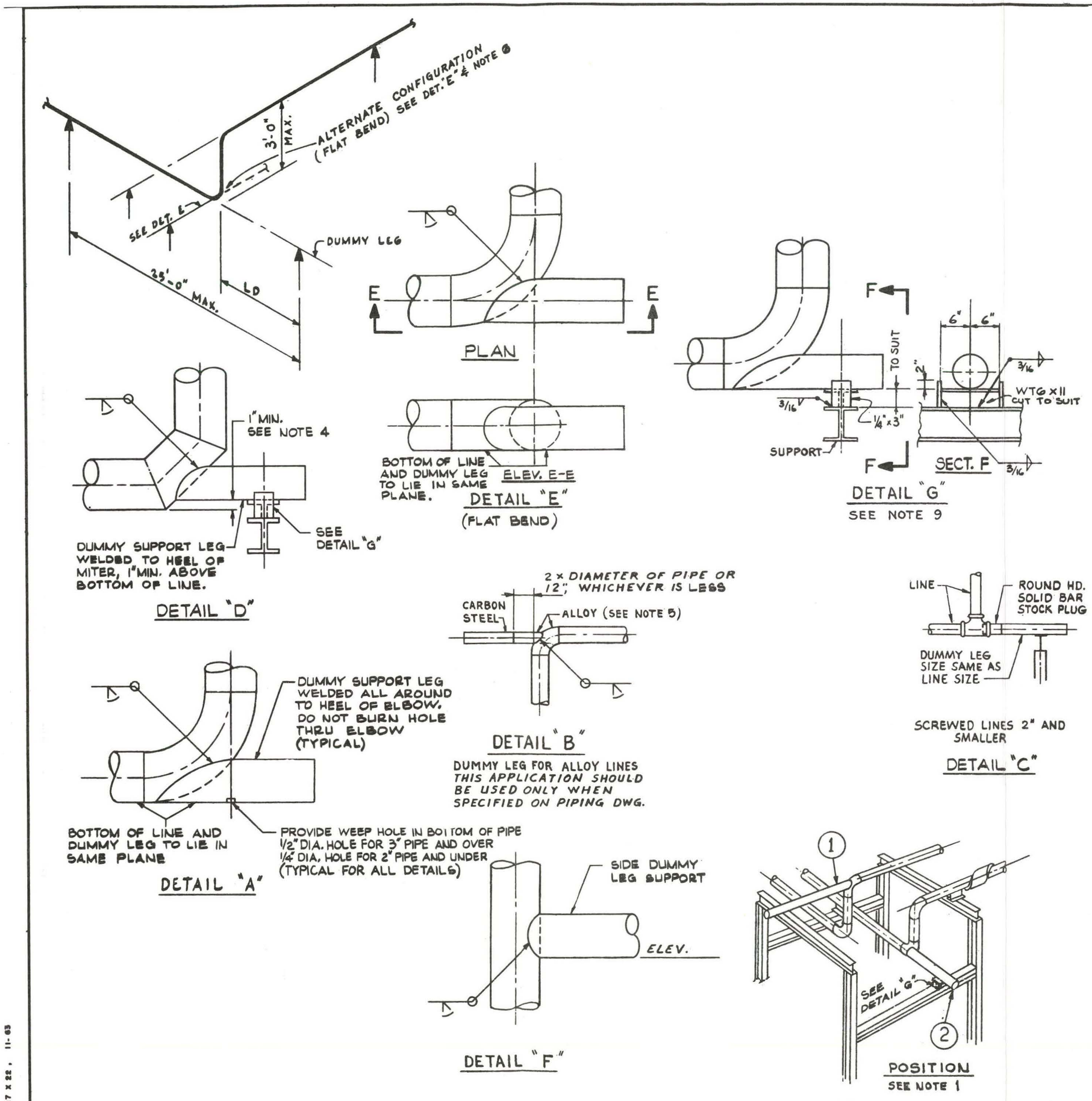
BAC FORM 167 (5/71)

BECHTEL

FORM 167

WELDING, HEAT TREATMENT AND NON-DESTRUCTIVE EXAMINATION OF PIPING

SIZE C



NOTES:

Refer to Standard DWG. L-532, Overhanging Pipe Limitations.

1. If the curves on DWG. L-532 indicate line overhang to be excessive there are two alternatives.
   - (a) Reroute the line.
   - (b) Add dummy support leg as shown at lower position 2 or upper position 1 whichever is most economical.
2. Dummy legs for welded lines shall be fabricated with the spool, particularly alloy lines and lines requiring stress relieving.
3. For lines with butt weld or socket weld fittings extend support leg per detail "A".
4. For lines with mitered elbows extend support leg per detail "D." To prevent attachment weld overlapping miter weld, bottom of dummy leg should be a minimum of 1" above bottom of line.
5. Dummy legs for alloy pipes should be of carbon steel unless detail "B" is specified. When detail "B" is required the alloy shall be of same material as the pipe. Size of dummy leg shall be shown on the piping drawing.
6. For alternate configuration make bottom of pipe flush with B.O.L.
7. A line extended across support with end capped, results in a dead leg and should not be used unless a definite future extension of the line is foreseen. In such cases a flange and blind should be considered.
8. Add saddle per detail "G" to supports under dummy legs on insulated lines.
9. Except as noted in detail "B," dummy legs may be STD. WT. carbon STL. Pipe economically sized to suit span & load. For normal conditions dummy legs may be sized as follows:
   - (a) SCRD. Lines - See detail "C."
   - (b) Buttweld lines size 1-1/2" and smaller-dummy legs same as line size.
   - (c) Buttweld lines size 2"-dummy leg may be 1-1/2".
   - (d) Buttweld lines size 3" thru 8"-dummy leg may be one pipe size smaller than the line.
   - (e) Buttweld lines size 10" and larger D.L. DIA. = D.70 x NOM. Pipe DIA. Min. Unless noted otherwise on pipe isometric or piping orthographic DWG.

REVISION NOTES

6 REVISED DET'S OF DUMMY LEGS FR. STRUCT. ST'L TO PIPE – REVISED TITLE BLOCK FORMAT TO CONFORM W/STD DWG A-515

No.	Date	Revisions	By	Chk'd				
6	6/74	SEE REV. 6 ABOVE	L.S.	[illegible]	[illegible]	[illegible]		
5	4/12/68	CHANGED & AND ADDED NOTE 10. REVISED TABLE CHANGED DETAIL B&E	JL	ap	SWC	SSR		

SCALE NONE | DRAWN E.S.W. | P.Y.B.

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

DETAIL OF DUMMY SUPPORT LEG
FOR PIPE LINES WITH EXCESSIVE OVERHANG

Job No.	Drawing No.	Rev.
STD	L-539	6

17 X 22, 11-63

Form P-4A (Back)

8. Description of Field Fabrication. (16) ______________________________

9. Field Hydrostatic Test ______(17)______ psi.

CERTIFICATE OF COMPLIANCE

We certify the statement in this data report to be correct

Date ______(18)______ Signed ______(18)______ by ______(18)______
(Fabricator) (Authorized Representative)

Our Certificate of Authorization No. ______(19)______ to use the Pressure Piping Symbol expires ______(19)______, 19____

CERTIFICATE OF COMPLIANCE

We certify that the field assembly of the described piping conforms with the requirements of Section I of the ASME Boiler and Pressure Vessel Code.

Date ______(20)______ Signed ______(20)______ By ______(20)______
(Assembler) (Authorized Representative)

Our Certificate of Authorization No. ______(21)______ to use the (A) (S) or (PP) ______(21)______ Symbol expires ______(21)______ 19____

(22) CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ______(23)______ and employed by ______________ of ______________ have compared the statements in this Manufacturer's Data Report with the described piping and state that the parts referred to as Data Items ______(24)______, not included in the Certificate of Shop Inspection, have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or assembler has constructed and assembled this piping in accordance with the applicable sections of the ASME Boiler and Pressure Vessel Code. The described piping was inspected and subjected to a hydrostatic test of ______(25)______ psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date ______________

______________ Commissions ______(26)______
Inspector Nat'l Board, State, Province, and No.

FORM P-4A MANUFACTURER'S DATA REPORT FOR FABRICATED PIPING

As Required by the Provisions of the ASME Code Rules

1. Manufactured by ___ 1 ___ Order No. ___ 1 ___
(Name and address of manufacturer)

2. Manufactured for ___ 2 ___ Order No. ___ 2 ___
(Name and address of purchaser)

___ 3 ___
(Destination)

3. Identification ___ 4 ___
(Main steam, boiler feed, blow-off or other service piping—state which)

4. Design Conditions of Piping ___ 5 ___ psi ___ 5 ___ F. Specified by ___ 6 ___
(Pressure) (Temperature) (Name of Co.)

Code Design by ___ 7 ___

5. The construction complies with the ASME BOILER AND PRESSURE VESSEL CODE, Section I. Materials and workmanship conform to the applicable Sections of the ASME BOILER AND PRESSURE VESSEL CODE. 8

6. Description of Piping: (Include materials identifications by ASME specification or other recognized Code designation.)

___ 9 ___

7. Shop Hydrostatic Test ___ 10 ___ psi.

13 CERTIFICATE OF COMPLIANCE

We certify the statement in this data report to be correct.

Date ___ 11 ___ Signed ___ 11 ___ by ___ 11 ___
(Manufacturer or Fabricator) (Authorized Representative)

Our Certificate of Authorization No. ___ 12 ___ to use the Pressure Piping Symbol expires ___ 12 ___, 19___

13 CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ___ 14 ___ and employed by ___ of ___ have inspected the piping described in this Manufacturer's Data Report on ___ 19___, and state that to the best of my knowledge and belief the manufacturer has constructed this piping in accordance with the applicable Sections of the ASME Boiler and Pressure Vessel Code.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date ___

___ Commissions ___ 15 ___
Inspector Nat'l Board, State, Province and No.

This form may be obtained from the Order Dept., ASME, 345 E. 47th St., New York, N.Y. 10017

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FORM H-292 7-66

△					
△	[illegible]	REVISED SPEC. REF. & ATTACHED FORMS	[illegible]	[illegible]	
△	11/11/80	ISSUED FOR PHASE ZERO	JK	HS	[illegible]
△	2/21/80	ISSUED FOR APPROVAL	[illegible]	HS	

ASFI THE BRECKINRIDGE PROJECT AECI U.S.DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR-20717 PROJECT SPECIFICATIONS PIPING INSTALLATION AND TESTING	JOB NO. 14222 SPECIFICATION 14222-L-6	REV 2

1. GENERAL

1.1 Scope

This specification describes requirements applying to field erection and testing of piping systems. The specification assumes competent field crews will erect and test piping, and normal craft practices and standards of good workmanship need not be described herein.

1.2 Codes

Piping and Instrument Diagrams and piping drawings show to what extent ASME Power Boiler Code or other special codes apply to piping. Where no particular codes or instructions are specified, the Code for Pressure Piping, Petroleum Refinery Piping, ANSI B31.3 - 1973 shall apply to pressure piping within property limits of the plant.

1.3 Workmanship

Work shall be done by qualified craftsmen, in a neat and workmanlike manner, conforming to code and industry standards for good workmanship.

2. DESIGN INFORMATION

2.1 Models and Drawings

Models, with photographs and/or drawings as outlined below, showing the piping arrangement and details and fabricator's drawings will be available for construction use.

2.2 Piping Drawings

The piping drawings may be orthographic arrangements and/or line isometrics. Appropriate standard detail drawings and other drawings showing typical details will be included.

2.3 Piping and Instrument Diagrams (P&ID)

The Piping and Instrument Diagrams indicate "to and from" routing, service classification and identification number for each line and which codes or requirements (other than the Petroleum Refinery Piping Code, ANSI B-31.3) apply to various parts of the piping systems as well as the limits of such code or requirement. They provide a basis for field checks of continuity and completeness of piping systems.

2.4 Line Designation Table

Mechanical Data Section of the Line Designation Table shows number, description, piping material class, design pressure and temperature, insulation and tracing requirements and test pressure for each line.

2.5 Line Numbers

Line numbers identify each line by plant or unit number, fluid designation, serial number, line size and piping material class. Line numbers appear on the P&ID's, models, drawings and isometric sketches. Plant or unit number and line serial number also appear as a part of the individual pipe spool number.

2.6 Materials

Piping Materials Specification includes individual piping material classes. Specification shows in detail pipe, valve, flange, fitting, bolting, gasket and other specific material requirements for different fluid temperature and pressure services. The Piping Stock Code Book describes code items shown in specifications and on drawings. Materials not identified otherwise on drawings or isometrics shall be strictly as specified in Piping Material Specification for that material class.

3. FABRICATION AND INSTALLATION

3.1 The field fabrication and welding shall be in accordance with Project Specification 14222-L-5.

3.2 All piping shall be installed in accordance with the drawings and/or models.

3.3 Cold springing or forcing of piping for the purpose of joint make-up is not permitted unless so specified on the drawings.

3.4 Where insulating flange kits are to be installed, care shall be taken not to damage the bolt sleeves and gasket. The completed joint shall be tested with a "Megger", DVOM or similar device to assure electrical isolation. If both sides of the flanges are grounded a reading of 1 to 10 Ohms will occur. If one or both sides are not grounded, a reading of 1000 or more Ohms should occur.

Caution: Welding grounds shall not be installed across isolation flanges.

3.5 Pump and compressor piping shall be installed up to a break point between nearest pipe support and the equipment. The remainder of the piping shall be properly fitted between the equipment nozzle and this break point. It is essential that this is done accurately in order to avoid any external loadings on the equipment connections.

3.6 Reinforced fiberglass pipe and the like shall be installed strictly in accordance with the vendors installation instructions. Personnel doing this work shall be properly trained and qualified prior to doing the installation.

FORM 203

3.7 Piping shall be supported as shown on the piping and support detail drawings. Temporary supports are permitted to facilitate piping installation provided they will be completely removed upon completion.

Attaching temporary supports to stainless or alloy steel piping by welding is not permitted.

Materials for "dummy leg" supports and the procedure for attachment welding will be shown on Form 167 and Standard Dwg L-539.

3.8 Underground piping shall be installed per Job Specification.

3.9 The handling of coated and wrapped pipe as well as the field coating and wrapping shall be in accordance with Specification 14222-L-7.

3.10 Valves shall be installed with stems oriented as indicated on piping drawings and/or models. Split disc wafer type check valves shall be installed with the shaft in vertical position. Globe valves shall normally be installed with bottom of disc facing the flow direction.

2 3.11 Screwed joints shall be properly fitted with the thread lubricant only applied to the male end in such a manner that will prevent compound reaching the interior of the pipe.

For the type of thread lubricant refer to Specification 14222-L-1.

3.12 Where seal welding is specified, the joints shall be made up without the application of thread lubricant and threads thoroughly cleaned from grease and oil. Seal welds shall cover exposed threads completely.

3.13 Following items shall never be seal welded:

Screwed Thermowells
Union Nuts
Screwed Ends of Gauge Glasses, Gage Cocks

3.14 Flanged joints shall be made up in such a manner as to avoid uneven loading of the gasket. Gasket compounds shall not be used. The length of machine and stud bolts shall be in accordance with ANSI Std. B16.5.

4. INTERFERENCES

Modifications to pipe routing may be necessary to avoid interferences. Such modifications shall be determined by the erector and shall be done in a neat and workmanlike manner and shall be reflected on "as-built" record drawings.

5. CLEANING

5.1 Piping spools shall be dry, thoroughly cleaned and free from dirt, slag and other loose foreign materials. Before assembly, they shall be cleaned by "up-ending" and rapping to dislodge any dirt and debris. Hot bends shall be turbined or otherwise cleaned to completely remove adherent burned-on sand. Special attention shall be given to lube and seal oil piping.

5.2 Completed systems shall be internally cleaned to remove all remaining dirt and foreign matter by water flushing or blowing with air or steam. Where special conditions exist, specific specifications will cover cleaning and preparations.

5.3 Flushing shall be done with clean water using hydrostatic test water where possible.

5.4 Compressor Suction Piping

5.4.1 Shortly before start-up the inside of all compressor suction piping shall be thoroughly cleaned to remove rust and scale.

Normally, the suction piping of a reciprocating compressor will be pickled between the suction K.O. drum and compressor flange. Suction piping of a centrifugal compressor is usually cleaned by air or gas blowing, sandblasting or other mechanical means.

5.5 Lube-Oil Piping

5.5.1 Shortly before start-up the inside of all lube-oil piping shall be thoroughly cleaned to remove rust and scale.

5.6 Chemical Cleaning

5.6.1 When specifically called for, lube-oil and compressor suction piping shall be pickled per specification 14222-L-8.

6. INSPECTION FOR COMPLETENESS

6.1 Upon completion of erection, piping systems shall be visually inspected for completeness, proper gasketing, proper valve installation, supporting, proper control valve installation, etc.

The P&ID's shall be used for this purpose.

7. TESTING

7.1 General Requirements

Process and utility pressure piping shall be tested as required by the applicable code and described herein.

7.2 Pressure Piping Defined

Pressure piping includes all piping designed to convey or contain process or utility fluids at either a positive or a negative internal pressure.

Open-ended vent, drain and like piping at essentially atmospheric pressure are not considered as pressure piping.

7.3 Boiler Code Piping

Piping governed by Section I, Power Boilers, of the ASME Boiler and Pressure Vessel Code shall be tested hydrostatically as described in Paragraph 137 of the Code for Pressure Piping, Power Piping, ANSI B31.1.

7.4 Refinery Code Piping

Pressure piping governed by the Petroleum Refinery Piping Code, ANSI B31.3, shall be hydrostatically tested as described in Paragraph 337 of that code.

Alternate tests are not permitted unless so specified.

Pneumatic testing shall not be applied without approval of the Project Engineer or unless so specified on the hydrostatic test diagram.

7.5 Test Source Information

7.5.1 Hydrostatic Test Diagrams

The hydrostatic test diagram will show the block limits for testing a system as well as the type and test pressure to be applied.

7.5.2 Initial Field Test Schedule for Equipment

This schedule shows the permissible test pressures for use in determination of the system test pressure.

7.5.3 Line Designation Tables

The Line Designation Table will show the type and minimum required line test pressure.

2 7.5.4 Piping Material Specification

Piping Material Specification 14222-L-1 shows by service class the maximum allowable test pressure for all piping specified to that service class except for specific lines listed in the Supplementary Table of Wall Thicknesses.

8. TESTS

8.1 Hydrostatic Test (Refinery Code)

Refinery Code piping shall be hydrostatically tested to a minimum pressure of 1-1/2 times the design pressure at any point in the system.

The test pressure shall be adjusted for temperature if the line operating temperature exceeds 650°F.

FORM 201

8.2 Operational Test

Low pressure systems may be tested by using the service fluid as the testing medium provided that:

8.2.1 The fluid is nonflammable and nontoxic such as steam, air, water, inert gas, etc.

8.2.2 The design pressure does not exceed 150 psig, and the design temperature does not exceed 360°F.

The following test procedure shall apply:

A preliminary check shall be made at not more than 25 psig. Thereafter the pressure shall be increased gradually in steps providing sufficient time to allow the piping to equalize strains during the test and to check for leaks.

8.3 Vacuum Piping

Lines in vacuum service, unless governed by specific design conditions, shall be tested at a minimum of 15 psig as specified in Paragraph 337.4.2 of ANSI B31.3.

8.4 Air Tests

Duct work and atmospheric pressure piping, for which hydraulic testing is impractical, will be air tested. Air tests will specifically noted in line designation tables.

8.5 Visual Examination

No pressure test is required of open-ended vent, drain and like piping. Such piping shall be checked thoroughly by visual examination after installation.

8.6 Flanged, Screwed and Socket Weld Closing Connections

Flanged connections at points where blinds are used during pressure tests do not require separate tests after test blinds are removed. Screwed and socket weld connections shall be inspected thoroughly after make-up to assure tightness.

8.7 Closing Welds

Where practical, pressure tests of piping shall include all closing welds between different parts of the system. Where it is not practical to include a closing weld in the pressure test, the weld shall be tested and examined in accordance with Paragraph 337.5.1 of ANSI B31.3.

8.8 Connections to Equipment

Piping test pressures shall not be applied to pumps or to other machinery except where specifically approved by Bechtel field engineer and client; and provided such procedure will not cause unsafe loads or other unreasonable hazards. Piping test pressures may be applied to connecting pressure vessels, exchangers, and like equipment designed for a similar test, at least equal to the required piping test pressure.

8.9 Test with Equipment

Connecting piping may be tested with pressure vessels or other equipment requiring field test provided resulting test pressure applied to piping is not greater than allowable or less than the required piping test pressure.

Care shall be taken when exchangers are included in the test. Both, tube and shell side shall be pressurized to avoid overstressing of tube sheets if these are designed for a limited differential pressure.

8.10 Jacketed Piping

In jacketed lines, the jacket shall be tested as described in Paragraph 337.4.2 of ANSI B31.3.

If the test pressure in the jacket is too high for the internal lines as an external pressure, the internal line shall be pressurized to minimize the differential pressure.

9. TEST MEDIUM

9.1 For hydrostatic testing the test medium shall be fresh water having a temperature between 60 and 100°F, except that any other suitable non-flammable liquid may be used if:

9.11 There is a possibility of damage due to freezing.

9.12 The operating commodity would be adversely affected by water.

9.13 The piping material would be adversely affected by water.

9.2 For pneumatic testing the test medium shall be oil-free air or any other nonflammable gas.

9.3 The test fluid shall not contain more than 30 ppm chlorides.

10. TEST PREPARATION

10.1 All joints in piping shall be accessible during test and shall not be painted, insulated, backfilled or otherwise covered until satisfactory completion of testing in accordance with this specification.

10.2 Test Loading

10.2.1 Care shall be taken to avoid overloading any parts of the supporting structures.

10.2.2 Piping which is spring or counterweight supported shall be blocked up temporarily to a degree sufficient to sustain the weight of the test medium.

10.2.3 Large piping designed for vapor or gas shall be provided with additional temporary supports, if necessary, to support the weight of the test fluid.

11. GENERAL TESTING REQUIREMENTS

11.1 Equipment which is not to be subjected to the pressure test shall be either disconnected from the piping or blocked off during the test. Valves may be used provided that the valve (including the closure mechanism) is suitable for the test pressure.

11.2 All orifice plates which interfere with filling, venting or draining shall be removed prior to testing.

11.3 Short pieces of piping which must be removed to permit installation of test blind shall be tested separately.

11.4 If expansion joints are to be included in the test, they shall be provided with temporary restraints if required.

11.5 When conducting tests at low metal temperatures (below 60°F) the possibility of brittle failure shall be considered and the Project Engineer shall be contacted for special requirements. Do not test when metal temperature is below 33°F. (Caution: Such low temperatures may also be caused by wind chill).

11.6 Piping containing check valves shall have the source of test pressure located on the upstream side of the check valve.

11.7 When test pressure is the same on both upstream and downstream sides of a control valve, the block and bypass valves shall be left open, with the control valve open.

11.8 When test pressure is different on upstream and downstream sides of a control valve, the test on upstream portion shall be made with the bypass valve closed, upstream block valve open, downstream block valve closed or blocked off, and the control valve open. If test pressure is too high for valve disc and seat, blinds shall be used instead.

11.9 Instruments such as relief valves, rupture discs, displacement and turbine meters, level gauges, transmitters, controllers, self-contained pressure regulators, rotameters, etc., shall be excluded from the hydrotest. The diaphragm connection on pressure balance control valves must be removed during test.

12. VALVES

12.1 The test pressure applied to valves shall not be greater than the maximum allowable test pressures specified below:

	Allowable Test Pressure PSIG	
Type of Valve	Body	Seat
200 lb bronze, screwed	600	600
125 lb cast iron flanged, 2" thru 12"	350	225
14" thru 24"	250	175
150 lb butterfly (Keystone Fig. 100)	425	150
150 lb ductile iron flanged	425	300
150 lb steel	425	350
300 lb steel	1,100	750
600 lb steel, except screwed and socket weld	2,175	1,500
600 lb steel, screwed or socket weld	2,175	2,100
900 lb steel, except stop-check	3,250	2,250
900 lb steel, stop-check	3,250	1,350
1500 lb steel, except stop-check	5,400	3,600
1500 lb steel, stop-check	5,400	2,250
150 lb corrosion resistant (MSS Patterns)	300	300
300 lb corrosion resistant (MSS Patterns)	900	600
Fabricated and Special Valves	(Follow manufacturer's recommendations)	

13. TEST RECORDS

13.1 Records shall be made of each system tested which shall include:

13.11 Date of test.

13.12 Identification of piping tested.

13.13 Test medium.

13.14 Test pressure.

13.15 Approval by the inspector.

13.2 Records for piping which require that pressure be held for a specified period of time shall include any corrections of test pressure due to temperature variations between the start and finish of the test.

13.3 Records for piping in which a specified leakage rate is permitted shall include the time at which water was added and the quantity added.

13.4 All test records and authorized Inspector's certifications shall be retained in the job records.

14. REFERENCES

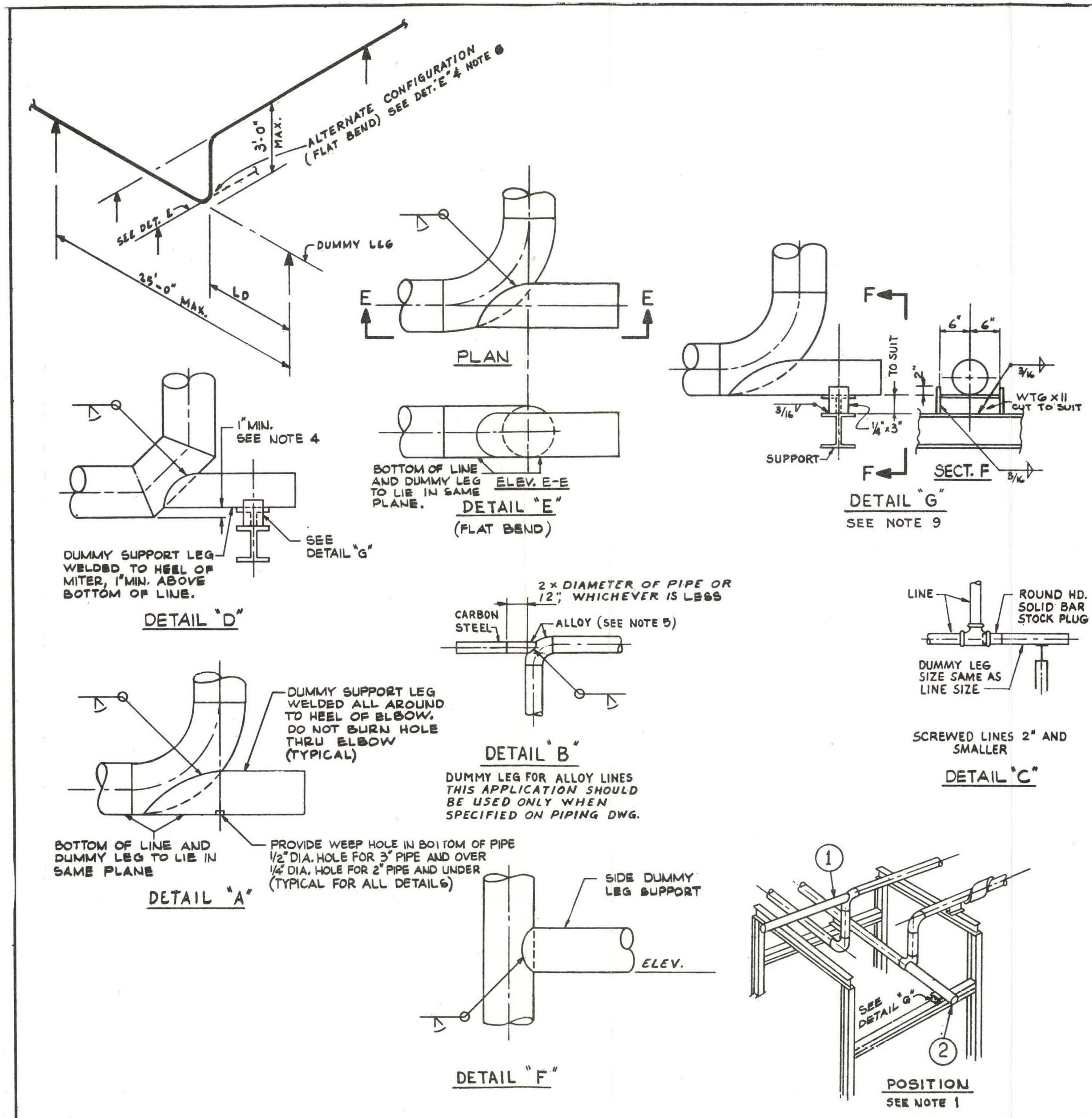
△2 14.1 Specification

14222-L-1	Piping Materials
14222-L-7	Coal Tar Coated and Wrapped Pipe
14222-L-8	Chemical Cleaning of Carbon Steel Piping
14222-L-5	Fabrication of Piping

14.2 Forms

L-539	Detail of Dummy Support Leg for Pipe Lines with Excessive Overhang
167	Welding and Non-destructive Testing
18	Line Designation Tables

SIZE C



NOTES:

Refer to Standard DWG. L-532, Overhanging Pipe Limitations.

1. If the curves on DWG. L-532 indicate line overhang to be excessive there are two alternatives.
   - (a) Reroute the line.
   - (b) Add dummy support leg as shown at lower position 2 or upper position 1 whichever is most economical.
2. Dummy legs for welded lines shall be fabricated with the spool, particularly alloy lines and lines requiring stress relieving.
3. For lines with butt weld or socket weld fittings extend support leg per detail "A".
4. For lines with mitered elbows extend support leg per detail "D." To prevent attachment weld overlapping miter weld, bottom of dummy leg should be a minimum of 1" above bottom of line.
5. Dummy legs for alloy pipes should be of carbon steel unless detail "B" is specified. When detail "B" is required the alloy shall be of same material as the pipe. Size of dummy leg shall be shown on the piping drawing.
6. For alternate configuration make bottom of pipe flush with B.O.L.
7. A line extended across support with end capped, results in a dead leg and should not be used unless a definite future extension of the line is foreseen. In such cases a flange and blind should be considered.
8. Add saddle per detail "G" to supports under dummy legs on insulated lines.
9. Except as noted in detail "B," dummy legs may be STD. WT. carbon STL. Pipe economically sized to suit span & load. For normal conditions dummy legs may be sized as follows:
   - (a) SCRD. Lines - See detail "C."
   - (b) Buttweld lines size 1-1/2" and smaller-dummy legs same as line size.
   - (c) Buttweld lines size 2"-dummy leg may be 1-1/2".
   - (d) Buttweld lines size 3" thru 8"-dummy leg may be one pipe size smaller than the line.
   - (e) Buttweld lines size 10" and larger D.L. DIA. = D.70 x NOM. Pipe DIA. Min. Unless noted otherwise on pipe isometric or piping orthographic DWG.

REVISION NOTES

6 REVISED DET'S OF DUMMY LEGS FR. STRUCT. ST'L TO PIPE – REVISED TITLE BLOCK FORMAT TO CONFORM W/STD DWG A-515

No.	Date	Revision	By				
6	6/74	SEE REV. 6 ABOVE	L.S.				
5	4/2/68	CHANGED & ADDED NOTE 10 - REVISED TABLE, CHANGED DETAIL B&E	JL				

SCALE NONE — E.S.W.

BECHTEL
SAN FRANCISCO

ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

DETAIL OF DUMMY SUPPORT LEG FOR PIPE LINES WITH EXCESSIVE OVERHANG

STD | L-539 | 6

PIPING CLASS OR SERVICE	CODE DESIGN CRITERIA	MATERIAL ASME SECT. IX		NOMINAL PIPE SIZE (INCH)	MAX. WALL THK. (INCH)	PREHEAT TEMP.(1)	POST WELD HEAT TREAT TEMP. (4)	WELDING (1) PROCEDURES	REV.	NON DESTRUCTIVE EXAMINATION RT, UT, MT OR PT (2)		NON PRESSURE ATTACHMENT MATERIAL	NON PRESSURE ATTACHMENT WELDING PROCEDURE (3)	REMARKS
		P-NO.	TYPE							SPECIFICATION	AMOUNT			

NOTES

1. FOR GENERAL REQUIREMENTS ON SHOP WELDING AND HEAT TREATMENT SEE SPEC. W-501 FOR GENERAL REQUIREMENTS ON FIELD WELDING AND HEAT TREATMENT SEE BECHTEL WELDING PROCEDURES PHT-500 AND PHT-501.
2. RT- RADIOGRAPHIC TESTING, MT- MAGNETIC PARTICLE TESTING, PT- LIQUID PENETRANT TESTING AND UT- ULTRASONIC TESTING.
3. PREHEAT AND POST WELD HEAT TREATMENT FOR NON PRESSURE ATTACHMENTS SHALL BE THE SAME AS FOR OTHER WELDS UNLESS OTHERWISE SPECIFIED IN THE "REMARKS" COLUMN.
4. POST WELD HEAT TREATMENT OF CARBON STEEL AT 1100°F MINIMUM IS REQUIRED WHEN THE WALL THICKNESS IS 0.75 INCH OR GREATER UNLESS OTHERWISE SPECIFIED IN THE "REMARKS" COLUMN.

BECHTEL

WELDING, HEAT TREATMENT AND NON-DESTRUCTIVE EXAMINATION OF PIPING

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-69
   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.

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2. ATTACHMENTS
3. CODES AND STANDARDS
4. MATERIALS AND WRAPPING REQUIREMENTS
5. NON-DESTRUCTIVE EXAMINATION
6. ENGINEERING
7. REFERENCES

FORM H-292 7-66

	10	REVISED SPEC. REFERENCE			
	11/11/80	ISSUED FOR PHASE ZERO	JK	HS	
0	2/21/80	ISSUED FOR APPROVAL		HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S.DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
COATED AND WRAPPED PIPE

JOB NO. 14222
SPECIFICATION 14222-L-7 REV 2

1. SCOPE OF WORK

The work includes the performance of all operations necessary for the coating and wrapping of carbon steel pipe in accordance with this specification.

2. ATTACHMENTS

In addition to the documents referenced in this specification, the following sources contain information pertinent to coating and wrapping of carbon steel pipe and the latest issue of same shall be considered a part of this specification.

2.1 Piping Material Specification

The piping material specification specifies, by service class, the requirements for coating and wrapping of carbon steel piping systems.

2.2 Purchase Order

The purchase order for shop applied coating and wrapping of carbon steel pipe shall include instructions supplementing requirements of this specification.

2.3 Where conflict exists between the aforementioned documents and this specification, the Seller shall contact the Buyer for clarification. No requirement of this specification shall have the effect of waiving the applicable code or standard unless more stringent than the code or standard.

3. CODES AND STANDARDS

3.1 Except where otherwise specified, all coating and wrapping of carbon steel pipe shall be in accordance with AWWA Standard C203-73 and Section A1.5 of the Appendix to AWWA Standard C203-73.

3.2 Where conflict exists between the aforementioned documents and this specification, the aforementioned documents shall apply. No requirements of this specification shall have the effect of waiving the applicable code or standard unless more stringent than the code or standard.

4. MATERIALS AND WRAPPING REQUIREMENTS

4.1 Materials

4.1.1 All materials shall be in accordance with AWWA Standard C203-73 and Section A1.5 of the Appendix to AWWA Standard C203-73.

4.1.2 The following materials or their approved equal shall be used for shop applied coatings:

4.1.2.1 Primer: Koppers Co. "JET SET" Type B

4.1.2.2 Enamel: Koppers Co. "708"

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4.1.2.3 Primer and enamel shall be obtained from the same manufacturer to assure compatibility.

4.1.2.4 Wrapping Materials:

a) Owens Corning Cormat 20; Johns Manville "Blue Flag" or equal.

b) Carey number 15 coal tar saturated felt (preformed) or equal.

c) Heavy wet strength Kraft paper, 100% sulfate smooth.

4.1.3 The following materials (or their equivalent) shall be used for field applied coatings:

Primer: Tapecoat Co. "TC Cold Prime"
Royston Roskote Mastic A51
Johns Manville Duratape Primer T-100

Wrapping: Tapecoat Co. "CT Tape Coat" (Double Wrap) or Royston Quik-Wrap Cold Applied Tape or Johns Manville Duratape Type W900-8 with or without Mylar Film.

4.1.4 The field wrapping thickness shall be between 90 and 100 mils.

4.2 Shop Coating and Wrapping

4.2.1 Prior to the application of primer all pipe shall be cleaned free of all loose mill scale, rust, corrosion products, dirt, grease, moisture or other foreign material. Grease or heavy oil shall be removed with a volatile solvent. Loose rust, mill scale, dirt, etc., shall be removed by abrasive blasting in accordance with SSPC-SP-6, using air (oil and moisture free). Impact wheels or knives and wire brush shall be used to remove tightly adhering mill scale. All pipe shall be cleaned with a minimum of one operation of the mechanical cleaning machine.

4.2.2 Primer shall be applied immediately after cleaning in accordance with requirements of AWWA Standard C203-73, Section 2.13.2.

4.2.3 Protection of primed pipe, prior to coating and wrapping, shall be in accordance with requirements of AWWA Standard C203-73, Section 2.13.2.4.

4.2.4 Following application of primer one 3/32" ± 1/32" coating of enamel shall be applied over the entire surface of the pipe to form a coating which cannot be peeled from the pipe. Application shall be by the machine method to the clean dry surface of the primed pipe at the temperature recommended by the manufacturer to produce best results, and not below the minimum temperature at which the enamel will fuse with the primer. Thickness and uniformity of the film shall be determined by visual inspection.

4.2.5 Immediately following application of the enamel and before enamel is cold, the specified fibrous glass mat shall be imbedded into the coating.

4.2.6 Immediately following application of the glass mat, an additional layer of 1/16" (minimum) shall be applied.

4.2.7 The second layer of enamel shall be followed by an outer-wrap of saturated asbestos felt securely bonded to the coating. The overlap at the edges of the wrappers shall not be less than 1/2 inch.

The wrappers shall be free of wrinkles and all end laps shall be cemented down with hot enamel to secure a firm wrapping.

4.2.8 All torn, abraded, or mutilated spots in the pipe coating shall be repaired by cleaning and priming the damaged area in accordance with paragraphs 4.2.1 and 4.2.2 and applying coating and wrapping in accordance with paragraph 4.2.3 through 4.2.7.

4.2.9 Coating and wrapping shall stop 6 inches from the ends of the pipe. This bare pipe shall be clean and primed to the end of the pipe to prevent rusting and reblasting in the field.

4.3 Field Coating and Wrapping

4.3.1 Prior to the application of primer the surfaces to be protected shall be cleaned free of all loose mill scale, rust, corrosion products, dirt, grease, moisture or other foreign material by wire brushing. Grease or heavy oil shall be removed with a volatile solvent such as xylol.

Petroleum type cleaners such as gasoline, diesel fuel, etc. shall not be used.

4.3.2 Primer shall be applied to the shop primed cut back surfaces before flood coating and shall be allowed to dry to a tacky consistancy.

4.3.3 Wrapping shall be applied spirally.

4.3.4 Wrapping shall be feathered at the pipe end to facilitate the field joint coating so that no abrubt edges are evident.

4.4 Field Joints of Shop Coated and Wrapped Pipe

4.4.1 Field joints shall be wrapped after the pipeline has successfully passed the hydrostatic test and the cathodic protection has been installed. Before priming, the bare pipe section shall be cleaned per par 4.3.1 and approx, 3" of wrapping at the end of precoated pipe sections shall be removed.

4.4.2 Primer shall be applied to the shop primed cut back surfaces and to that portion of the shop coating which is to be wrapped. Primer shall be allowed to dry to a tacky consistency.

4.4.3 Wrapping shall be applied spirally or cigarette type to primed surfaces, extending a minimum of 3" over the shop coating.

4.5 Field Repairs of Shop Coatings and Wrappings

4.5.1 When coatings require repair, the wrapping shall be removed to expose enamel or primed pipe and the exposed pipe shall be cleaned in accordance with paragraph 4.3.1.

4.5.2 Primer shall be applied to the exposed pipe, and that portion of shop coating that is to be wrapped, in accordance with paragraph 4.3.2.

4.5.3 Wrapping shall be applied spirally or cigarette type to primed surfaces extending a minimum of 3" from damaged area over the sound shop coating.

4.6 Handling of Coating and Wrapped Pipe

4.6.1 Coated and wrapped pipe shall be handled at all times with wide non-abrasive canvas or leather belts, or other equipment designed to prevent damage to coating. All such equipment shall be kept in repair so as to prevent injury to the coating. The use of tongs, bare pinch-bars, chain slings, rope slings, belt-slings with protruding rivets, or any other handling equipment found to be injurious to the coating, shall not be permitted. All skids used to support coated and wrapped pipe shall be padded. Walking on the pipe shall not be permitted.

4.6.2 For hot climates adequate protection shall be provided for coated and wrapped pipe to avoid sagging of coating during shipping and storage.

5. NON-DESTRUCTIVE EXAMINATION

5.1 All shop-applied coating and wrapping shall be inspected in accordance with AWWA Standard C203-73, Section 2.13.12, prior to shipment. All coated and wrapped pipe shall be inspected for voids, insufficient laps and other defects and required repairs shall be made in accordance with paragraph 4.2.8.

5.2 After application of all field coating and wrapping, all coated and wrapped pipe (both shop and field) shall be inspected for voids using a holiday detector and required repairs shall be made in accordance with paragraphs 3.1 and 4.5.

6. ENGINEERING

6.1 The Seller shall maintain records on all materials, and non-destructive examination for all coated and wrapped pipe specified herein. All such records, certificates, test data and reports shall be on file with the Seller and shall be available for Buyer review and copies of same shall be sent to Buyer upon request.

6.2 All requests for substitutions, modifications, or relaxations of this specification or the documents referenced in this specification shall be fully stated in writing for the consideration of the Buyer.

7. REFERENCES

2 Specification 14222-L-1 Piping Materials

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5. PROCEDURE FOLLOWING CLEANING (BY CONTRACTOR)
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1	11/11/80	ISSUED FOR PHASE ZERO	JK	HS	ZGS
0	2/21/80	ISSUED FOR APPROVAL	JGH	HS	

ASFI THE BRECKINRIDGE PROJECT AECI	JOB NO. 14222		
U.S.DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717	SPECIFICATION	REV	
PROJECT SPECIFICATIONS			
CHEMICAL CLEANING OF CARBON STEEL PIPING AT JOBSITE	14222-L-8	1	

1. SCOPE

1.1 This specification covers procedures for removal of lacquers, residual oils, greases, mill scale, and rust, from the interior surfaces of carbon steel piping systems, and protection of the cleaned surfaces.

1.2 Chemical cleaning of a system is usually done by a subcontractor who specializes in this type of work, and who has suitable equipment as well as experience with the use of various types of cleaning agents.

1.3 Section 3 of this specification describes in detail one acceptable cleaning procedure using inhibited hydrochloric acid. This detail is included to:

a) Indicate , in general, the quality and thoroughness desired in any procedure to assure adequate cleaning and subsequent metal protection, and:

b) Provide a step-by-step procedure which may be used in the field if it is decided for any reason not to subcontract this work.

1.4 Alternate procedures with alternate materials may be proposed, subject to approval and agreement. Such alternates must be capable to achieving acceptable cleanliness and corrosion rates equivalent to those attainable by procedure outlined.

1.5 Certain pre-cleaning preparation should be done (normally by the contractor) before starting the cleaning procedure. The extent to this work and the specific items which may be included in the subcontractor's work may vary for difference projects and should be established before proceeding with the work. The contractor will furnish the necessary information, drawings, and/or access to the installation to establish the subcontractor's scope of work for his proposal.

1.6 Subcontractor's proposal for the work shall include a diagrammatic sketch (preferably a rough isometric drawing) showing the piping circuitry to be used in the cleaning operation. The sketch shall show temporary jumper, bypasses, and location of vents and drains. It is necessary to clean the system in sections, a sketch shall be provided for each section. The subcontractor's proposal shall indicate the manner in which any "dead ends" in the circuit are to be properly cleaned and flushed.

1.7 The subcontractor shall be responsible for the safety of personnel and equipment in the area where the work is being performed. The safety regulations of OSHA, the contractor, and the owner shall be observed. The subcontractor shall institute any further precautionary measures he deems necessary for the proper protection of personnel and equipment.

2. PRE-CLEANING PREPARATION (BY CONTRACTOR)

2.1 Install high point vents, low point drains and blind end bleed-off connections.

2.2 Hydrostatically test the piping system to design hydrostatic test pressures, if this has not been done previously.

2.3 Remove or isolate from the system to be cleaned, all parts constructed from materials which are subject to corrosion attack by the cleaning medium. Materials to be removed will depend on the <u>cleaning chemicals used</u>. This shall be firmly established in collaboration with the subcontractor before starting this step.

2.4 Disconnect all machinery piping which is to be chemically cleaned, and plug or blind all machinery openings. Extreme care shall be exercised to prevent the entry of any cleaning chemical or vapors into any part of the machinery.

2.5 Remove all control valves, pressure gauges, flow orifices, transmitters, or other instruments that may be damaged by the cleaning procedure.

2.6 Install temporary piping as required to control flow through the system and hydrostatically test joints for leaks at sufficient pressure to insure tightness during cleaning.

2.7 All items removed per 2.3 and 2.5 shall be properly tagged, protected, and stored.

3. <u>CLEANING PROCEDURE (BY SUBCONTRACTOR)</u>

The following procedure will provide satisfactory cleaning. Alternative procedures may be submitted by the subcontractor for approval if he believes equivalent results will be obtained with his procedure.

3.1 <u>Inhibited Hydrochloric Acid Cleaning Procedure</u>

3.1.1 Remove or isolate from the system to be pickled items such as valve trim, pumps, etc., made of twelve percent chromium steel, 18-8 stainless steel, and other materials that are attacked by dilute inhibited hydrochloric acid at the temperatures and concentrations stated below. Coolers should be bypassed or tube bundles removed prior to cleaning. Filters should be bypassed to prevent damage to the internals. Refer to 2.3, 2.4 and 2.5 above.

3.1.2 Use high pressure air, steam or water to mechanically clean the interior of the pipe to assure removal of loosely held scale and other particles. Wherever possible, wire brush accessible areas.

3.1.3 Circulate a degreasing solution through the pipe for approximately two hours at 160°F. The degreasing solution shall be one of the following compositions:

3.1.3.1 Three percent by weight sodium hydroxide; three percent by weight sodium metasilicate; 0.01 percent by weight wetting agent.

3.1.3.2 Six percent by weight trisodium phosphate plus 0.01 percent by weight wetting agent may be used.

3.1.4 Flush with water until the degreasing solution has been completely removed, verifying removal by a litmus paper test. Open vents and all low point drains. Manually clean dirt deposits at low points and large volumes where the velocity was low.

3.1.5 Pickle the system to bare metal by circulating one of the following solutions:

3.1.5.1 Fifteen percent by weight inhibited hydrochloric acid for four to six hours at room temperature.

3.1.5.2 Ten percent by weight inhibited hydrochloric acid for two to four hours at 140°F.

3.1.5.3 Five percent by weight inhibited hydrochloric acid for four to six hours at 160°F.

In all cases, the pickling process should be stopped as soon as bare metal has been attained.

3.1.6 Drain pickling solution and rinse with a solution of 0.01 percent by weight citric acid, and drain system.

3.1.7 Circulate neutralizing and passivating solution through the system for a period of thirty minutes at 180°F, and then drain. This solution has the following composition:

0.25 percent (by weight) monosodium phosphate;
0.25 percent (by weight) disodium phosphate;
0.50 percent (by weight) sodium hydroxide;
0.50 percent (by weight) sodium nitrite.

One of the following alternate acceptable methods of neutralization and passivation may be used:

3.1.7.1 To a solution of 0.25 percent by weight citric acid add enough ammonia until the PH is ten. This solution is circulated in the system for approximately one hour.

3.1.7.2 Neutralize with 0.50 percent soda ash at 170°F. Passivate with a solution having the following composition:

0.50 percent (by weight) sodium nitrite.
0.25 percent (by weight) monosodium phosphate.
0.25 percent (by weight) disodium phosphate.

The passivating solution is to be circulated for 30 minutes.

3.1.8 After draining the neutralizing and passivating solution, the system shall be rinsed with clean fresh water until the pH of the water is approximately 7.0.

3.2 After the cleanliness of the system has been accepted by the contractor, subcontractor shall clean all areas where chemicals have spilled or splattered during the work. Remove all tools, apparatus, rubbish and waste materials to the approval of the contractor.

4. ALTERNATIVE CLEANING PROCEDURES (BY SUBCONTRACTOR)

4.1 In case stainless steel or 12 Cr cannot be isolated or removed such as with socket welded valves, one of several alternates shall be used. These proprietary methods include inhibited citric acid, phosphoric acid, hydroxy acetic acid, formix acid, etc. Cleaning subcontractors shall provide with their proposals, a complete description of any alternative procedures which they propose to use.

5. PROCEDURE FOLLOWING CLEANING (BY CONTRACTOR)

5.1 Immediately following cleaning, passivating, and rinsing, the system shall be blown out with hot air until the metal is dry.

5.2 Control valves, trim, stainless parts, etc., removed under Paragraphs 2. and 3. shall be re-installed.

5.3 After dry-out the following protective measures shall be taken to protect the cleaned piping and equipment.

5.3.1 Lube Oil, Seal Oil, or Hydraulic Oil Systems

Coat inside of piping with mineral oil and seal off all openings with plugs or blind flanges with gaskets. Alternatively, connect all piping into final position, fill the console reservoir with compressor oil and circulate oil through the systems until all surfaces are thoroughly covered with oil. Seal off the system, including the vent on the oil reservoir. Clearly mark the seal on the reservoir vent for removal prior to startup.

5.3.2 Compressor Suction Piping (Reciprocating compressors only)

Install blinds on the compressor suction nozzle and at the compressor suction drum. Nitrogen blanket the suction piping at positive pressure until startup.

6. INSPECTION

6.1 The contractor's Construction Superintendent or Resident Engineer shall be notified prior to cleaning so that the cleaning procedure may be observed at their option. Regardless of the procedure used, acceptance shall be based on adequacy of scale removal demonstrated to the above, by visual inspection at all accessible points.

6.2 A removable greasy and rusty test specimen of steel shall be provided at a convenient point in the system so it may be removed to observe the progress of the cleaning operation.

6.3 A preweighed, stressed, carbon steel corrosion coupon shall be placed in the circulation system by which corrosion during the process may be monitored and end result corrosion may be calculated.

7. DISPOSAL OF CHEMICALS AND FLUSHING MEDIA

7.1 All chemical streams, rinses and drains shall be contained, or shall be collected in suitable vats or tanks. No streams shall be allowed to drain upon the ground or create a mess in the plant area.

7.2 Disposal of chemicals, rinse water and flushing oils shall be coordinated with the contractor's field personnel. Approval should be obtained prior to draining any material to an existing sewer system. Proposed method of disposal shall include neutralization of drain streams to a pH of about 7.0. If disposal at the site is not feasible, subcontractor shall remove waste materials from the premises.

8. INTERRUPTED SCHEDULE

When it is necessary to do the chemical cleaning by an interrupted schedule with a shut-down at night or over a week end, the shut-down point shall be on completion of a water flush. The second point of shut-down shall be following the blowing with clean air. If the circulation of flushing oil is delayed more than the time necessary to make the switch in the sequence of operation, then the system should be pressurized with nitrogen, and shut-in under pressure until convenient to circulate flushing oil.

9. GUARANTEE

9.1 Subcontractor shall give written guarantee of the effectiveness of removal of mill scale and other oxides.

9.2 Subcontractor shall give written guarantee stating maximum amount of base metal which will be removed during the cleaning operations.

9.3 Subcontractor shall give written guarantee stating maximum amount of time cleaning operation will take.

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7. REFERENCES

FORM H-292 7-66

10-21-81	ATTACHED FORMS				
11/11/80	ISSUED FOR PHASE ZERO	JK	HS		
2/21/80	ISSUED FOR APPROVAL		HS		

1. SCOPE

This specification describes general requirements governing layout and spacing of plant equipment and units to provide for safe and easy operation, maintenance, fire prevention and control.

2. PLANT LAYOUT

The primary consideration in arrangement of units and equipment is to provide an economical facility, safe and easy to operate and maintain. The arrangement shall favor compactness and integrated disposition of units and equipment. Additional space for future needs will be provided only where specifically requested by job specifications.

2.1 Piping Layout

See Project Specification 14222-L-4.

2.2 Equipment Layout

Minimum clearance requirements of the Occupational Safety and Health Administration (OSHA) and the Oil Insurance Association (OIA) for locating equipment, and other clearances Bechtel considers to be good practice, are shown in Engineering Standard Drawings A-521 and A-522 and given in Specification 14222-L-4 and the following paragraphs.

2.3 Pumps

To minimize damage to overhead electrical, instrument and piping runs in the event of fire. Pumps should be located outboard of overhead pipeways.

Pumps Locations

a) When outriggers are used in an overhead pipeway, locate the pump discharge nozzle 3'-0" min. from the outside edge of the outrigger.

b) When no outriggers are used in an overhead pipeway, locate the pump discharge nozzle 5'-0" min. from the center line of the pipeway column.

2.4 Compressors

Large compressors may be elevated sufficiently to permit piping and auxiliaries to be located below operating platform. Small compressors may be grade mounted with piping and auxiliaries arranged for convenient access and maintenance.

2.4.1 Provide either a bridge or gantry crane or unobstructed access for a mobile crane to permit easy removal of compressor components.

2.4.2 Where climatic conditions dicate, shelters shall be provided for protection of equipment and personnel. If a mobile crane is to be used for removal of compressor components, shelter roof sheeting shall be designed in removable sections.

FORM 203

2.5 Vessels

2.5.1 Vertical Vessels shall be placed on a common centerline parallel to the main pipeway, unless design conditions dictate otherwise.

2.5.2 Horizontal Vessels shall be located to minimize piping runs and where practical, be lined up with their tangents on a common locating line on the pipeway side of the unit. Under no condition can the vessel and its piping encroach into established operating or access aisles.

2.5.3 Provide davits on top of vessels to handle relief valves 2" and larger, internals, etc., that are not available to mobile equipment. Orient davits in such a way, as to permit the lowering of this equipment to a clear area at grade. For vessel davits, see Engineering Standard Drawing M-507 and C-509.

2.6 Exchangers

2.6.1 Shell and tube exchangers shall be located with a common channel nozzle center line away from pipeways to facilitate tube bundle removal. The exchanger with the largest overall length will set this center line. Under no condition can the vessel and its piping encroach into established operating or access aisles.

2.6.2 For exchangers under drums or unit structures, the channel end should be clear of overhead obstructions for handling of channel end by mobile equipment.

2.7 Air Coolers

Air coolers shall be located so as to provide for safe and practical access for operation and maintenance. They may be located in the equipment areas or over pipeways. Provide sufficient access to permit removal or replacement of tube bundles, fans and drivers. Do not locate air coolers over a potential source of fire such as a light ends pump or hot oil pump with stock at or over its auto-ignitor point. Care shall be taken to keep bare hot lines or other hot equipment out from under the air intake to coolers and also to prevent recirculation of heated air.

2.8 Fired Heaters and Boilers

2.8.1 Furnaces and boilers shall be located near plot boundary for easy access. Tube pulling shall generally be by mobile crane. Adequate dropout and swinging space shall be provided. External piping shall be minimized at the tube pulling end of equipment. Road access shall also be provided at tube pulling end.

2.8.2 Where practical and economical, fired equipment shall be grouped together. Common stack(s) are permitted when they are more economical; however, dampers or suitable barriers must be provided in individual ducting to the stack.

2.8.3 Prevailing winds should be considered, and vessels, pumps, compressors and other equipment handling light hydrocarbons should be located downwind of fired heaters to minimize the possibility of vapors being carried toward open fires. Heater orientation and use of wind boxes shall be considered if operation would be affected by the maximum winds anticipated in the area.

2.9 Pipeways

2.9.1 Pipeways shall be sized for present needs plus 25%. This practice assumes a contingency of 10% at the outset of the job but anticipates this will have been used upon completion of engineering, leaving 15% for future needs.

2.9.2 Pipeways shall be generally overhead in units and at grade between main plant subdivisions. Overhead pipeways shall generally not be more than two decks high. The upper deck shall carry main utility headers and process piping. Pipeway elevations within Process Areas shall be as indicated on Engineering Standard Drawing A-522.

3. CLEARANCE AND ACCESSIBILITY

3.1 Overhead Clearances

3.1.1 Equipment, structures, platforms, piping, and its supports shall be arranged to provide the following minimum overhead clearances.

a) Over railroads, top of rail to bottom of any obstruction - - - - - - - - - - - 22 1/2 Feet

b) Over plant roads, for major mobile equipment - - - - - - - - - - - - - - - - 20 Feet

c) At pump row accessway, (under pipeway) to nearest obstruction - - - - - - - - - - - - - - - 12 Feet

d) Over pumps and turbines, from high point of grade - - - - - - - - - - - 8 Feet

e) Overhead walkways, passageways, and platforms, to nearest obstruction - - - - - - - 7 Feet (Except at dead ends)

3.2 Horizontal Clearances

3.2.1 Equipment, structures, platforms, piping and its supports shall be arranged to provide the following minimum horizontal clearances.

a)	Fired heaters to pumps and other flammable-containing equipment (exclusive of compressors) - - - - - - - - - - Reactors and feed/effluent exchangers may be situated closer than 50 feet to their associated heaters.	50 Feet
b)	Fired heaters to equipment handling non-flammable liquids - - - - - - - - - - - - - -	25 Feet
c)	Fired heaters to compressors handling flammable vapors - - - - - - - - - - - - - - - -	100 Feet
d)	Minimum spacing between large compressors - - -	8 Feet
e)	Compressors handling flammable vapors to non-associated process pumps, vessels, etc. - - - - - - - - - - - - - - - - - -	25 Feet
f)	Back of control panels - - - - - - - - - - - - -	4 Feet
g)	Operating Aisles - - - - - - - - - - - - - - - - -	4 Feet
h)	At driver end of pumps, where truck access is not required - - - - - - - - - - - - -	5 Feet
j)	At driver end of pumps, where truck access is required - - - - - - - - - - - - - -	10 Feet
k)	Under pipeways, between driver end of pumps, where access for an Austin-Western, Model 410 or equal is required - - - - - - - - -	18 Feet
l)	At shell cover end of exchangers at grade, for access way - - - - - - - - - - - - -	4 Feet
m)	Maintenance platform at channel end of elevated exchangers - - - - - - - - - - - - - -	3 Feet
n)	Maintenance platform at shell cover ends of elevated exchanger - - - - - - - - - - - - -	3 1/2 Feet
p)	In front of manways - - - - - - - - - - - - - -	3 Feet
q)	Minimum passageways at grade and on elevated platforms - - - - - - - - - - - - - - - -	2 1/2 Feet
r)	Between extremities, including piping of adjacent pumps - - - - - - - - - - - - - - - -	2 1/2 Feet
s)	Between extremities, including insulation, of paired exchangers or vessels - - - - - - - -	18 Inches
t)	Between piping and handrails, or between other obstructions, where occasional access is required for maintenance only - - - - - - - - - -	18 Inches

FORM 293

3.3 Access for Maintenance

3.3.1 Valve and Instrument Access

Operator access including platform and ladder requirements for valves and instruments are shown in paragraphs 4.2 and 6.4 of Project Specification 14222-L-4.

3.3.2 Crane Access

Equipment, structures, and piping shall be arranged to permit crane access to compressors, air coolers and major equipment parts not provided with built-in maintenance facilities.

3.3.3 Access to Pumps

Clear access, both vertically and horizontally will be provided under main pipeways for trucks or mobile equipment to service pumps.

3.3.4 Access to Exchangers

a) Whenever possible, tube bundles shall be removed with a mobile crane and tube bundle extractor. Permanent monorail structures will be provided only where crane access is impractical. Where required, the monorail shall extend far enough beyond exchanger channel end to permit full use of hoists to pull and lower tube bundle to grade.

b) Where built-in handling facilities are not provided, clear space for tube-bundle removal by mobile crane shall be provided. A clearance 1 1/2 times the bundle length in front of the exchanger measured from the tube sheet and extending 20 ft. on at least one side shall be provided.

3.3.5 Exchanger Shell Covers

Davits or other suitable means shall be provided to handle exchanger shell covers not accessible to mobile equipment. For exchanger shell cover davits, see Engineering Standard Drawing M-505.

3.3.6 Catalyst Loading

Adequate space shall be provided for handling and storage of catalysts (both fresh and spent), including mobile equipment access where appropriate.

3.3.7 Lowering Areas

Clear areas shall be provided at grade on the access side of elevated equipment for lowering external and internal fittings.

4. PLATFORMS, STAIRS AND LADDERS (ACCESS AND LAYOUT REQUIREMENTS)

Platforms, ladders, and stairways shall be the minimum consistent with access and safety requirements. For additional details, see Project Specification 14222-M-1 and Standard Drawings M-506, M-508, M-513, M-517, M-529, and M-532.

4.1 Platforms with Stair Access

Platforms with stair access shall be provided at:

4.1.1 Points which must be serviced once or more per 8 hour shift (furnace firing platforms, boilers, etc).

4.1.2 Locations serving mechanical equipment.

4.2 Platforms with Ladder Access

Platforms with ladder access shall be provided at:

4.2.1 Exchangers with centerline located 12 ft. or more above grade.

4.2.2 Points which require operating access less frequently than once per 8 hour shift, including valves and motors, etc.

4.2.3 Points requiring access for maintenance, including column or vessel manways except as listed in sub para a) below, nozzle flanges, relief valves, removable heads or covers, top flange of vertical reboilers, etc.

a) Platforms are not required for manways, when manway centerline elevation from grade is:

1. 15 feet and under without internals.

2. 12 feet and under with internals.

4.2.4 Air Coolers, with interconnecting walkways provided to service valving, fan motors and instruments.

4.3 Dual Access Requirements

Two means of access shall be provided at:

4.3.1 Elevated platforms 10 feet or more above grade serving three or more vessels, when lack of such means might prevent escape of personnel.

4.3.2 Any platform serving fired process equipment.

4.3.3 Any platform serving two or more pieces of equipment which are concurrently maintained or operated.

4.3.4 Large elevated structures, if any part of platforming has more than 75 - feet of travel from a single access.

4.4 Ladder Requirements

4.4.1 Side access ladders are preferred to front access ladders.

4.4.2 The maximum straight run of ladder between landings without offset is 30-ft. 0-in.

4.4.3 Whereve practicable, ladders shall be arranged so the user faces toward equipment or structures rather than facing open space.

FORM 203

5. SPACING BETWEEN FACILITIES

5.1 Process Areas

Process units shall be located a minimum of 50-feet apart, (battery limit to battery limit). Additional minimum spacing requirements are per Engineering Standard Drawings A-521 and A-522.

5.2 Tankage Areas - Off Plot

Storage tank clearances shall conform with the Federal Register, (OSHA) Part 1910.106 Section (b) and tank storage and the Minimum Spacing Standards as set forth by the (OIA) Oil Insurance Association. Some guidelines for minimum requirements and spacing are shown on Engineering Standard Drawing A-521

2

6. MISCELLANEOUS REQUIREMENTS

6.1 Tank Dike Enclosures

Walls of a diked area shall be of earth, steel, concrete or solid masonry and be liquid tight to withstand a full hydrostatic head.

6.11 Size, Height and Access

a) Size and height of dikes shall conform to Engineering Std. Drawing A-521 in Project Specification 14222-A-7.

b) Tanks shall have at least one side adjacent to an access road.

6.2 Roads

2

For the design of roads within a plant site, see Project Specification 14222-S-2.

6.3 Railroads

For railroad standards details and legal clearances, see Engineering Standard Drawing M-516.

6.4 Satellite Shelters

Satellite shelters or windbreaks may be required depending on distance from central control building, percentage of time operating personnel must remain in area, importance of function and weather.

7. REFERENCES

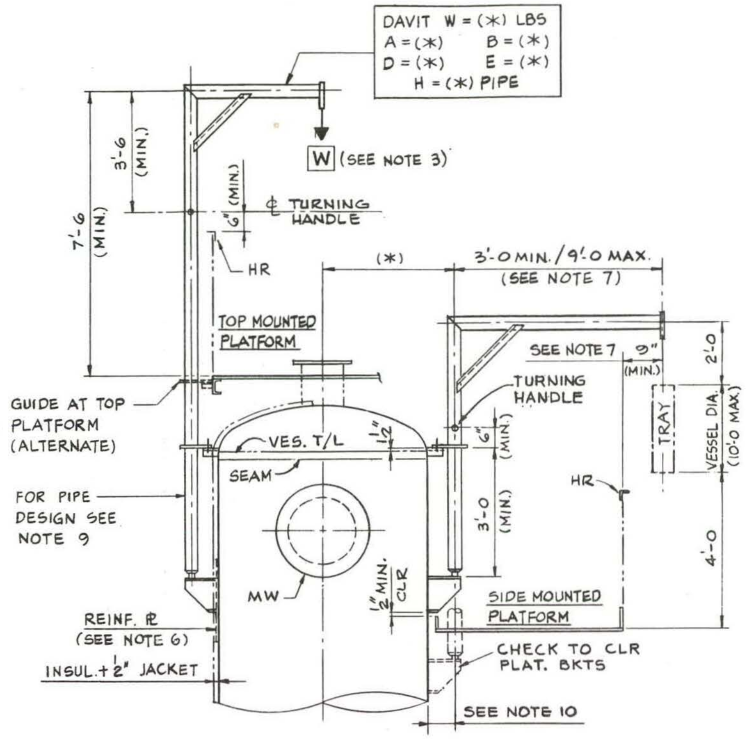
Project Specifications

14222-L-4	Plant Design & Piping Layout
14222-M-1	Structures
14222-S-2	Roads and Paving Design

Standard Engineering Drawings

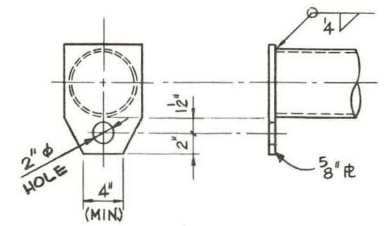
M-516	Railroad Std. Details & Clearances
A-521	Minimum Spacing Requirements of Equipment in Process & Off-Plot Tankage Areas
A-522	Cross-Section, Typical Process Unit
C-509	Manhole Davits for Vessels
M-505	Exchanger Shell Cover Davits
M-507	Top Davits for Vessels
M-508	Ladders & Platforms
M-513	Vessel Platform Details
M-517	Vessel Platform Details
M-529	Assembly Details - Ladder and Cages
M-532	Platform & Structures

SIZE D 22 X 34



TYPICAL DAVIT ARRANGEMENT

FOR LAYOUT GUIDE ONLY



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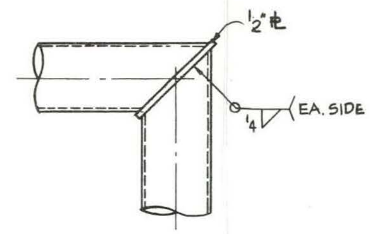

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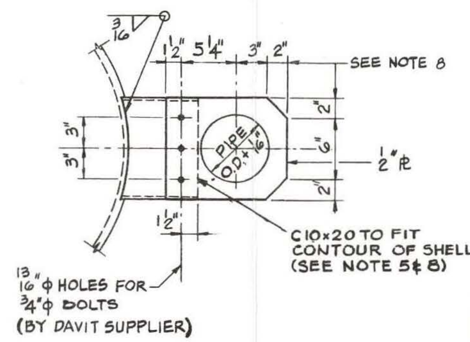
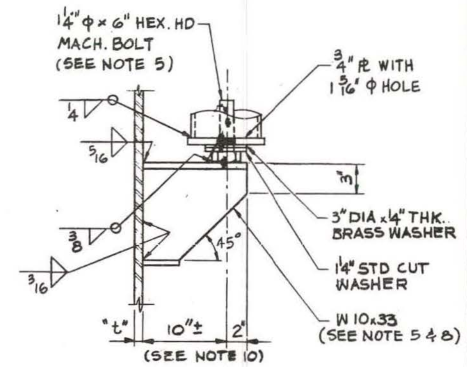


SECTION A



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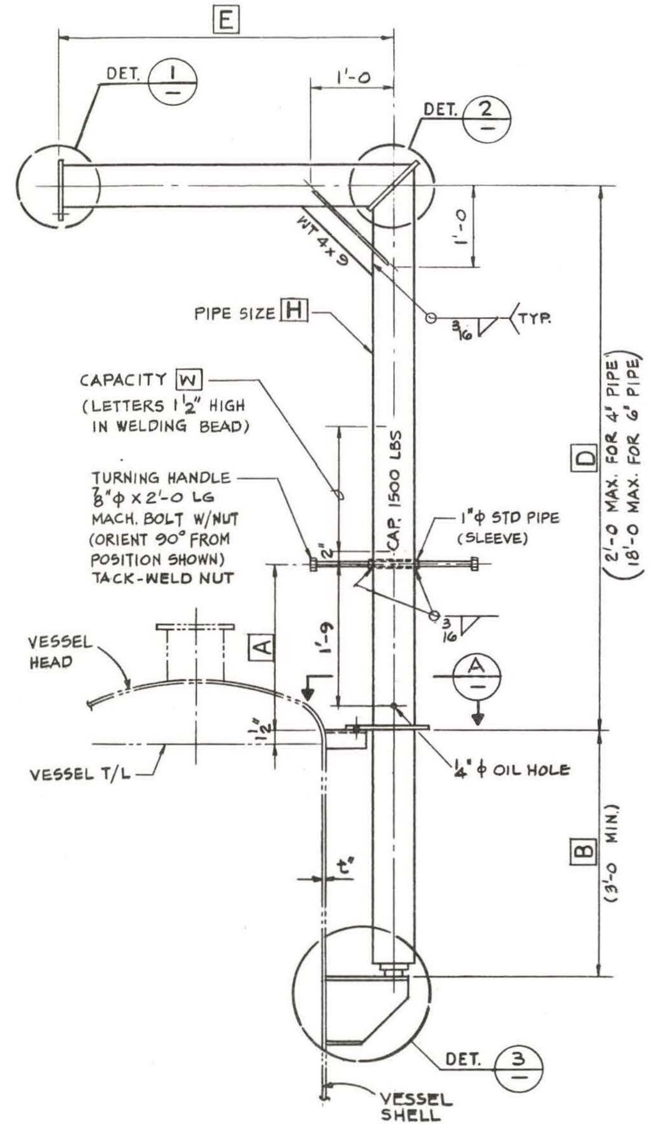


TYPICAL DAVIT DETAIL

GENERAL NOTES

1. FOR INFORMATION NOT SHOWN SEE DESIGN DRAWING.
2. (*) DENOTES DATA REQUIRED ON DESIGN. DRAWING.
3. THE DAVIT CAPACITY "W" IS THE ALLOWABLE LIFTED WEIGHT. ALL DAVITS SHALL BE DESIGNED FOR A MINIMUM "W" OF 1000 LBS EXCEPT AS NOTED IN NOTE 9a.
4. LOAD "P" = 2.25 W - THIS ALLOWS FOR A VERTICAL LOAD LINE PULL EQUAL TO LIFTED WEIGHT PLUS 25% IMPACT.
5. ALL ATTACHMENTS TO VESSELS ARE SUPPLIED BY THE VESSEL SUPPLIER UNLESS OTHERWISE NOTED. FOR STRESS RELIEVED VESSELS, INSTALLATION MUST PRECEDE STRESS RELIEVING.
6. VESSEL REINFORCING PLATE REQUIREMENTS FOR SHELL INDENTURE SHALL BE LOCATED AND DETAILED ON THE VESSEL DRAWING.
7. DAVIT ARM "E" SHALL BE SUCH THAT END SWINGS OVER LOAD TO BE LIFTED (SAFETY VALVE, ETC.) OR EXTEND A MINIMUM OF 9" BEYOND PLATFORM IN THE DESIGNATED LET-DOWN AREA, WHICHEVER IS GREATER.
8. DIMENSIONS AND SIZES ARE STANDARD UNLESS OTHERWISE SPECIFIED ON DESIGN DRAWING.
9. DAVIT PIPE DESIGN (SEE NOTE 4):
   a) MAX. (W) FOR 4" SCH 40 PIPE = 800 LBS
   b) MAX. (PxE) FOR 4" SCH 40 PIPE = 5400 FT-LBS
   c) MAX. (PxE) FOR 4" SCH 80 PIPE = 7100 FT-LBS
   d) MAX. (PxE) FOR 6" SCH 40 PIPE = 14200 FT-LBS
   e) MAX. (PxE) FOR 6" SCH 80 PIPE = 20400 FT-LBS
10. THE DISTANCE FROM VESSEL SHELL TO CENTER OF DAVIT IS LIMITED TO THE DEPTH OF THE BOTTOM DAVIT SUPPORT.

NO.	DATE	REVISIONS	BY	CH'K	DESIGN SUPV	ENG'R	PROJ. ENGR	APPR
2	10/1/78	REVISED & REDRAWN	K.L.	RGP				

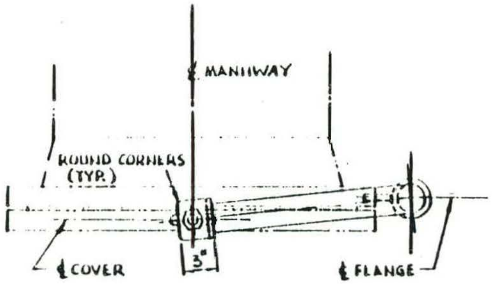
SCALE NONE | DESIGNED | DRAWN K. LEONG

BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

TOP DAVIT FOR PROCESS VESSEL

JOB No.	DRAWING No.	REV.
STANDARD	M-507	2

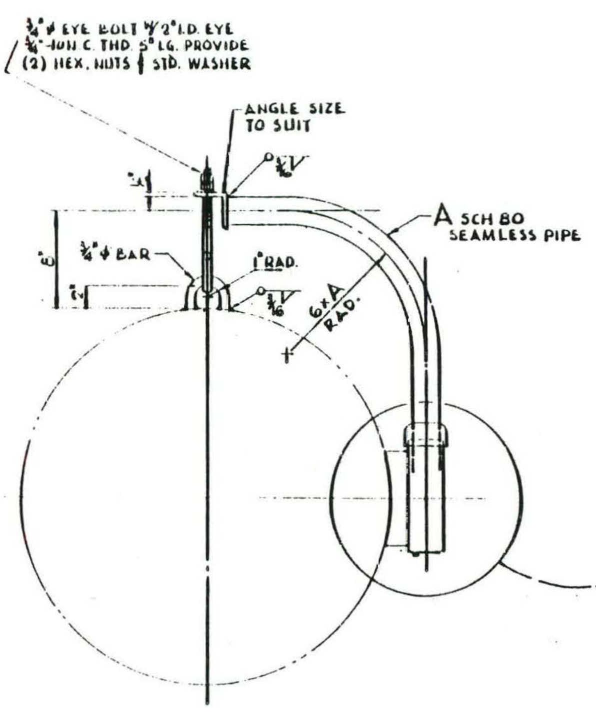


PLAN

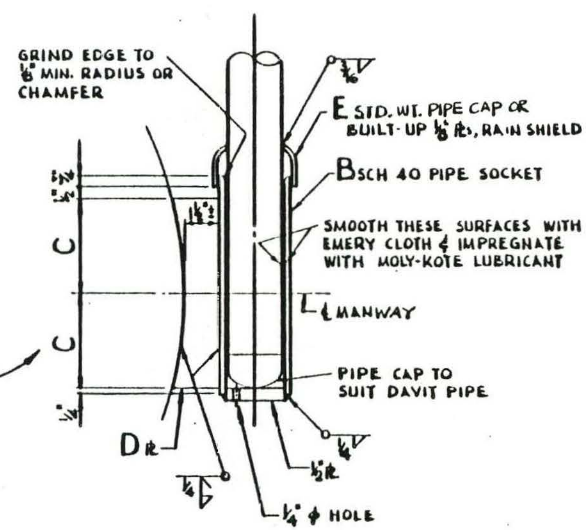
A	B	C	D	E	MAXIMUM FLANGE SIZE AND RATING (SEE NOTE 2)			
					18"	20"	24"	30"
1½"	2"	4"	¾"	3"	150#	150#	—	—
2"	2½"	5"	⅞"	3"	600#	300#	150#	—
2½"	3"	6"	1"	4"	—	600#	300#	300#

NOTES:

1. ALL MATERIAL SHALL BE CARBON STEEL
2. ALL FLANGES ARE ANSI STANDARD, EXCEPT 30" SIZE TO BE API-605



ELEVATION



NO.	DATE	REVISIONS	BY	CH'K	DEPT. SUPV.	ENGR	CHIEF ENGR.	CLIENT
2	5/77	REVISED NOTE 2 AND FLG. RATING FOR 20" & 24" [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
1	1/62	FORMERLY DWG C-C-509						
0	[illegible]	ISSUED AS ENGINEERING STD	YCL	[illegible]	[illegible]	7	[illegible]	

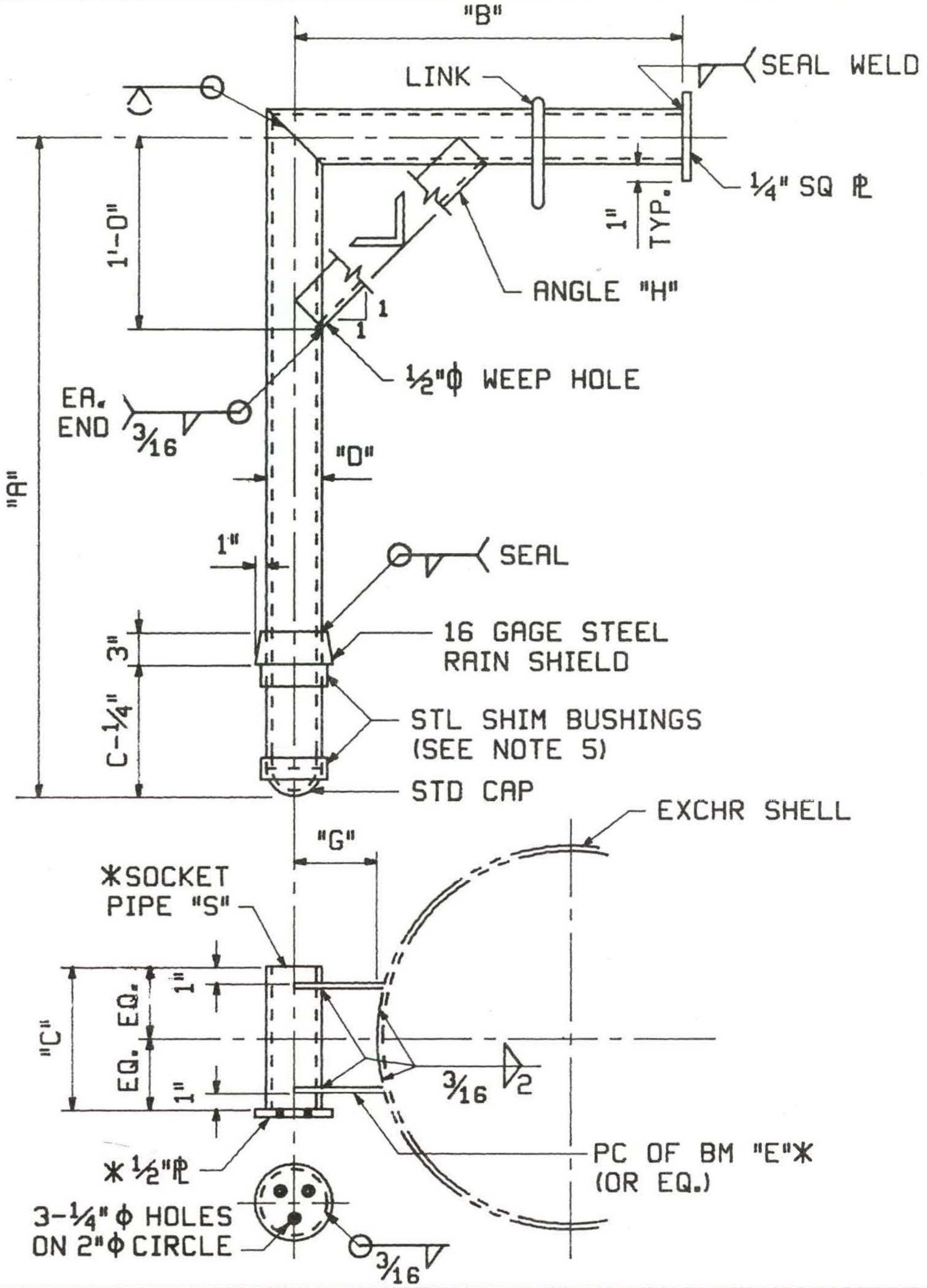
BECHTEL
SAN FRANCISCO

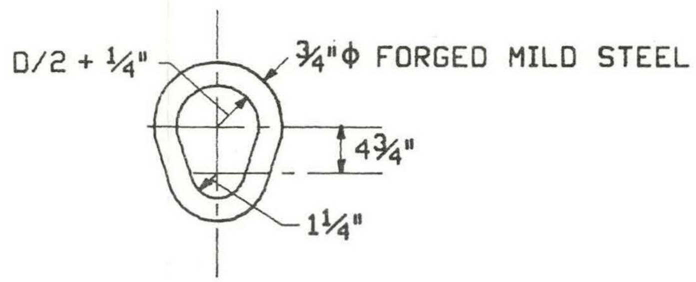
ENGINEERING STANDARD
REFINERY & CHEMICAL DIVISION

MANWAY DAVITS FOR VESSELS

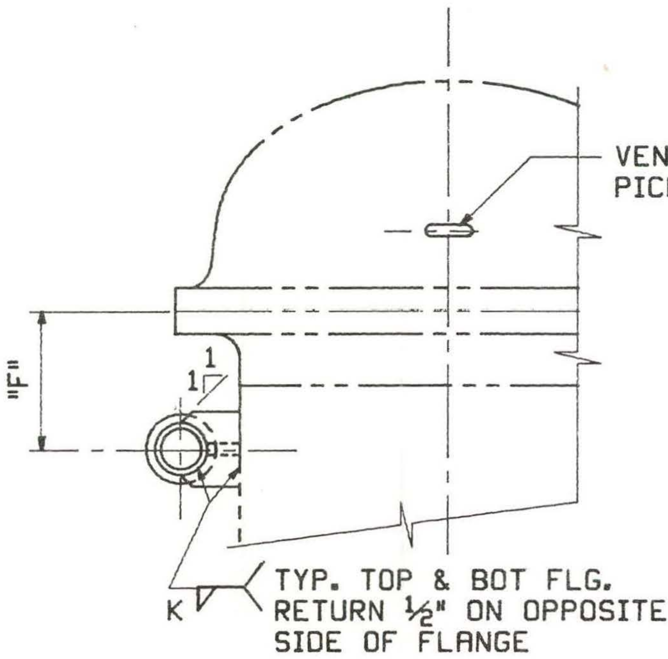
DESIGNED	DATE	DRAFT. SUPV.	ENG'R.	CHIEF ENG'R.	CLIENT
	[illegible]				

DRAWN	JOB NO.	DRAWING NO.	REV.
YCL	STANDARD	C-509	2
CHECKED [illegible]			
SCALE NONE			





DETAIL OF LINK



LOCATION PLAN

NOM. SHELL DIA.	DAVIT CAPACITY LBS.	A	B	C	D		E*	F	G	K	S*		H
					O.D.	MIN. WALL					NOM. SIZE	WALL t	
16	400	45	22	8	2-3/8	0.154	W8×17	7	4	3/16	2-1/2	0.217	L×2×2×3/16
20	400	49	25	10	2-3/8	0.218	W8×17	8	4	3/16	2-1/2	0.217	L×2×2×3/16
24	500	51	27	10	2-3/8	0.218	W8×17	8-1/2	4	1/4	2-1/2	0.217	L×2×2×3/16
28	750	53	30	10	2-7/8	0.276	W8×17	9	4	1/4	3	0.289	L×3×3×1/4
32	1000	56	34	12	3-1/2	0.250	W10×21	10	5-1/2	5/16	4	0.337	L×3×3×1/4
36	1300	59	38	14	4-1/2	0.281	W12×27	11	6	3/8	5	0.500	L×3×3×1/4
40	1700	64	42	18	4-1/2	0.281	W16×36	12	6	3/8	5	0.500	L×4×4×3/8
42	2000	66	43	18	4-1/2	0.438	W16×36	12	6	3/8	5	0.500	L×4×4×3/8

NOTE: ALL SIZES AND DIMENSIONS ARE IN INCHES

GENERAL NOTES

1. ALL PIPE SHALL CONFORM TO ASTM A-53 OR A-501.
2. DAVIT DIMENSIONS WILL ACCOMMODATE BODY COVERS FOR FLOATING TUBE SHEET EXCHANGERS OF 300 LB. FLANGE RATING.
3. FOR EXCHANGER SHELL DIAMETERS NOT GIVEN IN TABLE, PROVIDE DAVIT FOR NEXT LARGER SIZE.
4. COAT MALE & FEMALE PORTIONS OF DAVIT WITH A HEAVY RUST INHIBITING GREASE BEFORE SHIPMENT.
5. PROVIDE STEEL SHIM BUSHINGS TOP AND BOTTOM WHERE REQUIRED TO MAINTAIN TOTAL CLEARANCE FROM 0.040 IN. MIN. TO 0.080 IN. MAX. BUSHING MATERIAL SHALL BE WELDED TO PIPE TO MAINTAIN POSITION. GRIND OFF BURRS AND WELDS FOR SMOOTH FIT IN SOCKET.
6. THESE DAVITS ARE FOR HANDLING EXCHANGER HEADS ONLY, NOT FOR CHANNEL ENDS.
7. ITEMS MARKED WITH AN ASTERISK (*) SHALL BE FURNISHED AND INSTALLED BY HEAT EXCHANGER SUPPLIER PRIOR TO STRESS RELIEVING UNLESS OTHERWISE NOTED.

No.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
4	10/2/	REVISED & REDRAWN	CAD	BGB			WLH	RFS

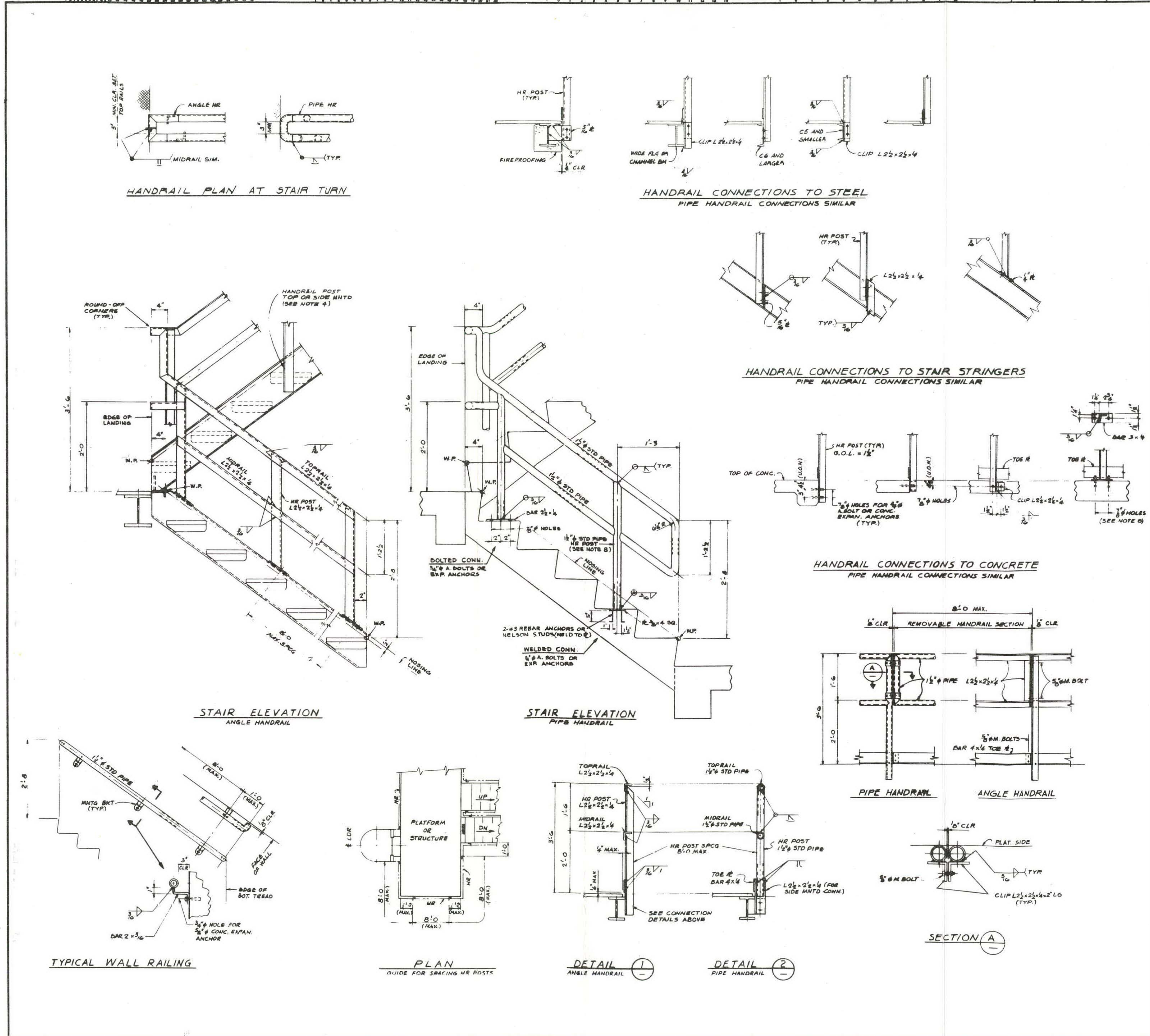
SCALE NONE | DESIGNED | DRAWN CAD | CHIEF ENGR WLH

BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

HEAD HANDLING DAVITS FOR
150 LB. & 300 LB. HEAT EXCHANGERS

JOB No.	DRAWING No.	REV.
STANDARD	M-505	4



SIZE E

GENERAL NOTES

1. FOR INFORMATION NOT SHOW SEE DESIGN DRAWING.
2. FOR STANDARD STAIR DETAILS SEE DWG M-519.
3. ALL HANDRAIL AND TOE PLATE SPLICES SHALL BE FIELD WELDED AND GROUND SMOOTH.
4. HANDRAIL POSTS SHALL BE SIDE MOUNTED AND BOLTED TO STRINGERS UNLESS OTHERWISE NOTED ON DESIGN DRAWINGS.
5. ALL BOLTS ARE ¾"φ (A-307) BOLTS UNLESS OTHERWISE NOTED.
6. A MINIMUM HAND CLEARANCE OF 3" IS REQUIRED BETWEEN TOP RAIL AND ANY WALL PROJECTION (COLUMNS, BEAMS, PIPING, ETC.)
7. USE ANGLE HANDRAIL AS PER DETAIL-1 UNLESS OTHERWISE NOTED ON DESIGN DRAWING.
8. FOR CONCRETE STAIRS OR STRUCTURES LOCATE CENTER OF HANDRAIL POST 4" FROM EDGE.

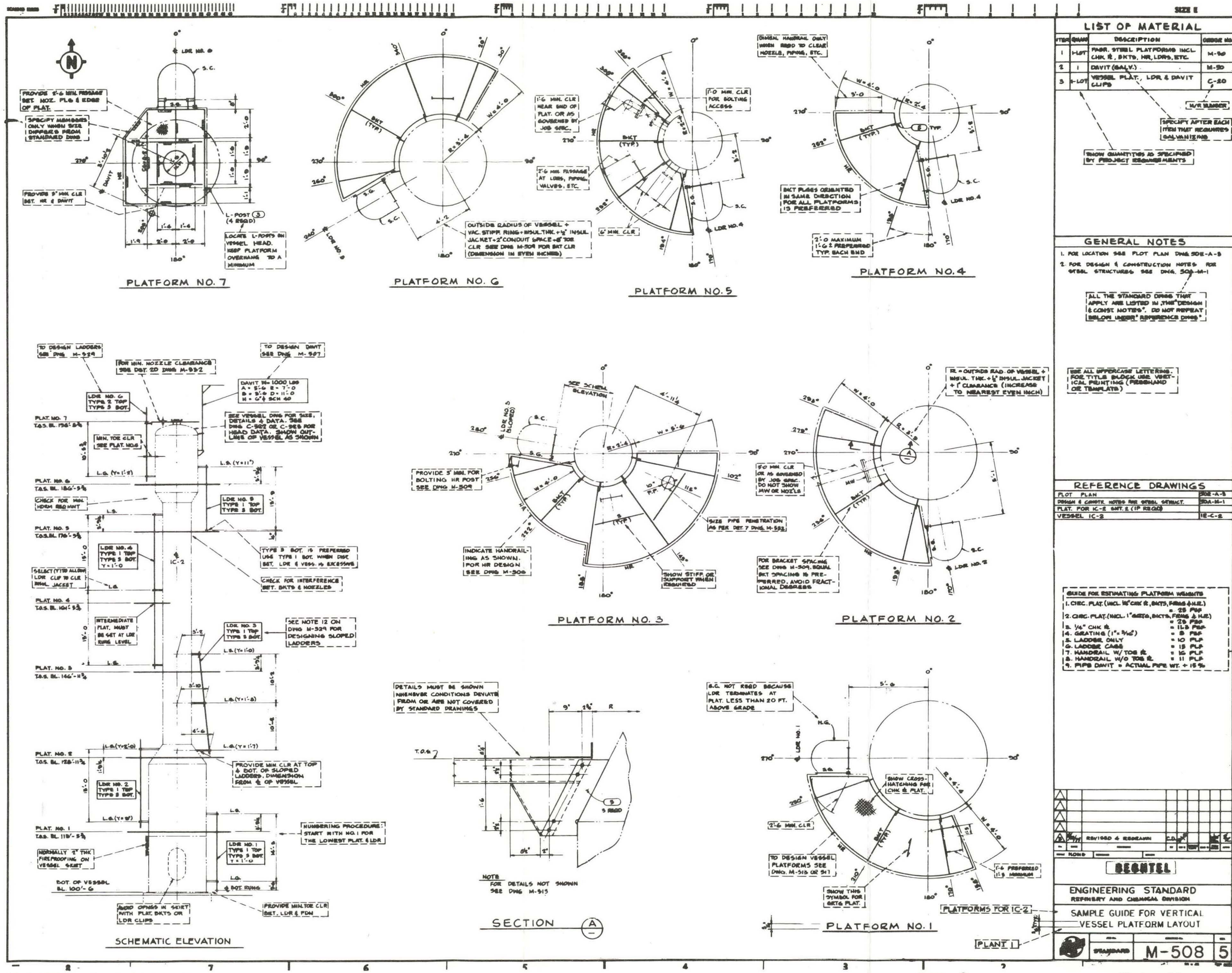
GENERAL REVISIONS
REVISED & REDRAWN
SCALE NONE

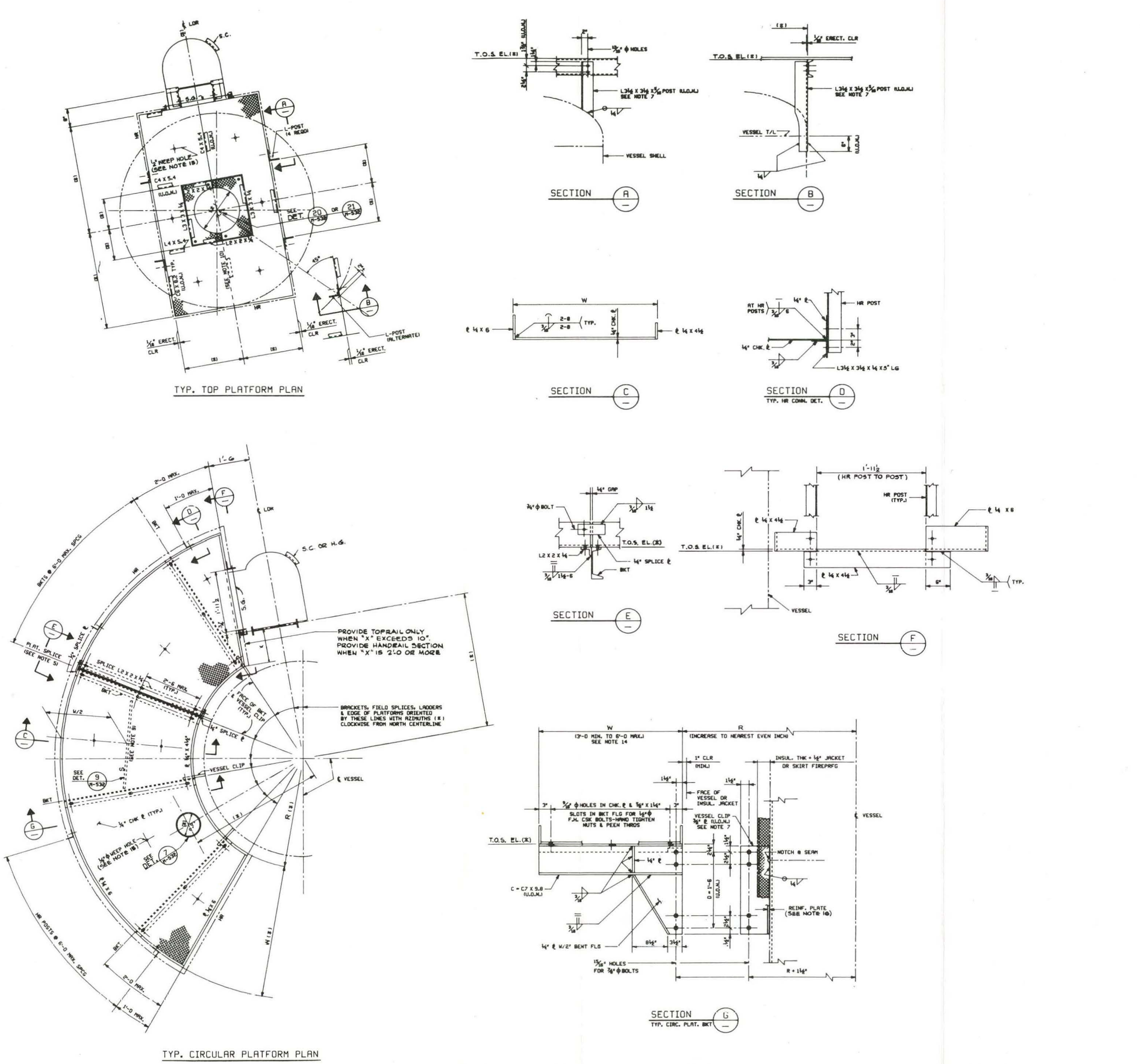
BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

HANDRAIL DETAILS

STANDARD M-506 7


LIST OF MATERIAL
PABR. STEEL PLATFORMS INCL. CHK PL, BKTS, HR, LDRS, ETC.
DAVIT (GALV.)
VESSEL PLAT., LDR & DAVIT CLIPS
SPECIFY AFTER EACH ITEM THAT REQUIRES GALVANIZING
SHOW QUANTITIES AS SPECIFIED BY PROJECT REQUIREMENTS
GENERAL NOTES
1. FOR LOCATION SEE PLOT PLAN DWG 50E-A-3
2. FOR DESIGN & CONSTRUCTION NOTES FOR STEEL STRUCTURES SEE DWG. 50A-M-1
ALL THE STANDARD DWGS THAT APPLY ARE LISTED IN THE "DESIGN & CONST NOTES". DO NOT REPEAT BELOW UNDER "REFERENCE DWGS"
USE ALL UPPERCASE LETTERING. FOR TITLE BLOCK USE VERTICAL PRINTING (FREEHAND OR TEMPLATE)
REFERENCE DRAWINGS
PLOT PLAN
DESIGN & CONSTR. NOTES FOR STEEL STRUCT.
PLAT. FOR IC-2 SHT. 2 (IP R200)
VESSEL IC-2
GUIDE FOR ESTIMATING PLATFORM WEIGHTS
PLATFORM NO. 7
PLATFORM NO. 6
PLATFORM NO. 5
PLATFORM NO. 4
PLATFORM NO. 3
PLATFORM NO. 2
PLATFORM NO. 1
SCHEMATIC ELEVATION
SECTION A
PLATFORMS FOR IC-2
PLANT 1
BECHTEL
ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION
SAMPLE GUIDE FOR VERTICAL VESSEL PLATFORM LAYOUT
M-508
5



GENERAL NOTES

1. FOR INFORMATION NOT SHOWN SEE DESIGN DRAWING.
2. PLATFORMS ARE DESIGNED FOR A LIVE LOAD OF 75 PSF OR A 1000 LB CONCENTRATED LOAD AT END OF BRACKET.
3. FOR HANDRAIL DETAILS SEE DWG. M-508
   FOR LADDER DETAILS SEE DWG M-529
   FOR SAFETY GATE DETAILS SEE DWG M-529.
4. ALL PIPE PENETRATIONS (P.P.) FOR PIPES 2" ϕ & LARGER SHALL BE SHOP FABRICATED WHEN SIZED AND LOCATED ON DESIGN DRAWING. FIELD SHALL PROVIDE ALL OTHER PENETRATION REQUIREMENTS AS PER DETAIL 7, DWG. M-532.
5. LOCATION AND NUMBER OF PLATFORM SLICES SHALL BE GOVERNED BY LARGEST UNITS SUITABLE FOR HANDLING, SHIPPING AND GALVANIZING. TO BE DETERMINED BY PLATFORM FABRICATOR.
6. T.O.S. DESIGNATES TOP OF STEEL OR BOTTOM OF FLOOR PLATE.
7. ALL ATTACHMENTS TO VESSELS ARE SUPPLIED BY THE VESSEL SUPPLIER UNLESS OTHERWISE NOTED. FOR STRESS RELIEVED VESSELS, INSTALLATION MUST PRECEDE STRESS RELIEVING.
8. (X) DENOTES INFORMATION REQUIRED ON DESIGN DRAWINGS. (U.O.N.) ABREV. FOR "UNLESS OTHERWISE NOTED".
9. FLOOR PLATE STIFFENER (S) IS REQUIRED WHEN PLATFORM WIDTH (W) EXCEEDS 4'-0.
10. PROVIDE ADDITIONAL FRAMING WHEN UNSUPPORTED FLOOR PLATE AREA EXCEEDS 3'-6 X 6'-0 IN EITHER DIRECTION.
11. ALL HOLES ARE 13/16" ϕ FOR 3/4" ϕ BOLTS UNLESS OTHERWISE NOTED.
12. PLATFORM ELEVATIONS OR TOP OF CHECKERED PLATE SHALL BE SET AT EVEN INCHES.
13. PLATFORM FABRICATOR SHALL PROVIDE ALL BOLTS REQUIRED FOR ATTACHING TO VESSEL CLIPS.
14. FOR PLATFORMS MORE THAN 6'-0 (W) WIDE REQUIREMENTS "C" AND "D" MUST BE CALCULATED TO SUIT.
15. PROVIDE A MINIMUM OF ONE 1/2" ϕ WEEP HOLE IN EACH PANEL OR FOR EVERY 20 SQ. FT. OF PLATFORM AREA.
16. VESSEL REINFORCING PLATE REQUIREMENTS FOR SHELL INDENTURE SHALL BE LOCATED AND DETAILED ON THE VESSEL DRAWING.
17. FOR VERTICAL VESSEL PLATFORM DESIGN GUIDE SEE DWG M-508.

No.	DATE	REVISIONS	BY	CHK				APP
6	10/2/78	GENERAL REVISION & REDRAWN	CAD	BGB				
5	1-74	REVISED AND REDRAWN						

SCALE NONE — DRAWN LHU

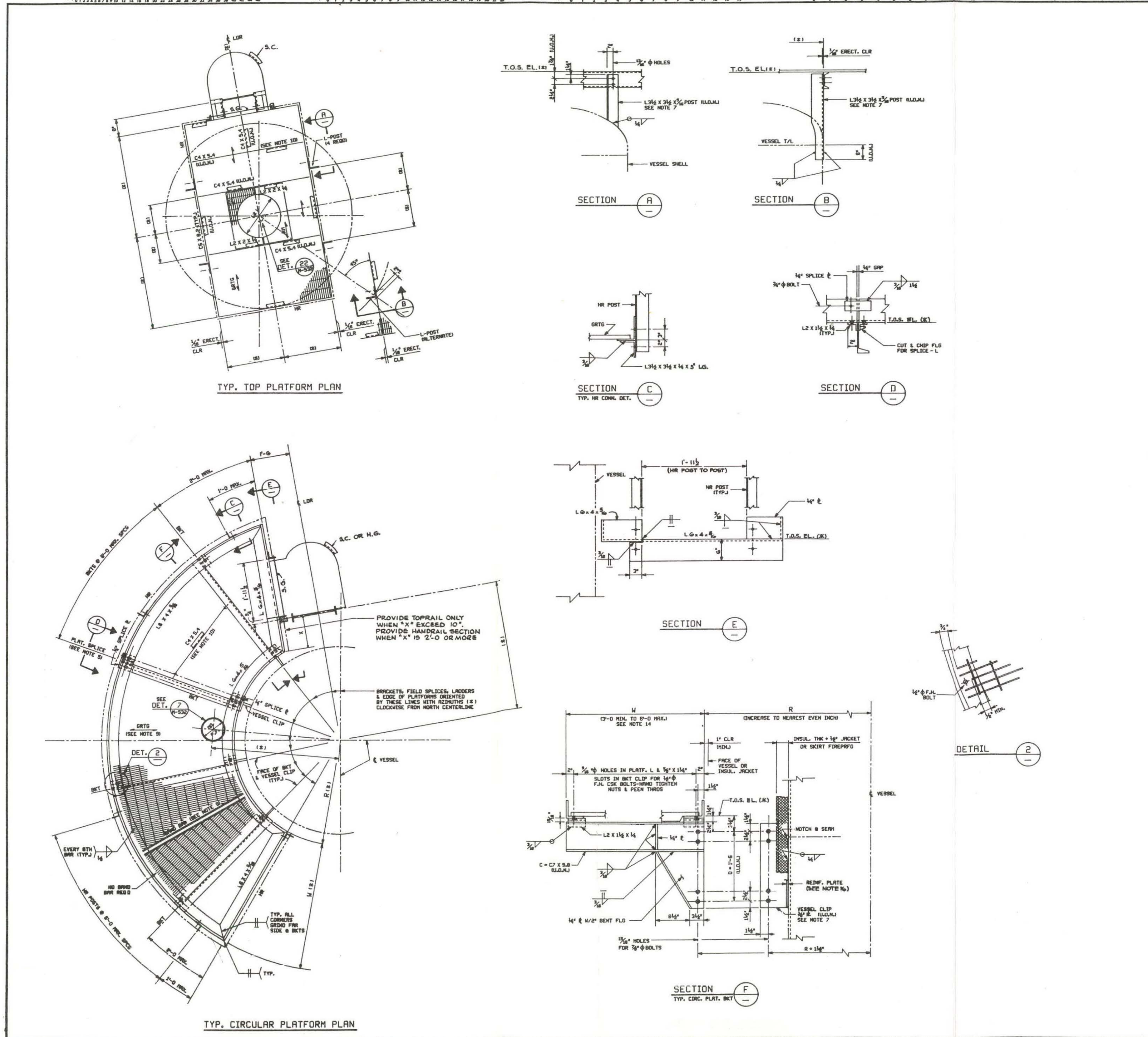
BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

VERTICAL VESSEL PLATFORMS
WITH PLATE - TYPICAL DETAILS

STANDARD | M-513 | 6

SIZE E — 34 x 44 "E" SIZE



SIZE E

GENERAL NOTES

1. FOR INFORMATION NOT SHOWN SEE DESIGN DRAWING.
2. PLATFORMS ARE DESIGNED FOR A LIVE LOAD OF 75 PSF OR A 1000 LB CONCENTRATED LOAD AT END OF BRACKET.
3. FOR HANDRAIL DETAILS SEE DWG. M-506
   FOR LADDER DETAILS SEE DWG M-529
   FOR SAFETY GATE DETAILS SEE DWG M-529.
4. ALL PIPE PENETRATIONS (P.P.) FOR PIPES 2" ϕ & LARGER SHALL BE SHOP FABRICATED WHEN SIZED AND LOCATED ON DESIGN DRAWING. FIELD SHALL PROVIDE ALL OTHER PENETRATION REQUIREMENTS AS PER DET. 7 DWG. M-532.
5. LOCATION AND NUMBER OF PLATFORM SPLICES SHALL BE GOVERNED BY LARGEST UNITS SUITABLE FOR HANDLING, SHIPPING AND GALVANIZING. TO BE DETERMINED BY PLATFORM FABRICATOR.
6. T.O.S. DESIGNATES TOP OF STEEL OR BOTTOM OF FLOOR GRATING.
7. ALL ATTACHMENTS TO VESSELS ARE SUPPLIED BY THE VESSEL SUPPLIER UNLESS OTHERWISE NOTED. FOR STRESS RELIEVED VESSELS, INSTALLATION MUST PRECEDE STRESS RELIEVING.
8. (*) DENOTES INFORMATION REQUIRED ON DESIGN DRAWINGS. (U.O.N.) ABREV. FOR "UNLESS OTHERWISE NOTED".
9. ALL GRATING SHALL BE GALVANIZED SERRATED 1" X 3/16" BRG BARS (IRVING TYPE IWA OR EQUAL) WITH 1½" X ¼" BAND BARS UNLESS OTHERWISE SPECIFIED.
   ⟵ DIRECTION OF BEARING BARS.
10. PROVIDE INTERMEDIATE SUPPORT WHERE GRATING BRG BARS EXCEED 4'-6 SPAN.
11. ALL HOLES ARE 13/16" ϕ FOR ¾" ϕ BOLTS UNLESS OTHERWISE NOTED.
12. PLATFORM ELEVATIONS OR TOP OF GRATING SHALL BE SET AT EVEN INCHES.
13. PLATFORM FABRICATOR SHALL PROVIDE ALL BOLTS REQUIRED FOR ATTACHING TO VESSEL CLIPS.
14. FOR PLATFORMS MORE THAN 6'-0 WIDE (W) REQUIREMENTS "C" AND "D" MUST BE CALCULATED TO SUIT.
15. FOR VERTICAL VESSEL PLATFORM DESIGN GUIDE SEE DWG M-508
16. VESSEL REINFORCING PLATE REQUIREMENTS FOR SHELL INDENTURE SHALL BE LOCATED AND DETAILED ON THE VESSEL DRAWING.

No.	DATE	REVISIONS	BY	CH'K				APPD
3	10/3/78	GENERAL REVISION & REDRAWN	CAD	DGD				
2	1-74	REVISED AND REDRAWN						

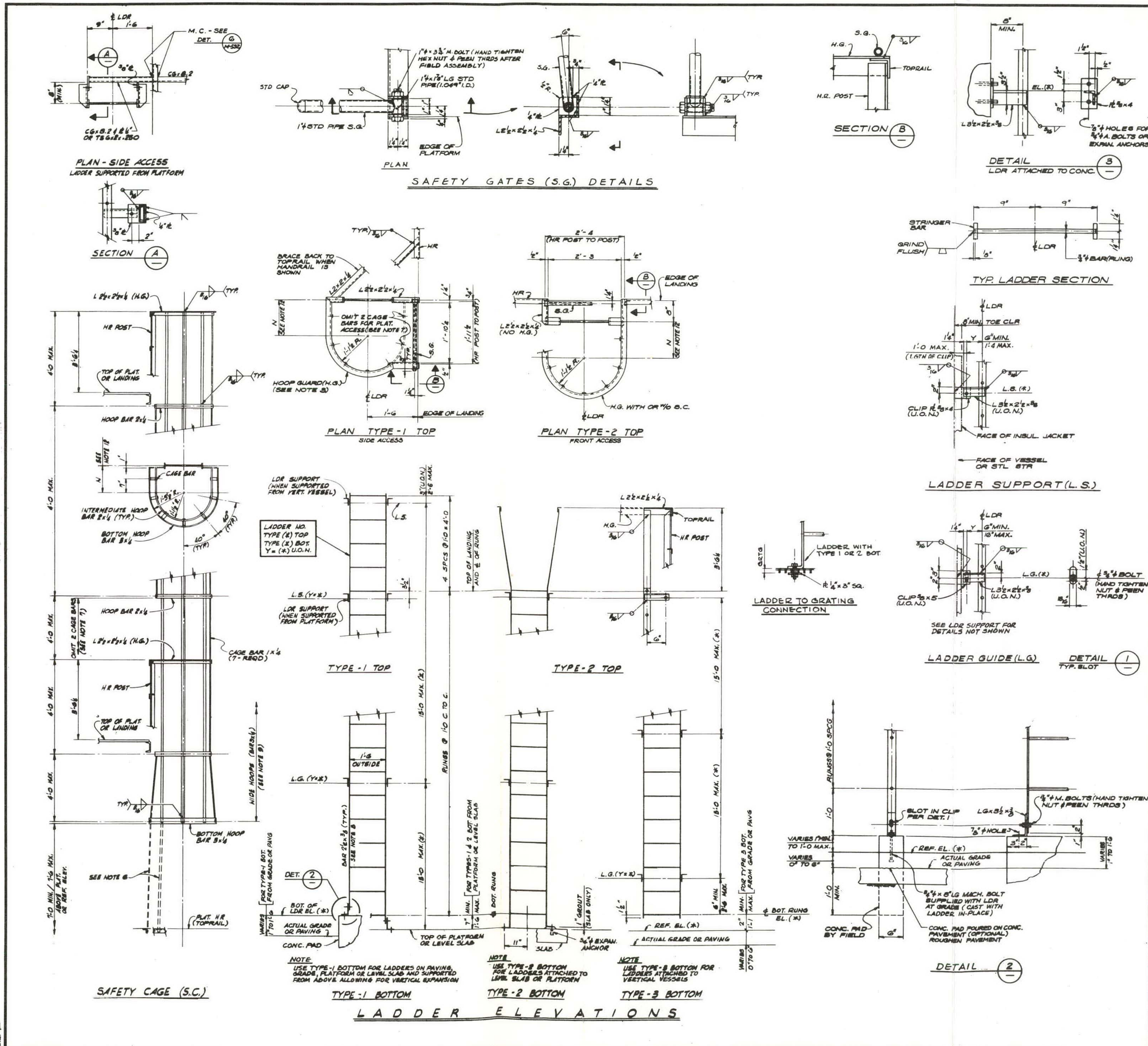
SCALE NONE | DRAWN CAD

BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

VERTICAL VESSEL PLATFORMS WITH GRATING - TYPICAL DETAILS

JOB No.	DRAWING No.	REV.
STANDARD	M-517	3



GENERAL NOTES

1. ALL CONNECTIONS SHALL BE SHOP WELDED EXCEPT AS NOTED.
2. WHEREVER POSSIBLE, THE SAFETY GATE SHALL BE HINGED AT THE SIDE SHOWN.
3. ALL LADDERS SERVING PLATFORMS 4'-0 OR MORE ABOVE GRADE SHALL BE EQUIPPED WITH SAFETY GATES. ALL LADDERS SERVING PLATFORMS OR LANDINGS 10'-0 TO 20'-0 ABOVE GRADE SHALL BE EQUIPPED WITH HOOP GUARDS. ALL PLATFORMS MORE THAN 20'-0 ABOVE GRADE SHALL BE EQUIPPED WITH SAFETY CAGES.
4. THE MAXIMUM UNBROKEN LENGTH OF LADDER BETWEEN LANDINGS IS 30'-0
5. FOR INFORMATION NOT SHOWN SEE DESIGN DRAWING.
6. ON ELEVATED PLATFORMS WHERE EDGE OF PLATFORM IN FRONT OF LADDER IS LESS THAN 4'-0 FROM ℄ OF RUNGS, EXTEND 3-FRONT CAGE BARS DOWN TO HANDRAIL AND FIELD WELD. WHERE EDGE OF PLATFORM TO RIGHT OR LEFT OF CAGE ℄ IS LESS THAN 3'-0 EXTEND 2-SIDE CAGE BARS DOWN TO HANDRAIL AND FIELD WELD (ADD 6" EXTRA LENGTH TO VERTICAL CAGE BARS FOR FIELD ADJUSTMENT.)
7. FOR SIDE ACCESS LADDERS WITH CAGE, OMIT 2-VERTICAL CAGE BARS 7'-0 UP FROM LANDING.
8. WHEN THE DISTANCE BETWEEN SUPPORTS (L.S.) AND/OR GUIDES (L.G.) IS MORE THAN 15'-0 APART, INCREASE STRINGER SIZE TO BAR $2\frac{1}{2} \times \frac{1}{2}$ (SPECIFY ON DESIGN DRAWING).
9. MAXIMUM SPACING BETWEEN WIDE HOOPS (BAR $3 \times \frac{1}{4}$) AND/OR HOOP GUARDS ($L2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$) IS 20'-0.
10. ALL ATTACHMENTS TO VESSELS ARE SUPPLIED BY THE VESSEL SUPPLIER (U.O.N.) INSTALLATION MUST PRECEDE VESSEL STRESS RELIEVING.
11. PLATFORM FABRICATOR SHALL PROVIDE ALL BOLTS REQUIRED FOR ATTACHING TO VESSEL CLIPS.
12. TOP HOOP GUARD ON SAFETY CAGES FOR INCLINED LADDERS SHALL BE HORIZONTAL. THE PERPENDICULAR DISTANCE (N) FROM LADDER SHALL BE AS FOLLOWS:

INCLINED ANGLE (FROM HORIZ.)	N
90° (VERT.)	1'-2
85° TO 89°	1'-3
80° TO 84°	1'-4
75° TO 79°	1'-5

NOTE

MAXIMUM ANGLE FOR INCLINED LADDERS SHALL BE 15° FROM THE VERTICAL PLANE.

13. U.O.N. = UNLESS OTHERWISE NOTED
(*) = DENOTES INFORMATION REQUIRED ON DESIGN DRAWING

REV. LDR. DET. 1, 2 & 3 AND SAFETY GATE
REVISED & REDRAWN

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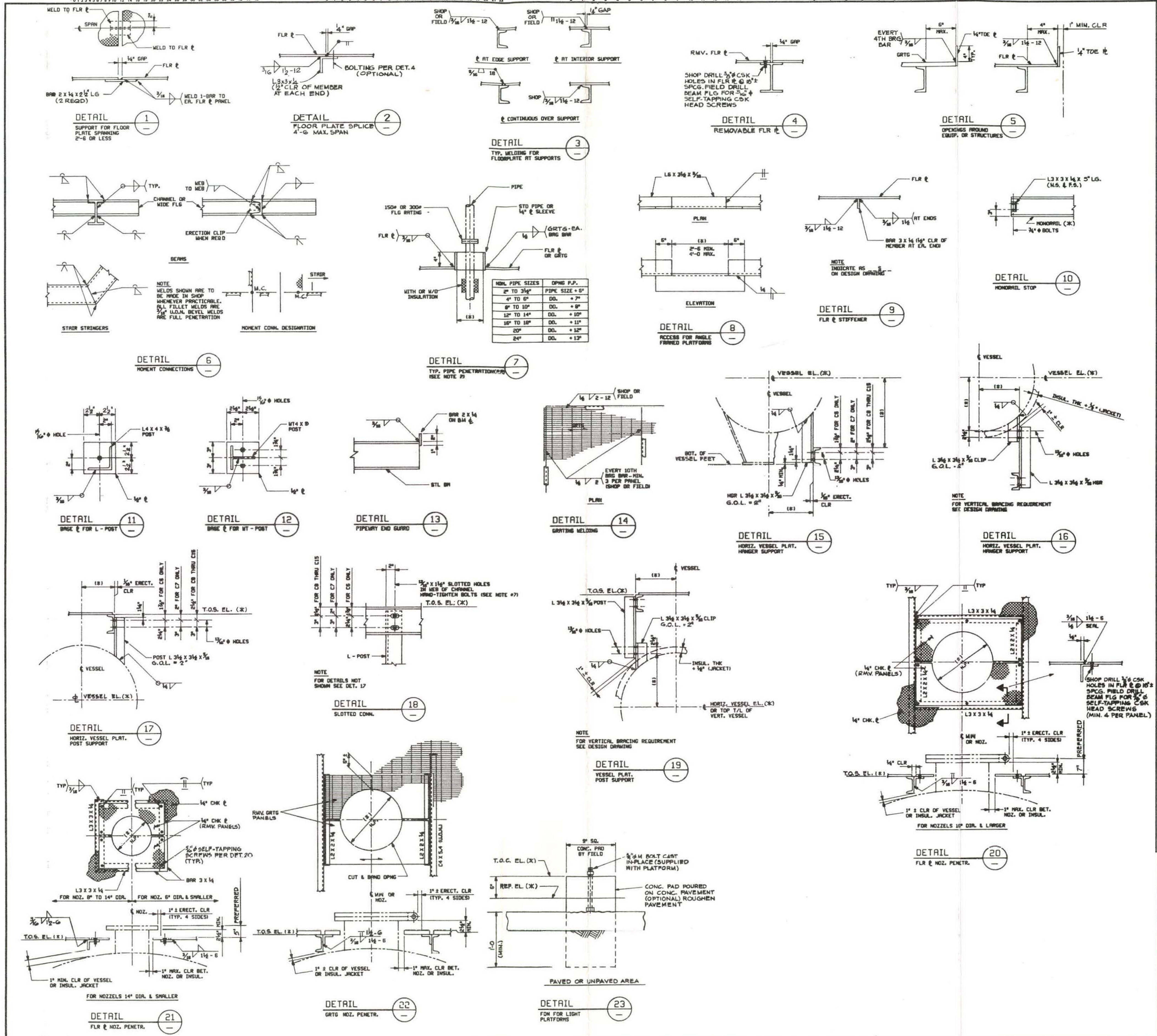
ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

LADDERS, SAFETY CAGE AND SAFETY GATE

STANDARD M-529 7

SIZE E



GENERAL NOTES

1. FOR INFORMATION NOT SHOWN SEE DESIGN DRAWING.
2. ALL PIPE PENETRATIONS (P.P.) FOR PIPES 2" ϕ & LARGER SHALL BE SHOP FABRICATED WHEN SIZED AND LOCATED ON DESIGN DRAWING. FIELD SHALL PROVIDE ALL OTHER PENETRATION REQUIREMENTS AS PER DETAIL 7.
3. PLATFORM FABRICATOR SHALL PROVIDE ALL BOLTS REQUIRED FOR ATTACHING TO VESSEL CLIPS.
4. ALL ATTACHMENTS TO VESSELS ARE SUPPLIED BY THE VESSEL SUPPLIER UNLESS OTHERWISE NOTED. FOR STRESS RELIEVED VESSELS, INSTALLATION MUST PRECEDE STRESS RELIEVING.
5. ALL BOLTS SHALL BE A307 ¾" ϕ UNLESS OTHERWISE NOTED.
6. (X) - INFORMATION REQUIRED ON DESIGN DRAWING.
   (U.O.N.) - ABBREV. FOR "UNLESS OTHERWISE NOTED".
   G.O.L. - ABBREV. FOR "GAGE OUTSTANDING LEG" OF ANGLE
   ⟶ DIRECTION OF GRATING BEARING BARS.
7. SLOTTED CONNECTIONS SHALL BE FINGER TIGHT PLUS ¼ TURN AND DOUBLE NUTTED (DETAIL 18).
8. WHEN GALVANIZING OF STEELWORK IS REQUIRED, ALL WELDED JOINTS SHALL BE COMPLETELY SEAL WELDED IN ADDITION TO THE STRUCTURAL WELDS SHOWN.

No.	DATE	REVISIONS	BY	CHK				APPR
5	10/2/78	REVISED AND REDRAWN	CAD	DGD				

SCALE NONE | DESIGNED | DRAWN CAD

BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

TYPICAL DETAILS FOR
PLATFORMS AND STRUCTURES

JOB No.	DRAWING No.	REV
STANDARD	M-532	5

LEGAL CLEARANCE REQUIREMENTS

1	2 Regulation Reference	3	4 Track Centers: Main Tracks	5 Track Centers: Any Two Subsidiary Tracks	6 Track Centers: Adjacent Subsidiary Track to Any Main Track	7 Track Centers: Ladder Track Adjacent to Any Parallel Track	8 Track Centers: Two Adjacent Parallel Ladder Tracks	9 Track Centers: Lead, Repair and Caboose Tracks	10 Track Centers: Team Tracks in Pairs	11 Track Centers: Unloading Tracks at Platforms	12 Vertical: General	13 Vertical: Thru Bridges	14 Vertical: Highway Bridges	15 Vertical: Tunnels	16 Vertical: Building Doors	17 Vertical: In Buildings	18 Horizontal: General	19 Horizontal: Thru Bridges	20 Horizontal: Highway Bridges	21 Horizontal: Tunnels	22 Horizontal: Building Doors	23 Horizontal: In Buildings	24 Platforms: A	25 Platforms: B	26 Platforms: C	27 Platforms: D	28 Platforms: E	29 Platforms: F	30 Signals: High	31 Signals: Low, Between Tracks: Height	32 Signals: Low, Between Tracks: Clearance	33 Signals: Switch Boxes, Etc.: Height	34 Signals: Switch Boxes, Etc.: Clearance	35 Poles	36 Mail Cranes	37 Icing Docks	38 Ore and Coal Docks	39 Cattle Chutes
ALABAMA	NOTE 1																																					
ALASKA	NOTE 1																																					
ARIZONA	G.O. R-5	1960	14-0	14-0	15-0	20-0	20-0	14-0	11-6	13-0	22-0	22-0	23-0	22-0	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6[3]	8-6	0-8	4-8			4-0	7-3[10]	8-6	3-0	6-0	0-4	3-0	8-6	E	7-8	8-6	8-6
ARKANSAS	CASE R-1012	1956	14-0	14-0	14-0	17-0	20-0	14-0	13-0	13-0	22-0	22-0	22-0	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0[3,5]	7-0[6]	0-8	5-0	4-0	5-9[7]	4-0	8-0	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
CALIFORNIA	G.O. 26-D	1964	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0	18-0[4]	8-6	8-0	8-6	8-0	8-6	8-6	0-8	4-8			4-0	7-6[10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	7-8	8-6	8-6
CANADA	G.O. E-2	1965	13-0	13-6	14-0	15-0	18-0	13-6	12-0	12-0	22-6	22-6	22-6	22-6	22-6	22-6	8-4 1/4	8-0	8-4 1/4	8-0	8-4 1/4	8-4 1/4	[19]	[19]	[19]	[19]	4-0	[19]	8-4 1/4		8-4 1/4			8-4 1/4	7-1 3/4	8-4 1/4	8-4 1/4	8-4 1/4
COLORADO	DEC. 55621	1961	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-0	22-6	22-0	22-6	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0	8-0[6]	0-8	5-0	4-0	5-9[7]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
CONNECTICUT	DOCK. 8995	1956	13-0	13-0	15-0	18-0	19-0	14-0	13-0	13-0	18-0[13]	18-0[13]	18-0[13]	18-0[13]	18-0[3]	18-0	8-6	8-0	8-6	8-0	8-0[3]	8-0	0-8	5-2			4-0	8-6[8,10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	8-6	8-0	8-6
DELAWARE	ORDER 214	1955	14-0	13-6	15-0	18-0	19-0	13-6	13-0	13-0	22-0	22-0	22-0	22-0	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-0[3]	8-0	0-8	5-1	4-0	5-7[9]	4-0	8-6[8,10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	7-8	E	8-6
DIST. OF COLUMBIA	ORDER	1954	14-0	14-0	15-0	18-0	19-0	14-0	13-0	13-0	22-0	22-0	22-0	22-0	18-0[3]	18-0	8-6	8-0	8-6	8-0	8-0	8-0	0-8	4-8	4-0	5-7[7]			8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6	8-6	8-6
FLORIDA	ORDER 1871	1953	13-6	13-6	13-6	19-0	19-0	13-6	13-0	13-0	22-0	22-0[2]	22-0	22-0[2]	17-0	17-0	8-0	8-0[2]	8-0	8-0[2]	8-0	8-0	0-8	4-8	CFH	5-9			8-0	3-0	6-0	0-4	3-0	10-0	6-5[11]	7-8	8-0	8-0
GEORGIA	NOTE 1																																					
IDAHO	G.O. 99	1955	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6[3]	8-6[3]	0-8	4-8	4-0	7-3	4-0	8-6[10]	8-0	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
ILLINOIS	G.O. 22	1920	13-6[15]	13-6[15]	15-0	17-0[16]	19-0[17]		13-6	13-6	21-6	21-3	21-6	21-6[2]	H		8-0	8-0	8-0	8-0[2]	7-0[3]	7-0	0-4	4-6	0-8	5-1[9]	CFH	5-8	8-6	2-8				9-0	8-0	8-0	8-0	8-0
INDIANA	STATUTES	1951									22-0	22-0[2]	22-0	22-0	22-0	22-0	8-0	8-0[2]	8-0	8-0[2]	8-0	8-0							8-0					8-0	8-0	8-0	8-0	8-0
IOWA	DOCK. K-1281	1936	14-0[15]	13-6[15]	15-0	17-0[16]	19-0[17]		13-6	13-6	22-0	22-0	22-0	22-0[2]	H		8-0	8-0	8-0	8-0[2]	7-0[3]	7-0	0-4	4-6	0-8	5-1[9]	CFH	5-8	8-0	2-8				8-0	6-3[11]	8-0	7-0	8-0
KANSAS	DOCK. 58144-R	1958	14-0	14-0	14-0	17-0	20-0	14-0	13-0	13-0	22-6	22-0	22-6	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0[5]	7-0[6]	0-8	5-0	4-0	5-9[7]	4-0	8-0	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
KENTUCKY	STATUTES	1942											22-0																									
LOUISIANA	NOTE 1																																					
MAINE	G.O. 2	1956									22-0	22-0	22-0	22-0[2]	17-0[3]	17-0	8-0	8-0	8-0	8-0[2]	7-0[3]	8-0	0-12	5-4	4-0	5-9[7]		[10]	8-0	3-2	5-5	0-4	3-0	8-0	6-1[11]	6-0	6-0	8-0
MARYLAND	ORDER 50138	1953	14-0	13-6	15-0	18-0	19-0	13-6	13-0	13-0	22-0	22-0	22-0	22-0	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-0[3]	8-0	0-8	5-1	4-0	5-7[9]	4-0	8-6[8,10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	7-8	E	8-6
MASSACHUSETTS	STATUTES	1956	13-0	13-0	13-0	17-0	17-0	17-0	13-0	13-0	22-6	22-6[2]	22-6	22-6[2]	22-6	22-6	8-6	8-6[2]	8-6	8-6[2]	8-6					5-9[7]			8-6	3-0	6-6			8-6	8-6	8-6	8-6	8-6
MICHIGAN	STATUTES	1957	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0	22-6	E	E	22-6[2]	22-6	22-6	8-6	E	E	8-6[2]	8-6	8-6							E	E	E	E	E	8-6	E	E	E	E
MINNESOTA	STATUTES	1943	14-0	14-0	14-0	17-0	19-0	14-0	14-0	14-0	22-0	22-0	22-0	22-0	22-0[3]	22-0	8-6	8-6	8-6	8-6	8-6[3]	8-6							8-6					8-6	8-6	8-6	8-6	8-6
MISSISSIPPI	NOTE 1																																					
MISSOURI	G.O. 24	1959	14-0	14-0	14-0	17-0	19-0	14-0	14-0	13-6	22-0	22-0	22-0	22-0	22-0	22-0	8-6	8-0	8-6	8-6	8-6[3]	8-6	0-4	4-6	0-8	5-1[9]	CFH	5-9	8-6	4-0	5-0[10] 8-0	0-3	4-2	8-6	6-5[11]	8-6	8-6	8-6
MONTANA	ORDER 2597	1956	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6[3]	8-6	0-8	4-8	4-0	5-9[7]	4-0	8-6[10]	8-0	3-0	6-0	0-4	3-0	8-6	8-6	5-9	8-6	8-6
NEBRASKA	ORDER 24501	1963	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-0	22-6	22-0	23-0	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0[3]	7-0[6]	0-8	5-0	4-0	5-9[6]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
NEVADA	CASE 1150	1947	14-0	14-0	15-0	20-0	20-0	20-0	11-6	13-0	22-0	22-0	23-0	22-0	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6[3]	8-6	0-8	4-8			4-0	7-3[10]	8-6	3-0	6-0	0-4	3-0	8-6	E	7-8	8-6	8-6
NEW HAMPSHIRE	ORDER 6922	1956	14-0	14-0	15-0[C]	18-0	18-0	14-0[18]	13-0	13-0	21-0	21-0	21-0	21-0	17-0[3]	17-0	8-0[14]	8-0[14]	8-0[14]	8-0[14]	7-0[3]	8-0	0-12	5-4	4-0	5-9[7]		[10]	8-6	3-2	5-5	0-4	3-0	8-6	6-1[11]	6-0	6-0	8-6
NEW JERSEY	NOTE 1																																					
NEW MEXICO	ORDER 2202	1957	14-0	14-0	15-0	17-0	20-0	14-0	13-0		22-6	22-0	22-6	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0[5]	7-0[6]	0-8	4-8	4-0	5-9[7]	4-0	8-0	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
NEW YORK	STATUTES	1961	13-6	13-6	15-0	18-0	19-0	13-6	13-6	13-6	22-0	22-0	22-0	22-0	18-0[3]	18-0	8-6	8-0	8-6	8-0	8-0[3]	8-0	0-8	5-1	4-0	5-7[9]	4-0	8-6[8,10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	8-0	E	8-0
NORTH CAROLINA	NOTE 1																																					
NORTH DAKOTA	STATUTES	1943	13-0	13-0	13-0	13-0	13-0	13-0	13-0	13-0	21-0[2]	21-0[2]	21-0	21-0[2]	21-0	21-0	8-0[2]	8-0[2]	8-0	8-0[2]	8-0	8-0					4-0	8-0	8-0					8-0	8-0	8-0	8-0	8-0
OHIO	ORDER 26531	1958	14-0	14-0	15-0	15-0	18-0	14-0			21-0	21-0[2]	21-0	21-0[2]	21-0	21-0	8-0	8-0[2]	8-0	8-0[2]	8-0	8-0							8-0					8-0	8-0	8-0	8-0	8-0
OKLAHOMA	ORDER 33347	1956	14-0	14-0	14-0	17-0	20-0	14-0	13-0	13-0	22-0	22-0	22-0	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0[3,5]	7-0[6]	0-8	5-0	4-0	5-9	4-0	8-0	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6
OREGON	ORDER 33700	1955	15-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6	8-6	0-8	4-8			4-0	7-3[10]	8-6	3-0	6-0	0-4	3-0	8-6	8-6	7-8	8-6	8-6
PENNSYLVANIA	ORDER	1954	13-6	13-6	15-0	18-0	19-0	13-6	13-6		22-0	22-0	22-0	22-0	18-0[3]	18-0	8-6	8-0	8-6	8-0	8-0[3]	8-0	0-8	5-1	4-0	5-7[9]	4-0	8-6[8,10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	8-0	E	8-6
RHODE ISLAND	DOCK 608	1955	13-0	14-0	15-0	18-0	19-0	14-0	13-0	14-0	18-0	18-0	18-0	18-0	18-0[3]	18-0	8-6	8-0	8-6	8-0	8-0[3]	8-0	0-8	5-2			4-0	8-6[8,10]	8-6	3-0	6-0	0-4	3-0	8-6	6-5[11]	8-6	8-0	8-6
SOUTH CAROLINA	NOTE 1																																					
SOUTH DAKOTA	ORDER F-2465	1957									22-6	22-6	22-6[2]	22-6	17-0	22-6	8-6	8-0	8-0[2]	8-6	7-0	8-6	0-8	4-8	CFH	5-9[7]			8-0			0-4	3-0	8-6	8-6	8-6	8-6	8-6
TENNESSEE	STATUTES	1949	14-0	13-0	14-0	18-0	18-0	14-0	13-0	13-0	22-0	22-0	22-0	22-0	17-0	17-0[4]	8-0	8-0	8-0	8-0	8-0	8-0	0-8	4-8	4-0	5-9	4-0	7-6	8-0		6-6	0-4	3-0	8-0	6-5[11]	7-0	8-0	8-0
TEXAS	STATUTES	1948									22-0	22-0	22-0	22-0[2]	22-0[3]	22-0	8-6	7-6	8-6	8-6[2]	8-6[3]	8-6	0-12	4-6					8-6	2-6	5-6	0-6	4-0	8-6	E	7-0	8-6	8-6
UTAH	G.O. 66	1953	14-0	14-0	15-0	17-0	20-0	14-0	11-6	11-6	22-6	22-6	22-6	22-6	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6[3]	8-6	0-8	4-8	1-9	5-8[9]	4-0	7-3[10]	8-6	3-0	6-0	0-4	3-0	8-6	E	7-8	8-6	8-6
VERMONT	STATUTES	1951										22-0	22-0				8-0	8-0	8-0	8-0	8-0	8-0																
VIRGINIA	NOTE 1																																					
WASHINGTON	G.O. T-8490	1957	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0[3]	18-0[4]	8-6	8-0	8-6	8-0	8-6[3]	8-6	0-8	4-8	4-0	5-9	4-0	8-6[10]	8-0	3-0	6-0	0-4	3-0	8-6	8-6	5-9	8-6	8-6
WEST VIRGINIA	G.O. 121	1953		13-0	15-0	15-0	18-0	13-0	13-0	13-0																												
WISCONSIN	STATUTES	1951	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0	22-0	22-0[2]	22-0	22-0[2]	22-0	22-0	8-6	E	8-6	8-6[2]	8-6	8-6	0-4 / 0-8	4-6 / 5-1	1-9	6-0[5]	5-0	6-4	8-6	E	E	E	E	12-0	E	8-6	8-6	8-6
WYOMING	DOCK. 9287	1959	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-0	22-6	22-0	23-6	23-0	17-0[3]	18-0[4]	8-6	8-0	8-6	8-0	7-0[3,5]	7-0[6]	0-8	5-0	4-0	5-9[7]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	6-8[12]	8-6	8-6

NOTES

THIS CHART FOR INFORMATION ONLY - NO LIABILITY CAN BE ASSUMED

ARCHITECTS, CONTRACTORS, ETC., SHOULD CHECK WITH RAILROAD INVOLVED

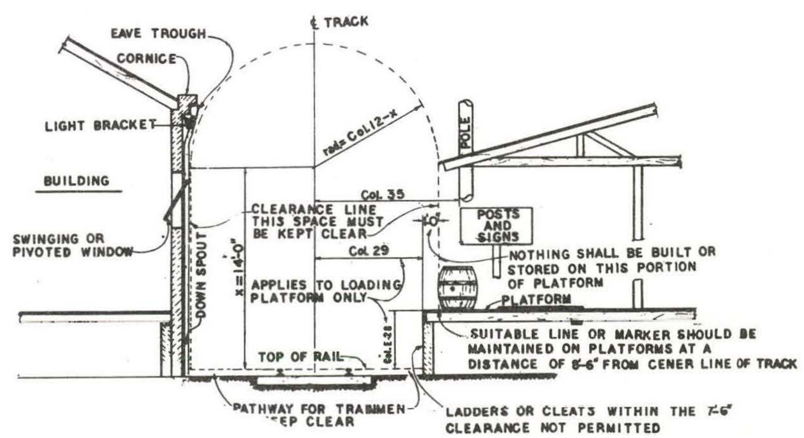
DIMENSIONS: SHOWN IN FEET AND INCHES.
ARE FOR TANGENT TRACK - MOST LAWS SPECIFY INCREASES FOR CURVED AND SUPERELEVATED TRACK.
VERTICAL - MEASURED FROM TOP OF RAIL, EXCEPT CANADA = BASE OF RAIL FOR OTHER THAN PLATFORMS.
HORIZONTAL - MEASURED FROM CENTER LINE OF TRACK.
APPLY TO NEW CONSTRUCTION, SOME RECONSTRUCTION AND SOME EXTENSIONS.
SOME CAN BE VARIED UPON APPROVAL OF APPLICATION BY GOVERNING BODY.
ARE BASED ON MAXIMUM CAR SIZE FOR ARIZONA, CALIFORNIA, IDAHO, MINNESOTA, MONTANA, NEVADA, NORTH DAKOTA, OREGON AND WASHINGTON.
ALL ARE MINIMUM EXCEPT COLUMNS 24, 26, 28, 31 AND 33 WHICH ARE MAXIMUM.

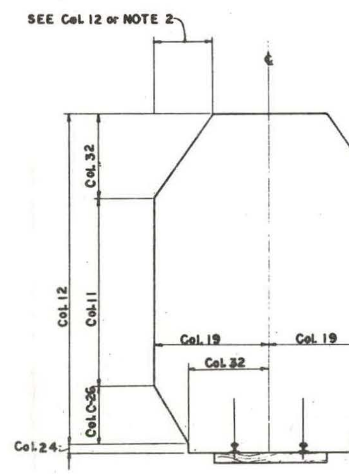
HAWAII OMITTED - NO COMMON CARRIER RAILROADS

C = CONDITIONAL - SEE SPECIFIC REGULATION
CFH = CAR FLOOR HEIGHT
E = EXEMPT
H = HEIGHT OF CARS GOVERNS

COLUMN 2 SHOWS BASIC REGULATION
3 SHOWS BASIC DATE OR DATE OF LATEST AMENDMENT
7 & 8 APPLY TO HAND AND MECHANICALLY OPERATED SWITCHES EXCEPT AS NOTED
12 & 18 PREVAILS FOR ALL ITEMS NOT OTHERWISE PROVIDED FOR
13 & 19 BRIDGES SUPPORTING TRACKS
14 & 20 BRIDGES SPANNING TRACKS
24 & 25 PASSENGER PLATFORMS
26 & 27 FREIGHT PLATFORMS ON SIDE TRACKS EXCEPT AS NOTED
28 & 29 FREIGHT PLATFORMS ON SIDE TRACKS
STEPPED PLATFORMS ARE NOT GENERALLY ALLOWED
35 OTHER THAN TROLLEY CONTACT POLES
36 TO CENTER OF STAND EXCEPT AS NOTED
37 APPLIES TO BOTH SUPPORTS AND PLATFORMS EXCEPT AS NOTED

1. NO CURRENT REGULATION - CHECK WITH RAILROAD INVOLVED
2. LESSER CLEARANCES NOT PERMITTED IN QUADRANTS
3. ENGINE HOUSES AND SHOP BUILDINGS EXEMPT OR PERMITTED LESSER DIMENSIONS
4. ONLY IF TRACKS END WITHIN BUILDINGS
5. MAY BE REDUCED TO 5-9 IF 8-3 (8-6 FOR WYOMING) PROVIDED ON OPPOSITE SIDE
6. MAY BE REDUCED TO 5-9 IF 8-0 (8-6 FOR NEB. & WYO.) PROVIDED ON OPPOSITE SIDE
7. ONLY IF 8-0 (7-3 FOR MONT. & WYO.; 8-6: D.C., MASS., S. DAK.) PROVIDED ON OPPOSITE SIDE
8. MAY BE LESS ON ONE SIDE IF FULL GENERAL (COL. 18) PROVIDED ON OPPOSITE SIDE
9. PASSENGER PLATFORMS ONLY
10. MAY BE 8-0 AT 4-6 FOR REFRIGERATOR CAR PLATFORMS ONLY
11. TO ENDS OF ARMS IN OPERATING POSITION
12. FOR PLATFORMS AT CAR EAVE HEIGHT - SUPPORTS TO BE 8-0 (8-6 FOR TEXAS)
13. FOR MAIN TRACKS - ALL OTHERS 22-0
14. 8-6 FOR MAIN AND PASSING TRACKS
15. FOR FREIGHT TRACKS - CAN BE 13-0 FOR PASSENGER TRACKS
16. FOR HAND OPERATED SWITCHES - MAY BE 15-0 FOR MECHANICALLY OPERATED SWITCHES
17. FOR HAND OPERATED SWITCHES - MAY BE 17-0 FOR MECHANICALLY OPERATED SWITCHES
18. PARALLEL LEAD TRACKS: 18-0
19. REGARDING CANADA - CHECK STANDARD CLEARANCE DIAGRAM, APPROVED BY BOARD OF TRANSPORT COMMISSIONERS FOR CANADA, FOR RAILWAY INVOLVED.
20. REFERENCE - AREA MANUAL FOR RAILWAY ENGINEERING, VOL. II CHAPTER 28.
21. INFORMATION ON THIS DRAWING IS BASED ON BECHTEL P. & T. DIV. STANDARD DWG. C-22)





BRIDGE CLEARANCE

No.	Date	Revisions
1	10/9/72	REVISED FORMAT
0	9/3/??	ISSUED AS STANDARD

Scale: NONE

BECHTEL

ENGINEERING STANDARD
REFINERY AND CHEMICAL DIVISION

RAILROAD STANDARD DETAILS
LEGAL CLEARANCES

STANDARD | M-516 | 1

Structures—M

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△					
△	10/16/80	ISSUED FOR PHASE ZERO			
△	8/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATIONS
DESIGN OF STRUCTURES

JOB NO. 14222

SPECIFICATION	REV
14222-M-1	1

1.0 SCOPE

1.1 This specification covers the basic requirements relative to the design for all structures of steel and/or reinforced concrete.

1.2 In case of conflict between the requirements of this specification and the drawings, the drawings shall govern.

2.0 CODES, STANDARDS AND SPECIFICATIONS

Design, materials, fabrication, and erection of the structures as a whole, and all structural elements and connections thereof, shall conform to the requirements of the following codes, standards and specifications, except as modified or otherwise specified hereinafter.

2.1 Abbreviations as used in this specification shall have the following definitions:

ACI - American Concrete Institute

AISC - American Institute of Steel Construction

AISI - American Iron and Steel Institute

ANSI - American National Standards Institute

ASTM - American Society for Testing and Materials

AWS - American Welding Society

SJI - Steel Joist Institute

OSHA - The Occupational Safety and Health Act

2.2 CODES AND STANDARDS

AISC Manual of Steel Construction, Eighth Edition, 1980.

AISC Code of Standard Practice for Steel Buildings and Bridges, 1976.

AISC Specification for the Design, Fabrication and Erection of Structural Steel for Building, 1978.

AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts, approved by Research Council on Riveted and Bolted Structural Joints of Engineering Foundation, 1978.

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ASTM A6	Standard Specifications for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use, 1979.
ASTM A36	Specification for Structural Steel, 1977a.
ASTM A53	Specification for Grade B Welded and Seamless Pipe, 1979.
ASTM A108	Specification for Steel Bars, Carbon, Cold Finished Standard Quality, 1979.
ASTM A283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and bars, 1979.
ASTM A307	Specification for Carbon Steel Externally Threaded Standard Fastener, 1978.
ASTM A325	Specification for High Strength Bolts for Structural Steel Joints, including Suitable Nuts and Plain Hardened Washers,1979.
ASTM A441	High Strength Low Alloy Structural Manganese Vanadium Steel, 1979.
ASTM A500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structure Tubing in Rounds and Shape, 1978.
ASTM A501	Specification For Hot-Formed Welded and Seamless Carbon Steel Structural Tubing, 1976.
ASTM A569	Specification for Steel Carbon (.15 maximum percent) Hot-Rolled Sheet and Strip. Commercial Quality, 1972.
ASTM A572	High Strength Low Alloy Columbium Vanadium Steels of Structural Quality, 1979.
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, 1979.
SJI & AISC	Standard Specifications for Open Web Steel Joists, J-Series and H-Series, 1965.
SJI & AISC	Standard Specification for Longspan Steel Joists LJ-and LH-Series and Deep Longspan Steel Joists, DLJ-and DLE-Series, 1969 and 1970 respectively.

AWS D1.1	Structural Welding Code-Steel, 1979.
UBC	Uniform Building Code of the International Conference of Building Officials, 1979.
ANSI A58.1	Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, 1972.
ACI 318	Standard Building Code Requirements for Reinforced Concrete, 1977.
OSHA	The Occupational Safety and Health Act, 1978.

2.3 REFERENCE SPECIFICATIONS:

14222-M-2	Steel Building Frames.
14222-M-3	Fabrication of Structural Steel, Miscellaneous Steel and Joists.
14222-M-4	Erection of Structural Steel, Miscellaneous Steel and Joists.
14222-N-6	Fireproofing of Vessels and Structural Steel.
14222-Q-1	Foundations.
14222-Q-2	Plain and Reinforced Concrete.
14222-L-9	Equipment Layout.
14222-X-3	Shop Painting.
14222-X-1	Field Painting.

3.0 GENERAL

3.1 TYPES OF CONSTRUCTION

3.1.1 In general, structures supporting equipment above grade which are required to be fireproofed, and pipe support stanchions which are required to be fireproofed, shall be constructed of structural steel.

3.1.2 In general, structures not required to be fireproofed shall be constructed of structural steel.

3.1.3 In either steel or concrete structures, all secondary steel framing consisting of platform support, monorails, walkways and diagonal bracing which does not contribute to vertical load support of equipment, shall be unfireproofed and of welded or bolted construction. For specific fireproofing requirements refer to Specification 14222-N-6, Fireproofing of Vessels and Structural Steel.

4.0 DESIGN

4.1 DESIGN LOADS

4.1.1 "Dead Load" shall be the weight of materials forming the structural unit, including insulation and fire-proofing, plus the weight of all supported equipment, piping and all other permanent attachments.

4.1.1.1 "Equipment Loads" shall be the weight of machinery and/or all process equipment together with all dead load attachments.

4.1.2 "Hydro-static Test Load" is the weight of the equipment and piping full of water together with the weight of its attachments.

4.1.3 "Operating Load" is the weight of equipment and piping with operating liquid plus the dead and live load on attachments to the equipment.

4.1.4 "Live Load" refers to superimposed loads on a floor or platform area due to operation and maintenance only, and shall have the following minimum values:

a) Platforms and walkways - 50 psf and 100 psf on supporting members.

b) Stairways - Greater of 75 psf or a moving concentrated load of 1000 pounds.

c) Flat roofs - 25 psf.

d) Flat roofs carrying equipment - 100 psf.

e) Floor - 100 psf.

It does not include the weight of equipment, piping or storage of materials. Where heavier live loadings are likely to occur, they shall be provided for in the design.

4.1.5 "Pipe Loads" shall be the weight of all pipelines, valves, fittings, insulation, etc., and shall include the weight of contents during test, or normal operation, whichever is greater.

4.1.6 Earthquake loads, shall be zone 2 as set forth in the Uniform Building Code, (UBC), 1979.

4.1.7 Loads for pulling heat exchanger tube bundles shall be taken equal to the weight of the tube bundle and shall be resisted by one pier.

4.1.3 Wind loads on structures shall be determined according to Uniform Building Code, 1979, 25 psf wind pressure map areas in Table No. 23-F.

4.1.9 Design snow load shall be 25 psf.

4.1.10 Crane runway forces shall be taken as set forth in Section 1.3 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, for both power and hand operated equipment. For monorails the same conditions shall apply except that the lateral force shall be taken as zero.

4.1.11 THERMAL EXPANSION LOADS

4.1.11.1 All equipment support structures and elements shall be designed to accomodate the loads or effects produced by thermal expansion.

4.1.11.2 In the design of pipeway support structures, a horizontal frictional force due to thermal expansion of lines, shall be applied at the beam bearing surface. This force shall be assumed to act in either direction parallel to the piping run; and shall be one of the following which, in combination with gravity loads, produces the more severe effect on beams, columns or foundations.

a) A thermal expansion force equal to 7.5% of the operating weight of all piping.

b) A thermal expansion force equal to 30% of any one or more lines known to act simultaneously in the same direction.

4.1.11.3 Pipe anchor loads shall be as calculated to resist anchorage loadings in piping systems, and shall be additive to the expansion load specified in Paragraph 4.1.11.2.

4.1.11.4 Thermal expansion loads shall be combined with the appropriate loading combinations set forth in Section 4.3 except that for pipeway stanchions they shall ordinarily not be combined with loads produced by hydrostatic test, wind or earthquake.

4.2 MACHINE DYNAMIC LOADINGS

4.2.1 Structures and their elements shall provide for safe and tolerable response to the cyclic loadings produced by rotating or reciprocating equipment.

4.3 Loading Conditions

All structures and their foundations, and all elements thereof, shall be designed for the most severe of any of the following combination of loads and forces.

4.3.1 Shutdown dead load of equipment (empty, but with all permanent internals, piping, platforms and insulation in place) combined with wind or earthquake, whichever is greater.

Note: For vertical towers, the above condition with wind will often result in the minimum ratio of stability against overturning, thus governing size of foundation, However, the possibility that a vessel in erection condition (empty bare shell without any attachments or internals) may govern stability requirements, shall not be overlooked.

4.3.2 Normal operating loads with all dead and live loads in place, but no wind or earthquake.

4.3.3 Normal operating loads with all dead loads in place, combined with wind or earthquake, whichever is greater.

4.3.4 Vessels and piping under hydrostatic test with all dead loads in place, but no wind or earthquake.

4.3.5 Emergency Upset—Normal operating load plus any load resulting from a possible abnormal condition, misoperation, instrument failure, etc.

4.3.6 Stability Against Overturning

4.3.6.1 All structural units consisting of stacks, exchangers, vertical and horizontal vessels, together with their foundations, shall have the following minimum stability ratio for the loading conditions set forth in Section 4.3:

	Stability Ratio
Paragraph 4.3.1	1.5
Paragraph 4.3.2 thru 4.3.5	2.0

4.3.6.2 Stability Ratio is defined as the stabilizing moment divided by the overturning moment. In the case of structures supported

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by a single foundation, the stabilizing moment shall be taken about the outside edge of the foundation.

4.3.6.3 Where a foundation for an integral structure unit consists of two or more footings, as in the case of an elevated heater or a framed structure supporting equipment, the stability ratio of the structure as a whole including its equipment, shall be not less than 1.5 for any condition of loading when the stabilizing moment is taken about the center of outermost footing(s).

4.3.6.4 Provision of Paragraph 4.3.6.1 and 4.3.6.2 do not apply to pile-supported structures wherein permissible tension capacity of piles is properly developed.

4.4 For ultimate strength design of the foundation, the operating load and test load factor shall be the same as for dead load.

5.0 <u>DESIGN REQUIREMENTS</u>

5.1 <u>Access and Maintenance Structures</u>

5.1.1 Refer to the Equipment Layout Specification for requirements relating to the following:

Built-in maintenance facilities.

Overhead and horizontal clearances.

Basic dimensional requirements.

General requirements for accessibility.

General requirements for platforms, ladders and stairways.

5.1.2 Platform flooring shall be 1½" x 3/16" bar serrated galvanized steel grating unless otherwise noted. Flooring requiring removal shall be bolted.

5.1.3 Handrails are to be 3'6" high and shall extend around edges of all platforms, landings, walkways and stairways. Spacing of handrail posts shall not exceed 8'0". Handrail to be angle type construction unless otherwise specified and be galvanized after fabrication.

5.1.4 Toeplates shall not be less than 9" high and shall extend continuously around edge of all platforms, landings, walkways and openings except at stair and ladder accesses. Platform less than 6'0" above grade shall not have toeplates.

5.1.5 Platform handrails, supports and brackets in the vicinity of inspection openings shall be designed to permit removal of equipment internals. On heaters, these elements shall be designed to facilitate tube removal and replacement.

Any pipe, support, nozzle, etc. protruding through a platform with more than one inch horizontal clearance between the protrusion and the edge of the platform shall have a toeplate around the opening.

5.1.6 Vertical support members of platforms should not be attached to horizontal surfaces of vessel heads or shells. It is preferable to support platforms off clips mounted on vertical surface of vessels.

5.1.7 At least two means of access shall be provided from structures supporting several pieces of equipment.

5.2 Stairways and Ladders

5.2.1 Stairways

5.2.1.1 Stairways shall have a minimum width of 2'-6", a minimum tread width of 9½", a maximum riser of 8", and the maximum vertical distance between landing shall be 15 feet.

5.2.1.2 All stairway runs on the same structure shall have, if possible, the same slope, preferably 9 vertical to 12 horizontal.

5.2.1.3 All treads shall be galvanized, serrated grating type as called for on the drawings. Stairway handrails shall be continuous with landing and platform handrails.

5.2.2 Ladders

5.2.2.1 All ladders serving platforms or landings 4 feet or more above grade shall be equipped with safety guards. All ladders serving platforms or landing 12 feet or more above grade shall be equipped with safety cages. Ladder cages shall be extended from the top to not over 8'0" from the landing at the bottom.

5.2.2.2 On elevated platforms where the edge of the platform in front of the ladder is less than 4'0" from the centerline of rungs, extend 3 front cage bars down to handrail and field weld. Where edge of platform to right or left of cage centerline is less than 3'-0" extend 2 cage bars down to handrail and field weld.

5.2.2.3 Ladder runs shall be offset at a maximum of 30 feet, landing to landing. This requirement does not apply to stacks or chimneys.

5.2.2.4 Ladders required to have cages shall be side stepoff in all cases where access and layout permits.

5.2.2.5 Ladders for stacks or chimneys do not require a cage but will be equipped with an OSHA approved safety device such as SAF-T-Climb (as manufactured by space devices) or equal.

5.3 Design Details

5.3.1 It is preferred that all splices in main rigid frames be made by welding. Bolted joints are, however, acceptable provided high strength bolting is employed.

5.3.2 In general, connections of main framing and bracing shall be designed so that connected members or fastener patterns can be justified by fully rational calculations.

5.3.3 Bracing connections shall be designed to transmit the forces in an adequate manner. Where necessary, the bracing forces shall be transmitted to the flanges of the braced members. This is important where the structure is subject to earthquake.

5.3.4 Shear loads on anchor bolts embedded in concrete shall not exceed the loads set forth in Standard HQ-510 Rev. 2 Anchor Bolts unless shear lugs or similar rationally designed devices are provided to resist their share of such load. Friction of column base plates on concrete shall not be considered as resisting these loads.

6.0 MATERIALS

6.1 Steel Structures

6.1.1 For the technical requirements for detailing, materials, fabrication and delivery of structural steel, miscellaneous steel and joists see Specification 14222-M-3.

6.1.2 Generally the design shall be based on the use of ASTM A36 structural steel using the allowable stresses as stated in the "AISC Specification for the Design, Fabrication and Erection of Sructural Steel for Buildings".

6.2 Concrete Structures

6.2.1 All concrete materials, testing, furnishing, proportioning, and construction shall be in accordance with specification 14222-Q-2.

6.2.2 In general, minimum compressive strength of concrete at 28 days shall be 3,000 psi. Specifically, the 28-day strengths shall be as called for on the drawings.

6.3 Reinforcing steel shall be ASTM A615, grade 60 using the allowable stresses as stated in the ACI Specification "Standard Building Code Requirements for Reinforced Concrete".

7.0 CONNECTIONS

7.1 Connections shall be as indicated on the design drawings and as specified herein.

7.2 Shop connections shall be welded, unless shown or noted otherwise on the design drawings.

7.3 Field welded connections shall be permitted only where shown on the design drawings, or authorized by the Buyer.

7.4 Unless otherwise shown or noted, all field connections, except ladders, stairs and handrails, shall be made with high strength bolts conforming to ASTM A325. Connections for ladders, stairs and handrails shall be made with machine bolts conforming to ASTM A307.

7.5 Unless the reaction is given on the design drawing, beam to beam and beam to column connections shall be designed for a reaction equal to half the uniform load capacity for the given span of a beam shown in the tables, "Allowable Loads on Beams", of the AISC Manual of Steel Construction. The connections must also comply with the requirements of Table I and III, "Framed Beam Connections" of the above manual.

7.6 All bolts shall be 3/4 inch diameter, except as shown or noted on the design drawings.

7.7 All gusset plates shall be 3/8 inch thick unless noted on the design drawings.

7.8 Moment connections shall be designed to develop the full bending strength of the weakest connected member, unless the moment is noted or connection is detailed on design drawings.

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8.0 HIGH STRENGTH BOLTING

8.1 All galvanized joints using high strength bolts shall be "bearing-type connections", unless otherwise shown or noted. Non-galvanized joints using high strength bolts may be "friction-type connections". The allowable loads shall be based on all bolts having threads in the shear plane.

8.2 High strength bolted connections shall be made in accordance with provisions of AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Bolts may be tightened by either the turn-of-nut method or by the calibrated wrench method, or with the use of a direct tension indicator as provided in the AISC specification.

8.3 When bolts, installed by the turn-of-the-nut method, have been brought to a snug-tight fit, they shall be tightened additionally by the applicable amount of nut rotation as specified in the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Impact wrenches, if used, shall have sockets marked each 90 degrees on outer periphery to enable the nut rotation to be verified.

8.4 For bolts, installed by the calibrated wrench method, wrenches shall be calibrated at least twice a day when in use, once before the start of the working day and once at the midpoint of the working day and whenever there is any question or doubt whether or not a wrench is operating properly.

8.5 Where direct tension indicators are being used, they shall be installed according to the manufacturers installation specifications.

8.6 When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of burrs, dirt and other foreign material that would prevent solid seating of parts.

8.7 The Inspector will observe operations for the installation and tightening of bolts to determine whether the work is being performed properly, and will inspect the nut surface for indication of wrench impaction. Bolts tension will be checked, at Inspector's discretion, with a torque wrench in accordance with the applicable provisions of Section 6 (d) of the AISC Specification for Structural Joints Using ASTM A325 or A590 Bolts.

8.8 Where either a A325 or A490 are used as fitup bolts in a connection and are not tightened to the specified minimum tension, bolts may be left in place, and subsequently tightened as permanent bolts.

8.9 Ungalvanized ASTM A325 bolts that have been installed by any of the methods specified in Section 5 of the "AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts" may be loosened and retightened one more time, providing the nut can be turned freely by hand for the full length of the threads after removal from the joint.

8.10 Galvanized ASTM A325 and ASTM A490 bolts which have been tightened to the full extent specified in Section 5 will not be reused.

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1.0 SCOPE

1.1 This specification covers the design, details, materials, fabrication, and erection of steel building frames complete with all purlins, girts, bracing and other structural elements and connections. It also applies to any architectural attachments, such as roofing, siding, walls, and partitions, where such attachments are incorporated in the design to act as structural elements.

1.2 General layout and dimensional requirements are shown on the drawings or are described elsewhere in the supporting documents.

2.0 CODES, STANDARDS AND SPECIFICATIONS

2.1 Design, materials, fabrication, and erection of the building (s) as a whole, and all structural elements and connections thereof, shall conform to the requirements of the applicable portions of the following codes and specifications, except as modified or otherwise specified hereinafter.

2.1.1 Structural Steel - "American Institute of Steel Construction Specification for the Design, Fabrication, amd Erection of Structural Steel for Buildings", 1978.

2.1.2 Light Gauge Steel - "American Iron and Steel Institute Specification for the Design of Light Gauge Cold-Formed Steel Structural Members", 1977 Edition.

2.1.3 Open Web Joists - "Standard Specification for Open Web Steel Joists" adopted by AISC on the following dates:

DLJ and DLH Series	1970
LJ and LH Series	1969
J and H Series	1965

2.1.4 General Design Requirements, Except as hereinafter modified - "Uniform Building Code" of the International Conference of Building Officials, 1979 Edition, and ANSI A58.1, American National Standards Institute "Building Code Requirements for Minimum Design Loads in Building and other Structures", 1972.

2.1.5 Welding Practice - "American Welding Society Structural Welding Code - Steel", AWS D1.1, 1979.

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2.1.6 Wind Load Application Coefficients - per ANSI A58.1, see Paragraph 2.1.4.

2.2 Where requirements of the AISC Specification and the Uniform Building Code and ANSI A58.1 referred to in Paragraphs 2.1.1. and 2.1.4 respectively are in conflict the AISC Specification shall govern.

3.0 GENERAL

3.1 Types of Construction

This specification applies to, but is not necessarily restricted to the following types of construction:

3.1.1 Structures of rigid frame construction.

3.1.2 Structures of truss and column construction.

3.1.3 Structures of post and beam construction.

3.1.4 Structures of beam construction supported by masonry walls.

3.1.5 Structures of truss or open-web joist contruction supported by masonry walls.

4.0 DESIGN

4.1 Design Loads

4.1.1 Building(s) as a whole, or any portion or connection thereof, shall be designed to resist within allowable stress limitations the basic design loadings acting either singly or in conjunction as specified below:

4.1.1.1 Basic Design Loadings occurring as a result of:

a) Wind on vertical projected areas. In accordance with Uniform Building Code-1979, 25 psf wind pressure map areas in Table No. 23-F.

b) Snow Load (no other roof live load) on horizontal projected areas. (25 psf)

c) Roof Live Load (no snow load) on horizontal projected areas. (25 psf)

d) Floor Live Load taken as the superimposed load on a floor or platform due to operation and maintenance. (100 psf)

e) Seismic Load (Zone 2)

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4.1.1.2 Dead Loads - Weight of building plus weight of all supported equipment, machinery, piping with contents, storage loads, and all other permanent attachments, with no other transient, live, or snow loads in place or acting.

4.1.1.3 Crane and/or Monorail Loads shall be taken as shown on the drawings or as described elsewhere in the supporting documents. Impact and runway horizontal forces shall be in accordance with the specification referred to in Paragraph 2.1.1 above, and these forces shall be ignored in the case of manually chain operated equipment.

4.1.1.4 Storage Loads shall include contents of tanks, bins and hoppers, or special storage floor loadings, and shall be taken as shown on the drawings or as decribed elsewhere in the contract documents. For purpose of design, these shall be treated as permanent dead loads.

4.2 Design shall be based on any one or more of the following loading conditions which produces the highest stress in members or connections.

Condition A Dead load plus basic roof live load or snow load. No wind or earthquake.

Condition B Dead loads plus basic wind or earthquake loads.

4.3 For buildings having power operated overhead cranes or trolleys, the specified lateral, and vertical load and impact forces, shall be additive to loading Condition A, above.

4.4 Roof live load and snow load are not additive. In buildings for which no snow load is specified, basic live load may be reduced in accordance with provisions of the Uniform Building Code. No reduction shall be taken in basic snow load.

4.5 Basic allowable unit stresses in members or fasteners may be increased 1/3 for loading combinations in which wind or earthquake is acting, provided that such increase in stress does not result in lighter members or connections than would be in the case for loading Condition A alone.

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5.0 DESIGN REQUIREMENTS

5.1 Light gauge, cold-formed sections may be used for purlins, girts, door and window framing. Purchaser reserves the right to reject such members for use as eave struts, bracing chords, and other members subject to combinations of axial compression and transverse loading. In general, members subject to such loading shall be composed of rolled structural shapes unless rationally sized to carry such loadings, and adequate lateral bracing is provided for the light gauge members.

5.2 Webs and flanges of main rigid frames shall be composed of rolled structural shapes, or properly built-up plate of not less than 3/16" thickness.

5.3 Buildings to have exterior siding of asbestos-cement or single thickness corrugated metal, shall be designed to support the entire weight of the siding. Such siding shall not be assumed to be supported by the foundation.

5.4 Buyer reserves the right to reject rod bracing for any building where in his opinion, such bracing is inadequately connected; will result in excessibe member distortions or deflections, or otherwise detracts from the safety or serviceability of the structure.

5.5 Light gauge sections shall in no case be composed of thinner material than No. 18 U.S. gauge.

5.6 Design shall reflect prudent attention to the possibility of failure through elastic or inelastic instability of any element in the structure, however small. All main framing shall be adequately proportioned and properly braced in areas of compressive stress.

5.7 Where the "skin or shell" of the structure is used as a diaphragm to transmit shears, or as lateral bracing to stay structural members,such use shall be substantiated by rational analysis or by tests by an approved agency.

5.8 Stairways

5.8.1 Stairways shall have a minimum width of 3'-0" a minimum tread horizontal run of 10", a maximum riser of 7-½" and the maximum vertical distance between landings shall be 15 feet.

5.8.2 All stairway runs in the same building shall have, if possible, the same slope, preferable 9 vertical to 12 horizontal.

5.9 Design Details

5.9.1 Framing members may be fastened by welding, riveting, standard bolting, high strength bolting, or combinations thereof. The use of high strength bolting shall be based strictly on the requirements of the AISC Specification as listed in Paragraph 2.1.1.

5.9.2 It is preferred that all splices in main rigid frames be made by welding. Bolted joints are, however, acceptable provided high strength bolting is employed.

5.9.3 All welding shall reflect first class workmanship, and shall conform strictly to the code requirements set forth in Paragraph 2.1.5 hereof. No welding shall be performed when ambient temperature is below 40°F unless parts to be joined are preheated to not less than 150°F as determined by Tempelstik.

5.9.4 In general, connections of main framing and bracing shall be designed so that connected members or fastener patterns can be justified by fully rational calculations. In this respect, special attention shall be given to manner in which wind columns at ends of building transmit their reactions into the roof bracing system.

5.9.5 Rod bracing, where used, shall be designed to terminate in connections of adequate strength and rigidity so that elements of structural members are not subject to high localized stresses or distortions.

5.9.6 Shear loads on anchor bolts embedded in concrete shall not exceed the loads set forth in Table 26-D of the Uniform Building Code, unless shear lugs or similar rationally designed devices are provided to resist their share of such load. Friction of column base plates on concrete shall not be considered as resisting these loads.

6.0 DRAWINGS AND CALCULATIONS

Purchaser will require shop details and structural calculations for review prior to fabrication, unless specifically waived in the supporting documents.

7.0 MATERIALS

7.1 All materials shall be of new and unused stock.

7.2 Hot rolled structural steel and plate shall conform to either ASTM Specifications A36 or A529.

7.3 Light gauge steel of structural quality shall conform to either ASTM Specification A570, Grade 50 or A607, Grade 50.

7.4 High strength bolts, nuts, and washers shall conform to the AISC Specification as listed in Paragraph 2.1.1.

7.5 Standard bolts shall conform to ASTM 307.

7.6 Open web steel joists and their bracing shall conform to the Specifications listed in Paragraph 2.1.3.

8.0 FABRICATION AND ERECTION

8.1 Fabrication shall meet all applicable requirements of codes and specifications referred to in Section 2.0 above.

8.2 Shop drawings shall define all welding to be done on main framing members, either by adequate notes, developed details, or proper welding symbols. Recommendations and requirements of the American Welding Society Code referred to in Paragraph 2.1.5 shall be strictly adhered to in fabrication and/or erection.

8.3 Wherever high strength bolts are used in the work, erection drawings shall so indicate.

9.0 PAINTING

9.1 Surfaces to be painted exposed to the weather or other adverse elements shall be shop coated in accordance with Specification 14222-X-3.

9.2 Surfaces to be painted not exposed to the weather or other adverse elements shall be given one shop coat in accordance with Seller's standard.

9.3 Surfaces to be field painted shall be coated in accordance with Specification 14222-X-1.

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1.0 SCOPE

1.1 This specification covers the technical requirements for the detailing, materials, fabrication and delivery of structural steel, miscellaneous steel and steel joists.

2.0 CODES, STANDARDS AND SPECIFICATIONS

This specification shall be used in conjunction with Specifications 14222-M-1, 14222-M-2 and 14222-M-4.

Design, materials, fabrication, and erection of the structures as a whole,and all structural elements and connections thereof, shall conform to the requirements of the following codes, standards and specifications, except as modified or otherwise specified hereinafter.

2.1 Abbreviations as used in this specification shall have the following definitions:

ACI American Concrete Institute

AISC American Institute of Steel Construction

AISI American Iron and Steel Institute

ANSI American National Standards Institute

ASTM American Society for Testing and Materials

AWS American Welding Society

SJI Steel Joist Institute

OSHA The Occupational Safety and Health Act

2.2 Codes and Standards

AISC Manual of Steel Construction, Eighth Edition, 1980.

AISC Code of Standard Practice for Steel Buildings and Bridges, 1976.

AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, 1978.

AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts, approved by Research Council on Riveted and Bolted Structural Joints of Engineering Foundation, 1978.

ASTM A6	Standard Specifications for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use, 1979.
ASTM A36	Specification for Structural Steel, 1977a.
ASTM A53	Specification for Grade B Welded and Seamless Pipe, 1979.
ASTM A108	Specification for Steel Bars, Carbon, Cold Finished Standard Quality, 1979.
ASTM A123	Zinc (Hot Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip), 1978.
ASTM A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware, 1978.
ASTM A283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars, 1979.
ASTM A307	Specification for Carbon Steel Externally Threaded Standard Fastener, 1978.
ASTM A325	Specification for High Strength Bolts for Structural Steel Joints, including Suitable Nuts and Plain Hardened Washers, 1979.
ASTM A441	High Strength Low Alloy Structural Manganese Vanadium Steel, 1979.
ASTM A500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structure Tubing in Rounds and Shapes, 1978.
ASTM A501	Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing, 1976.
ASTN A569	Specification for Steel Carbon (.15 maximum percent) Hot-Rolled Sheet and Strip, Commercial Quality, 1972.
ASTM A572	High Strength Low Alloy Columbian Vanadium Steels of Structural Quality, 1979.
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, 1979.
SJI & AISC	Standard Specifications for Open Web Steel Joist, J-Series and H-Series, 1965.

SJI & AISC	Standard Specification for Longspan Steel Joists LJ-and LH-Series and Deep Longspan Steel Joists, DLJ-and DLH-Series, 1969 and 1970 respectively.
AWS D1.1	Structural Welding Code-Steel, 1979.
AWS A5.1	Specification for Mild Steel Covered Arc Welding Electrodes, 1979.
UBC	Uniform Building Code of the International Conference of Building Officials, 1979.
ANSI A58.1	Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, 1972.
ACI 318	Standard Building Code Requirements for Reinforced Concrete, 1977.
OSHA	The Occupational Safety and Health Act, 1978.

2.3 Reference Specifications:

14222-M-1	Design of Structures
14222-M-2	Steel Building Frames
14222-M-4	Erection of Structural Steel, Miscellaneous Steel and Joists.
14222-N-6	Fireproofing of Vessels and Structural Steel
14222-Q-1	Foundations
14222-Q-2	Plain and Reinforced Concrete
14222-L-4	Plant Design and Piping Layout
14222-X-3	Shop Painting
14222-X-1	Field Painting

3.0 GENERAL

3.1 Definitions

3.1.1 Owner - Ashland Synthetic Fuels, Inc. and AIRCO Energy Co., Inc. or their representative

3.1.2 Buyer - Bechtel or their designated representative

3.1.3 Seller - The party with whom the Buyer has contracted to furnish material and services.

3.1.4 Inspector - Owner's or Buyer's designated representative.

4.0 DRAWINGS

4.1 The Buyer will furnish design drawings which will give all information required for shop detailing.

4.2 The Seller shall furnish the following shop drawings to the Buyer:

4.2.1 Erection drawings showing clearly the marking and position of each member.

4.2.2 Details of all members and their connections.

4.3 The Seller's erection drawings shall be referenced to the Buyer's design drawings. Detail sheets shall be referenced to the related erection drawing.

4.4 The Buyer or his designated representative will review the shop drawings for conformance to the design drawings. If corrections are required the Seller shall make and clearly mark such corrections and resubmit the drawings for final review. Detail and erection drawings shall be reviewed before fabrication of any material commences.

4.5 Review of Seller's drawings by the Buyer or his designated representative shall not relieve the responsibility of the Seller for the completeness and accuracy of dimensions and details.

4.6 Structural shapes shown on design drawings shall be AISC series conforming to the standard shape profiles listed in ASTM A6.

4.7 Where high strength bolts are used in the work, erection drawings shall so indicate.

5.0 MATERIALS

5.1 All materials shall be of new stock, unless noted otherwise on design drawings.

5.2 All materials shall conform to the requirements of the specifications as listed in Section 2 of this Specification.

5.3 Welding filler metal and flux shall conform to AWS D1.1, "Structural Welding Code". Only electrodes and filler wire which produce minimum deposited tensile strength of 70,000 psi shall be used. The electrodes other than low hydrogen electrode E7018 conforming to AWS A5.1 are subject to approval of the Buyer.

5.4 Steel Joists

5.4.1 Open joists, long span and deep longspan joists shall be manufactured from hot-rolled structural shapes, bars and angles conforming to the SJI and AISC specifications listed in section 2 of this Specification.

5.4.2 Unless otherwise noted, all open web steel joists, long span and deep longspan steel joists shall be of the underslung type sized as shown on the plans. Approximate camber shall be as called for by the SJI and AISC specifications.

5.4.3 Bridging shall be horizontal bridging or cross bridging with spacing as specified by the SJI and AISC specifications unless otherwise shown.

5.5 Grating

5.5.1 Generally all flooring shall be 1¼" x 3/16" welded steels grating unless otherwise noted on the design drawings. Top surface of the bearing bars shall be serrated where indicated on the drawings for a non-slip surface.

5.5.2 Cross bars shall be spaced not more than 4 inches center to center. Main bars and cross bars of adjacent panels shall be in line.

5.5.3 Grating shall be galvanized unless otherwise noted on the drawings for other types of finish. Galvanizing of grating shall be in accordance with ASTM-A123, with not less than two (2) oz. of zinc coating per sq. ft. of flat area.

5.5.4 Junctions between bearing and cross bars shall be fully fused without reduction in the area of the bearing bars.

5.5.5 All cutouts for columns, bracing connections and other openings in grating shall be banded. Banding bars shall be at least the same thickness as the bearing bars to which they are welded.

5.5.6 Where grating can be attached to its supporting steel in the shop, it shall be shop welded prior to galvanizing. Where grating is to be installed in the field, it shall be fastened to the supporting steel with "friction type" clips.

5.6 Checkered Plate

5.6.1 Where indicated, flooring shall be ½" checkered plate.

5.6.2 Provide at least one ½" diameter weep hole in each floor plate panel. All penetrations for piping shall be cut and suitably banded in field except where dimensioned on drawings in which case they shall be shop cut and banded.

5.6.3 Where floor plate is to be installed in the field it shall be shop drilled with 9/16" dia. countersunk holes @ 1'-0" ± c/c. Shop shall drill beam flanges with 11/16" dia. holes for ½" dia. flat head bolts with hex head nuts. Shop assembled floor plate shall be seal-welded to its supporting members in accordance with Paragraph 9.0 of this specification.

6.0 FABRICATION

6.1 Fabrication shall meet the applicable requirements of all codes and specifications listed under Section 2.0 and all the requirements of this specification.

6.2 Fabrication shall commence only after shop drawings are reviewed by the Buyer. Substitutions of sections or modifications of design details shall be made only as approved by the Buyer.

6.3 All members shall be clearly marked for field assembly with designating numbers of letters corresponding to the field erection drawings.

6.4 Platforms, stairways and handrails shall be shop-assembled in the largest units suitable for handling and shipping.

6.5 All ragged edges, welds, protruding bolts or other fasteners, which might cause injury to personnel, shall be avoided, or if required, ground smooth.

6.6 Mechanical operating devices such as hinges, hasps, holdopens, and like items shall operate smoothly and efficiently.

7.0 CONNECTIONS

7.1 Connections shall be as indicated on the design drawings and as specified herein.

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7.2 Shop connections shall be welded unless shown or noted otherwise on the design drawings.

7.3 Field welded connections shall be permitted only where shown on the design drawings, or authorized by the Buyer.

7.4 Unless otherwise shown or noted, all field connections, except ladders, stairs and handrail, shall be made with high strength bolts conforming to ASTM A325. Connections for ladders, stairs and handrail shall be made with machine bolts conforming to ASTM A307.

7.5 Unless the reaction is given on the design drawing, beam to beam and beam to column connections shall be designed for a reaction equal to half the uniform load capacity for the given span of a beam shown in the tables, "Allowable Loads, on Beams", of the AISC Manual of Steel Construction. The connections must also comply with the requirements of Table I and III, "Framed Beam Connections" of the above manual.

7.6 All bolts shall be 3/4 in. diameter, except as otherwise shown or noted on the design drawings.

7.7 All gusset plates shall be 3/8 in. thick unless otherwise noted on the design drawings.

7.8 Moment connections shall be designed to develop the full bending strength of the weakest connected member, unless the moment is noted or connection is otherwise detailed on design drawings.

8.0 HIGH STRENGTH BOLTING

8.1 All gavanized joints using high strength bolts shall be "Bearing-type connections", unless otherwise shown or noted. Non-galvanized joints using high strength bolts may be "friction-type connections". The allowable loads shall be based on all bolts having threads in the shear plane.

8.2 High strength bolted connections shall be made in accordance with provisions of AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Bolts may be tightened by either the turn-of-nut method or by the calibrated wrench method, or with the use of a direct tension indicator as provided in the AISC specification.

8.3 When bolts, installed by the turn-of-the-nut method, have been brought to a snug-tight fit, they shall be tightened additionally by the applicable amount of nut rotation as specified in the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Impact wrenches, if used, shall have sockets marked each 90 degrees on outer periphery to enable the nut rotation to be verified.

8.4 For bolts, installed by the calibrated wrench method, wrenches shall be calibrated at least twice a day when in use, once before the start of the working day and once at the midpoint of the working day and whenever there is any question or doubt whether or not a wrench is operating properly.

8.5 Where direct tension indicators are being used, they shall be installed according to the manufacturers installation specifications.

8.6 When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of burrs, dirt and other foreign material that would prevent solid seating of parts.

8.7 The Inspector will observe operations for the installation and tightening of bolts to determine whether the work is being performed properly, and will inspect the nut surface for indication of wrench impaction. Bolt tension will be checked, at Inspector's discretion, with a torque wrench in accordance with the applicable provisions of Section 6(c) of the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

8.8 Where either a A325 or A490 are used as fitup bolts in a connection and are not tightened to the specified minimum tension, bolts may be left in place, and subsequently tightened as permanent bolts.

8.9 Ungalvanized ASTM A325 bolts that have been installed by any of the methods specified in Section 5 of the "AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts" may be loosened and retightened one more time, providing the nut can be turned freely by hand for the full length of the threads after removal from the joint.

8.10 Galvanized ASTM A325 and ASTM A490 bolts which have been tightened to the full extent specified in Section 5 will not be reused.

9.0 WELDING

9.1 All welding shall be performed by the manual shielded metal-arc (SMAW) or submerged-arc (SAW) welding processes. The flux cored-arc (SCAW) welding process may be used provided that an external shielding gas is used.

9.2 Welding procedures which conform in all respects to the provisons of Section 2,3, and 4 of AWS D1.1, "Structural Welding Code" shall be deemed as prequalified and are exempt from tests for qualifications.

9.3 Procedures other than those prequalifed shall be qualified by tests as specified in Section 5 of AWS D1.1. The written welding procedures and the qualification test records shall be submitted to the Buyer for approval.

9.4 Welding shall be performed only by welders or operators who have been qualified in accordance with Section 5 of AWS D1.1. The welders qualification tests records shall be made available to the Buyer.

9.5 Each weld shall be uniform in width and size throughout its full length. Each layer of welding shall be smooth and free of slag, cracks, pinholes and undercut, and shall be completely fused to the adjacent weld beads and base metal. In addition, the cover pass shall be free of coarse ripples, high crown, deep ridges and valleys between the beads, and shall blend smoothly and gradually into the surface of the base metal.

9.6 Butt welds shall be slightly convex, of uniform height, and shall have full penetration.

9.7 Fillet welds shall be of specified size with full throat and the legs of uniform length.

9.8 Repair, chipping, or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the base metal thickness.

9.9 Non-destructive testing of all full penetration buttwelds is required and shall meet the provisions of Article 6.7 of AWS D1.1.

10.0 SHOP PAINTING

10.1 Shop painting shall conform to Specification 14222-X-3. Paint shall be excluded from areas within 2 inches of joints to be field welded and faying surface of high-strength bolted connections. Members to be fireproofed or embedded in concrete need not be painted.

11.0 GALVANIZING

11.1 Unless otherwise specified, preparation for and galvanizing of structural steel shall conform to ASTM-A123.

11.2 Galvanizing of bolting material shall conform to ASTM A153.

11.3 Unless otherwise specified, all fabricated structural steel shall be galvanized. However, members that are completely encased in fireproofing shall not be galvanized. Members that are partially fireproofed (ie, load bearing beams that have top flange exposed, columns that are fireproofed only along part of their length) shall be completely galvanized.

11.4 Where galvanizing of steelwork is called for it shall be done after shop fabrication. Welded joints in material to be galvanized shall be completely sealed with not less than the equivalent of a 3/16 in. fillet weld in addition to the structural welding as shown. This seal welding shall be provided whether or not called for on the drawings.

11.5 Damage to galvanizing, and weldments to galvanized material, shall be thoroughly cleaned by wire brushing or grinding, and given a heavy touch-up coat of Z.R.C. as manufactured by the Sealube Company, Wakefield, Mass. or equal as approved by the Buyer.

12.0 SPECIAL IDENTIFICATION REQUIREMENTS

12.1 All shipping units, such as bundles, sub-assemblies or individual pieces for platforms on vertical and horizontal vessels shall be identified by an adequate erection drawing or erection schedule which locates the piece in its particular platform assembly, and also identified by the Bechtel equipment number of the vessel to which the platform will be attached. These erection data shall either precede or accompany the individual shipments to the jobsite. This provision does not abrogate the general requirement for furnishing erection drawings for other categories of steelwork.

12.2 A separate shop order number shall be assigned to each individual complete structural system as, for example each building, each equipment support structure, complete pipeway support system, all platforms on any large single piece or grouping of similar equipment, etc.

13.0 SHOP INSPECTION

13.1 The Buyer reserves the right to inspect all material for compliance with this Specification, including welding, surface preparation and painting.

13.2 The Seller shall provide facilities required for the inspection of material and workmanship as requested by the Inspector.

14.0 DELIVERY

14.1 Delivery of material shall meet the requirements of specifications stated in Section 2.0.

14.2 No material shall be shipped until the shop coat of paint is thoroughly dry and clearly marked with waterproof ink or paint.

14.3 It shall be the Seller's responsibility to provide adequate packing, crating, blocking and/or bracing to prevent damage to the fabricated material while Loading, in transit and while unloading.

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1.0 SCOPE

1.1 This specification covers the technical requirements for erection of structural steel, miscellaneous steel and steel joists.

2.0 CODES, STANDARDS AND SPECIFICATIONS

This specification shall be used in conjuction with Specifications 14222-M-1, 14222-M-2 and 14222-M-3.

Design, materials, fabrication, and erection of the structures as a whole, and all structural elements and connections thereof, shall conform to the requirements of the following codes, standards, and specifications, except as modified or otherwise specified hereinafter.

2.1 Abbreviations as used in this specification shall have the following definitions:

ACI American Concrete Institute

AISC American Institute of Steel Construction

AISI American Iron and Steel Institute

ANSI American National Standards Institute

ASTM American Society for Testing and Materials

AWS American Welding Society

SJI Steel Joist Institute

OSHA The Occupational Safety and Health Act

2.2 Codes and Standards

AISC Manual of Steel Construction, eight Edition, 1980.

AISC Code of Standard Practice for Steel Buildings and Bridges, 1976.

AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buidings, 1978.

AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts, approved by Research Council on Riveted and Bolted Structural Joints of Engineering Foundation, 1978.

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ASTM A6	Standard specifications for General Requirements for Rolled Steel Plate, Shapes, Sheet Piling and Bars for Structural Use, 1979.
ASTM A36	Specification for Structural Steel, 1977a.
ASTM A53	Specification for Grade B Welded and Seamless Pipe, 1979.
ASTM A108	Specification for Steel Bars, Carbon, Cold Finished Standard Quality, 1979.
ASTM A283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars, 1979.
ASTM A307	Specification for Carbon Steel Externally Threaded Standard Fasteners, 1978.
ASTM A325	Specification for High Strength Bolts for Structural Steel Joints, including Suitable Nuts and Plain Hardened Washers, 1979.
ASTM A441	High Strength Low Alloy Structural Manganese Vanadium Steel, 1979.
ASTN A500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structure Tubing in Rounds and Shapes, 1978.
ASTM A501	Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing, 1976.
ASTM A569	Specification for Steel Carbon (.15 Maximum per-cent) Hot-Rolled Sheet and Strip, Commercial Quality, 1972.
ASTM A572	High Strength Low Alloy Columbian Vanadium Steels of Structural Quality, 1979.
ASTM A615	Deformed amd Plain Billet-Steel Bars for Concrete Reinforcement, 1979.
SJI & AISC	Standard Specifications for Open Web Steel Joists, J-Series and H-Series, 1965.
SJI & AISC	Standard Specification for Longspan Steel Joists LJ-and LH-Series and Deep Longspan Steel Joists, DLJ-and DLH-Series, 1969 and 1970 respectively.
AWA D1.1	Structural Welding Code-Steel, 1979.

AWS A5.1	Specification for Mild Steel Covered Arc Welding Electrodes.
UBC	Uniform Building Code of the International Conference of Building Officials, 1979.
ANSI A58.1	Building Code Rrequirements for Minimum Design Loads in Building and Other Structures, 1972.
ACI 318	Standard Building Code Requirements for Reinforced Concrete, 1977.
OSHA	The Occupational Safety and Health Act, 1978.

2.3 Reference Specifications:

14222-M-1	Design Structures
14222-M-2	Steel Building Frames
14222-M-511	Fabrication of Structural Steel, Miscellaneous Steel and Joists
14222-N-6	Fireproofing of Vessels and Structural Steel
14222-Q-1	Foundations
14222-Q-2	Plain and Reinforced Concrete
14222-L-4	Plant Design and Piping Layout
14222-X-3	Shop Painting
14222-X-1	Field Painting

3.0 GENERAL

3.1 Definitions

3.1.1 Owner - Ashland Synthetic Fuels, Inc. and Airco Energy Co., Inc. or their designated representative

3.1.2 Buyer - Bechtel or their designated representative

3.1.3 Erector - The party or any subcontractor performing, under agreements with Owner or contractor, work subject to the requirements of this specification.

3.1.4 Inspector - Owner's or Buyer's designated representative

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4.0 MATERIALS

4.1 Welding electrodes for field welding shall conform to AWS Specification A5.1, Low Hydrogen Electrode E 7018.

4.2 Shim plates for setting column bases shall conform to ASTM A36.

5.0 CONNECTIONS

5.1 Connections shall be as indicated on the design drawings and as specified herein.

5.2 Shop connections shall be welded unless shown or noted otherwise on the design drawings.

5.3 Field welded connections shall be permitted only where shown on the design drawings, or authorized by the Buyer.

5.4 Unless otherwise shown or noted, all field connections, except ladders, stairs and handrail, shall be made with high strength bolts conforming to ASTM A325. Connections for ladders, stairs and handrail shall be made with machine bolts conforming to ASTM A307.

5.5 All bolts shall be 3/4 inch diameter, except as shown or noted on the design drawings.

5.6 All gusset plates shall be 3/8 inch thick unless noted on the design drawings.

5.7 Moment connections shall be designed to develop the full bending strength of the weakest connected member, unless the moment is noted or connection is otherwise detailed on design drawings.

6.0 HIGH STRENGTH BOLTING

6.1 High strength bolted connections shall be made in accordance with provisions of AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Bolts may be tightened by either the turn-of-nut method or by the calibrated wrench method, or with the use of a direct tension indicator as provided in the AISC specification.

6.2 When bolts, installed by the turn-of-the-nut method, have been brought to a snug-tight fit, they shall be tightened additionally by the applicable amount of nut rotation as specified in the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Impact wrenches, if used, shall have sockets marked each 90 degrees on outer periphery to enable the nut rotation to be verified.

6.3 For bolts, installed by the calibrated wrench method, wrenches shall be calibrated at least twice a day when in use, once before the start of the working day and once at the midpoint of the working day and whenever there is any question or doubt whether or not a wrench is operating properly.

6.4 Where direct tension indicators are being used, they shall be installed according to the manufacturers installation specifications.

6.5 When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of burrs, dirt and other foreign material that would prevent solid seating of parts.

6.6 The Inspector will observe operations for the installation and tightening of bolts or determine whether the work is being performed properly and will inspect the nut surface for indication of wrench impaction. Bolt tension will be checked, at Inspector's discretion, with a torque wrench in accordance with the applicable provisions of Section 6(c) of the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

6.7 Where either a A325 or A490 are used as fitup bolts in a connection and are not tightened to the specified minimum tension, bolts may be left in place, and subsequently tightened as permanent bolts.

6.8 Ungalvanized ASTM A325 or A490 bolts that have been installed by any of the methods specified in Section 5 of the "AISC Specifications for Structural Joints Using ASTM A325 or A490 bolts" may be loosened and retightened one more time, providing the nut can be turned freely by hand for the full length of the threads after removal from the joint.

6.9 Galvanized ASTM A325 and ASTM A490 bolts which have been tightened to the full extent specified in Section 5 will not be reused.

7.0 WELDING

7.1 All welding shall be performed by the manual shielded metal-arc (SMAW) or submerged-arc (SAW) welding processes. The flux cored-arc (FCAW) welding process may be used provided that an external shielding gas is used.

7.2 Welding procedures which conform in all respects to the provisions of Section 2,3, and 4, of AWS D1.1, "Structural Welding Code" shall be deemed as prequalified and are exempt from tests for qualifications.

7.3 Procedures other than those prequalified shall be qualified by tests as specified in Section 5 of AWS D1.1. The written welding procedures and the qualification test records shall be submitted to the Buyer for approval.

7.4 Welding shall be performed only by welders or operators who have been qualified in accordance with Section 5 of AWS D1.1. The welders qualification tests records shall be made available to the Buyer.

7.5 Each weld shall be uniform in width and size throughout its full length. Each layer of welding shall be smooth and free of slag, cracks, pinholes and undercut, and shall be completely fused to the adjacent weld beads and base metal. In addition, the cover pass shall be free of coarse ripples, high crown, deep ridges and valleys between the beads, and shall blend smoothly and gradually into the surface of the base metal.

7.6 Butt welds shall be slightly convex, of uniform height, and shall have full penetration.

7.7 Fillet welds shall be of specified size with full throat and the legs of uniform length.

7.8 Repair, chipping, or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the base metal thickness.

7.9 Non-destructive testing of all full penetration buttwelds is required and shall meet the provisions of Article 6.7. of AWS D1.1.

8.0 HANDLING AND STORAGE

8.1 The Buyer shall receive, unload, sort and store all materials to be erected at the jobsite in a designated area.

8.2 The Buyer shall protect the steel against damage including protection of painted surface prior to erection.

8.3 Erector shall inspect structural steel for damage before commencing the erection and submit written report to Buyer.

8.4 The erector shall protect the steel against damage including protection of painted surfaces during erection.

9.0 ERECTION

9.1 General

9.1.1 Unless otherwise specified or shown on the design, shop detail, and erection drawings, erection of structural steel shall conform to AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and to the Code of Standard Practice for Steel Buildings and Bridges.

9.1.2 Erection of steel joists shall conform to the SJI and AISC Standard Specifications for steel joists listed in Section 2 of this Specification.

9.2 Setting Base Plates

9.2.1 Column base plates shall be set and shimmed to correct positions and elevation shown on the drawings.

9.2.2 Grouting and foundation bolt installation shall not be in the scope of this specification. The columns with attached base plates will be plumbed and then the erection of other portions of structrural steel shall commence only when grouting and anchors are in the condition that the grout and anchors can adequately support all the loads subjected to them and their expected capacity will not be influenced due to the erection operation.

9.3 Alignment and Fittings

9.3.1 Each part of a structure shall be properly aligned before completing field connections.

9.3.2 All members in completed frames shall be true to line and free from bends, twists, and open joints.

9.3.3 Fitting-up bolts and drift pins shall not be used to bring improperly fabricated members and parts into place thus causing a strain on bolts in finished work. Drift pins shall not be driven with such force as to injure adjacent metal.

9.3.4 No packing, shimming, or wedging will be permitted to correct faulty work, unless so directed by the Buyer.

9.3.5 Minor misfitting, which shall be remedied by a moderate amount of reaming and slight cutting and chipping, may be corrected by the Erector when, in the Inspector's opinion, it will not be detrimental to the strength or appearance of the structure. All shop errors shall be reported to the Inspector and the proposed method of correction shall be submitted to the Buyer for approval.

9.3.6 Damage caused by handling during erection shall be reported to the Inspector. Corrective measures shall be completed as directed.

9.3.7 Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Splices shall be permitted only where indicated on the drawing.

9.3.8 Erection bolts used in welded construction shall be either tightened securely and left in place or removed and the holes filled with plug welds.

9.4 <u>Erection Tolerances</u>

9.4.1 Erection tolerances shall be in accordance with AISC Code of Standard Practice for Steel Building and Bridges, Section 7(b) and specific requirements of this specification.

9.4.2 Unless otherwise shown, runways for electric overhead cranes shall not exceed the following tolerance limitations:

Lateral Tolerance:	Plus or minus ½ inch in center distance between two crane rails; plus or minus ½ inch maximum deviation of the rail center line shown. Both items per 50 feet of runway.

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Vertical Tolerance: Plus or minus ½ inch from the elevation shown at the top of the rail, in the unloaded condition, per 50 feet of runway.

9.4.3 Rail joints shall be tight and provide for a smooth transfer of the wheel from one rail to another.

9.5 Checkered Plates

9.5.1 Where floor plate is to be installed in field it shall be shop drilled with 9/16" dia. countersunk holes at 1'-0" (±) c/c. Shop shall drill beam flanges with 11/16" dia. holes for ½" dia. flat head bolts with hex nuts.

9.5.2 Removable panels of floor plate shall be fastened with ½" diameter cadmium plated steel countersunk head bolts.

9.5.3 The penetration for piping,ducts, etc. shall be cut and suitably banded, where no dimensions are given on the drawing they are required to be cut in field.

9.6 Grating

9.6.1 Where grating is to be installed in field it shall be fastened to its supporting members with "friction type" clips. Main bars and cross bars of adjacent sections shall be in line.

9.6.2 Joints in floor panels shall occur only over supports. Notching of bearing bars at supports to maintain elevations shall not be permitted.

9.6.3 Removable grating panels shall be fastened to support members by bolt and bent clip fasteners.

9.6.4 Expanded steel grating shall be fastened by spot welding at a maximum of six inch centers at each support.

9.6.5 All cutouts for columns, bracing connections and other openings in grating shall be banded. Banding bars shall be at least the same thickness as the bearing bars to which they are welded.

9.7 Touch-up Painting

9.7.1 After completing erection, surfaces where paint was omitted for field welding or field bolting and all areas damaged subsequent to shop painting shall be repaired, cleaned and painted in accordance with specification 14222-X-3.

9.7.2 Damage to galvanizing, and weldments to galvanized material, shall be thoroughly cleaned by wire brushing or grinding, and given a heavy touch-up coat of Z.R.C. as manufactured by the Sealube Company, Wakefield, Mass. or equal as approved by the Buyer.

10.0 INSPECTION

10.1 The Inspector shall inspect the erected steel work and workmanship for conformance with the requirements of this specification, including but not limited to checking for plumbness, high strength bolting, field welds, touch-up painting.

10.2 Erector shall provide facilities including platforms, ladders, tools and calibration records for inspection of the erected steel work as requested by the Inspector.

Insulation—N

1. SCOPE

This specification covers insulation for hot piping and equipment. Hot means a temperature of 140 F and higher. Equipment includes vessels, heat exchangers, tanks, turbines, pumps and other machinery.

2. PURPOSE

Hot piping and equipment shall be insulated to:

a) Conserve heat.
b) Protect personnel.
c) Maintain temperature for process control.

3. MATERIALS

3.1 Insulation

3.11 Insulation for piping shall be rigid curved blocks containing no asbestos and meeting the requirements of ASTM specification C533 - Calcium silicate.

3.12 Insulation for Vessels, Exchangers and Tanks shall meet the requirements of the following ASTM Specification:

C612 - Mineral Fiber "Block and "Board" Thermal Insulation, Class 3, for use up to 850 F, Class 4, for use up to 1000 F, and Class 5 for use up to 1800 F.

3.13 Insulation for Stiffening Rings on vertical vessels shall be "Thermal Insulating Wool" (TIW) Types I or II, Owens Corning Fiberglas Corp., or equal, approved by Buyer.

3.14 Insulation for Turbines, Pumps and Other Machinery. if required, shall be:

Hydraulic set type Thermal Insulating Cement meeting the requirements of ASTM C449 per Section 3.2. The hardened cement shall be sealed with a coating of mastic per Section 3.3, reinforced with glass fabric per Section 3.4.

3.15 Insulation for Austenitic (Chromium-Nickel) Stainless Steel Piping and Equipment shall be in accordance with Standard Specification N-4.

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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 INSULATION FOR HOT PIPING AND EQUIPMENT	14222-N-2	1

3.2 Thermal Insulating Cement shall be Pabco Division of Louisiana-Pacific Corp Pabcote, Ryder Ind., Thermocote IMWP or equivalent, as accepted by the buyer.

3.3 Mastic Sealer for Coating Hardened Insulating Cement shall by polyvinyl acetate general purpose mastic, Foster Division of H.B. Fuller CO, "Sealfas GPM, "Number 45-00 Spray Grade or Number 35-00 Trowel Grade, Childers Vi-cryl CP-10 Trowel, CP-11 Spray Grade, Vimasco WC-5, or equal, approved by Buyer.

3.4 Glass Fabric Reinforcement for Mastic shall be Burlington "GLAS-FAB", 10x20, or equal approved by Buyer.

3.5 Weatherproofing Jacket

Weatherproofing for pipe and equipment shall be 0.016" thick embossed aluminum sheet per ANSI H35.1, designation 3003-H14 or 5005-H16 with factory applied epoxy moisture barrier, except as noted otherwise on the referenced detail drawings. For personnel protection the jacket shall be painted gray to provide an emissivity of 0.9.

3.6 Caulking Material, when required, shall be Foster Number 95-44, or Childers Chil-Byl Cp-76, or equal, approved by Buyer.

3.7 Support Fittings

3.71 Support fittings, such as wing type seals, banding straps, "S" clips, "J" clips, expansion joints, finger straps, etc., shall be Type 302 stainless steel.

3.72 Breather springs shall be Type 302 stainless steel, with tensile strength of 275 ksi, four inches long, Techalloy, Childers, or equal.

3.73 All blind rivets shall be aluminum. Sheet metal screws shall not be used.

4. INSTALLATION OF INSULATION - GENERAL

4.1 Piping Insulation

a) Prior to installation of insulation, the pipe shall be cleaned of all dirt, oil grease and loose rust. Cleaning shall be done in accordance with Steel Structures Painting Council (SSPC) SP-1, solvent cleaning.

b) Valves shall be insulated only if they are steam traced or listed as insulated on the Index of Steam Traced Lines.

c) Flanges shall be insulated only if listed on the "Index of Steam Traced Lines" as insulated. This includes flanges of pipe, valves and fittings.

d) Insulation adjoining flanges shall be beveled back one bolt length to allow easy removal of stud bolts and nuts.

e) Seal pots, vent chambers and drip pots shall be insulated only if they are steam traced.

f) Threaded and socket welded pipe fittings and bends shall be insulated with insulation cement per Section 3.2. and sealed with fabric reinforced mastic per Sections 3.3 and 3.4.

g) Butt welded pipe fittings and bends shall be insulated with segments of pipe insulation, and the surface coated with an 1/8" thick layer of insulating cement per Section 3.2 and sealed with fabric reinforced mastic per Sections 3.3 and 3.4 Pre-molded covers may be used in place of segmet of block insulations. Fitting jackering of aluminum may be used, where practical, in place of cement.

h) Insulating cement shall be applied in two or more layers to a thickness equal to that of the adjacent pipe insulation. When the thickness exceeds 1-1/2" it shall be reinforced with a layer of galvanized wire mesh, 1"x20 ga., placed 3/4" from the insulated surface.

i) Pipe insulation shall be held in place by 18 gage stainless steel wire on 9" centers for pipe diameter 12 inches and 16 gage stainless steel wire for pipe diameter 12 incher and larger. Wires shall be properly tightened, loose ends cut off and twisted ends bent down flush with the insulation.

j) Pipe insulation shall be covered with a jacket as specified in Section 3.5 Pipe fittings covered with insulating cement shall be sealed with a mestic per Sections 3.3 and 3.4. Jacketing shall be banded with 1/2" wide bands of stainless steel 0.020" thick.

k) Steam traced lines shall be insulated with pipe insulation per Section 3.11. Insulation shall be of a size to fit the pipe and its tracers. Insulation with extended legs shall be used if readily available.

4.2 Vessel, Exchanger & Tank Insulation

a) Prior to insulation installation, clean surfaces of all dirt, oil, grease and loose rust as in Section 4.1 (a).

b) Vessel manway nozzle and access opening and exchanger channel covers shall not be insulated.

c) Blanket insulation shall be covered with a jacket as specified in Section 3.5. Jacketing shall be banded with 3/4" wide bands of stainless 0.020" thick.

d) Vessels 30" O.D. and smaller shall be insulated with pipe insulation per Section 3.11.

e) Bands shall include a "Breather Spring" as Specified in Section 3.72.

4.3 Turbine Pump & Other Machinery Insulation

a) Prior to insulation installation, clean surfaces of all dirt, oil,grease and loose rust as in Section 4.1 (a).

b) When called for, insulation of turbines,pumps and other machinery, shall be per Section 3.14.

c) Insulating cement shall be applied in two or more layers to the specified thickness. When the thickness exceeds 1-1/2" it shall be reinforced with a layer of galvanized wire mesh, 1"x20 ga., placed 3/4" from the insulated surface.

5. THICKNESS OF INSULATION

Thickness of insulation shall be in accordance with the attached tables for personnel protection and economic thickness. The table for economic thickness is based on a payout period of three (3) years and other parameters as shown.

6. REFERENCE DRAWINGS

The following drawings showing installation details are a part of this specification. The Seller is encouraged to offer new materials and new methods of installation which he considers better and less costly. However, such deviations from this specification and its drawings must be approved by the Buyer in writing to be valid.

List of drawings:

	Drawing No.	Title
1.	C-531	Insulation Supports for Hot Vessels.
2.	N-504	General Arrangement, Composite Vertical Vessel, Insulation & Weatherproofing.
3.	N-505	Detail "A" - Insulation & Weatherproofing at Center Nozzle on Top Head.
4.	N-506	Detail "B" - Insulation & Weatherproofing at Shell to Head Joint.
5.	N-507	Detail "C" - Insulation and Weatherproofing for Shell & Cone.
6.	N-508	Detail "D" - Insulation and Weatherproofing for Shell & Cone.
7.	N-509	Detail "E" - Insulation and Weatherproofing for Vertical Vessel Without a Skirt.
8.	N-510	Detail "F" - Insulation and Weatherproofing for Vessel Stiffening Ring.
9.	N-511	Detail "G" - Insulation and Weatherproofing at Bottom Head and Skirt.
10.	N-512	Detail "H" - Insulation and Weatherproofing for Nozzles at Shell.
11.	N-513	Detail "J" - Insulation and Weatherproofing for External Clips.
12.	N-514	Detail "K" - Weatherproofing Expansion Joint for Shell.
13.	N-515	General Arrangement - Insulation and Weatherproofing for Horizontal Vessel.
14.	N-516	General Arrangement - Insulation and Weatherproofing for Sphere.
15.	N-517	General Arrangement - Insulation and Weatherproofing for Piping.
16.	N-518	Support for Insulation on Vertical Pipe.
17.	N-519	Details of Insulation & Weatherproofing of Pipe Fittings.
18.	N-520	Details of Insulation & Weatherproofing of Flanges & Steam Traced Pipe.
19.	N-521	Insulation & Weatherproofing for Horizontal Heat Exchangers.

6. REFERENCE DRAWINGS (Cont'd.)

List of drawings (cont'd.):

	Drawing No.	Title
20	N-522	General Arrangement - Insulation & Weatherproofing for Flat Bottom Tanks.
21	N-523	Supplementary Insulation Support Details - for Tanks Over 25' Diameter
22	N-524	General Arrangement - Insulation & Weatherproofing for Valves.

7. REFERENCE SPECIFICATIONS

1. 14222-N-4 Insulation for Austenitic Stainless Steel Piping and Equipment.

TABLE 1

PERSONNEL PROTECTION

K at 100 F = 0.31
K at 600F = 0.56
E = 0.90 (emissivity)

Wind Factor = Still Wind
Avg. Ambient= 50F

Max. Ambient = 100F
Max. Surface Temp = 140

MAXIMUM TEMPERATURE FOR SPECIFIED INSULATION THICKNESS

Pipe Size In.	1"	1-1/2"	2"	2-1/2"	3"	3-1/2"
1	485 F	625 F	760 F	890 F	1005 F	1125 F
1.5	460	590	710	880	940	1045
2	445	565	685	800	905	1005
3	425	540	640	745	845	940
4	410	520	620	715	810	900
6	400	495	590	675	765	845
8		480	570	650	735	815
10		470	555	635	710	790
12		465	550	625	700	770
14		460	540	615	690	765
16		455	535	610	680	750
18		450	530	600	670	740
20		445	525	595	665	735
24		440	515	585	655	720
30		435	510	575	640	705

TABLE 2

HEAT CONSERVATION

Payout = 3 yrs.
Heat Cost = $15.00

K at 100 F = 0.31
K at 600 F = 0.56

Wind Factor = 7 mph
Avg. Ambient= 50 F

MAXIMUM TEMPERATURE FOR SPECIFIED INSULATION THICKNESS

Pipe Size In.	1½"	2"	2½"	3"	3½"
1	425 F	625 F	800 F	1200 F	
1.5	375	550	725	1200	
2	370	525	725	1200	
3	325	500	650	1200	
4	300	475	625	825	1200 F
6	250	375	525	675	1200
8		375	525	650	1200
10		325	450	575	1200
12		300	400	525	1200
14		275	375	475	1200
16		275	350	475	1200
18		275	350	475	1200
20		275	350	475	1200
24		250	350	475	1200
30		250	350	475	1200

Note: For vessels, equipment, machinery etc. use thicknesses shown for 30" pipe.

1. SCOPE

This specification covers the materials for and method of insulating cold piping. Cold means a temperature less than 50 F down to minus (-) 260 F (LNG).

2. PURPOSE

Cold piping is insulated to:

(a) Reduce heat gain by the refrigerated liquid and consequent "boil-off".

(b) Prevent "icing" of the pipe, valves and fittings due to water vapor condensing on the cold metal surface.

3. MATERIALS

3.1 Insulation

Insulation material shall be in accordance with the following: ASTM Designation C-552, Cellular Glass Block and Pipe Thermal Insulation. An acceptable material is Pittsburgh-Corning Corp. "Foamglas" insulation, or equal approved by buyer.

3.2 Bore Coating

The bore coating shall be one of the following:
U.S. Gypsum Co - Hydrocal B-11

3.3 Joint Sealant - Inner Layer

The butt joints and longitudinal joints in the inner layer shall be left bare. At present there is no joint sealant suitable for minus (-)259 F.

3.4 Joint Sealant - Outer Layers

The butt joints and longitudinal joints in the outer layers shall be sealed with one of the following:

Vimasco Coatings Corp. No. 750

Childers Products Co. No. CP - Stet

Foster Div. H.B. Fuller Co. No. 95-44

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1	10/24/80	ISSUED FOR PHASE ZERO	AD	HS	[illegible]
0	7/25/80	ISSUED FOR APPROVAL	AD	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL DESIGN SPECIFICATION
INSULATION FOR COLD PIPING

JOB NO. 14222
SPECIFICATION 14222-N-3 REV 1

3.5 Weatherproof Vapor Barrier

The weatherproof vapor barrier shall be a glass fabric reinforced mastic and one of the following:

SXEX (Interior Only)

Childers Products Co. No CP-30 Trowel or Spray Grade

Foster Div. H. B. Fuller Co. No. 60-35, Trowel or 90-66 Spray Grade

3.6 Bands

Bands shall be applied on 12" centers and shall be 1/2" wide by 0.015" thick stainless steel.

3.7 Tie Wire (for fitting insulation)

Tie wire shall be 14 gage soft annealed stainless steel.

3.8 Expansion Joints

Expansion joints shall be packed with Pittsburgh-Corning "Temp-Mat" or equal approved by Buyer.

3.9 Glass Fabric

Glass Fabric shall be Koppers Co. No 10x20"Glas-Fab" or equal approved by Buyer.

4. INSULATION THICKNESS

⚠1 Insulation thickness shall be completed in the Phase I effort.

FORM II-293 7/66

1. SCOPE

This specification outlines the requirements for wicking-type insulation used with austenitic stainless steel piping and equipment. Wicking-type insulation includes that made of calcium silicate, expanded perlite, fiberglass, mineral fiber and similar materials; ASTM-, C533, C547, C553, C592, C610, C612, and C795.

2. BACKGROUND

The austenitic (chromium-nickel) stainless steels have a tendency to crack at stress points when exposed to certain corrosive environments. Chloride ion concentration at a stress point will catalyze crack propagation when moisture is present. Sodium silicate inhibits stress corrosion cracking. The concentrations of chloride, sodium and silicate have an important bearing on the stress corrosion effect of wicking-type insulation on austenitic stainless steels.

3. CHEMICAL REQUIREMENTS

3.1 The samples of insulation shall be analyzed in accordance with ASTM C871 for leachable chloride, sodium and silicate and the plot point of these analyses shall fall within the acceptable area of Figure 1.

3.2 The minimum allowable sodium plus silicate shall be 50ppm.

3.3 Leach water from the insulation samples shall have a pH greater than 7.0, but not greater than 11.7 at 77F.

4. PREPRODUCTION REQUIREMENTS

Prior to supplying any insulation in accordance with this specification the Seller shall comply with the preproduction requirements specified either in 4.1 or 4.2.

4.1 A Seller who has previously furnished insulation to this specification or who has and can supply a copy of a report of compliance to the requirements of this specification, shall have met the preproduction requirements of this specification when:

a) The insulation previously produced to this specification, or to the report of compliance, shall have met all the requirements of this specification.

b) The insulation previously produced was produced to the same formulation, by the same production processes and using ingredients of the same kind, nature and quality as those which will be employed to produce insulation to this specification. If any change has been made the requirements of 4.2 shall apply.

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△					
△					
△	11/18/80	ISSUED FOR PHASE ZERO	AD	HS	
△	7/25/80	ISSUED FOR APPROVAL	AD	HS	

4.2 A Seller who has not previously furnished insulation to this specification, or cannot furnish a report of compliance with this specification, or when required by Paragraph 4.1b, shall test a sample from a production lot as specified in Paragraph 5.2. The production lot from which the sample is taken shall be of the same formulation, made by the same production processes and from the same kind, nature and quality of ingredients as those which will be employed for porduction of insulation to this specification. The Seller shall have complied with the preproduction requirements of this specification when the following requirements have been met:

a) The sample taken meets the requirements of Paragraph 5.1.

b) The sample has been tested as required by the preproduction corrosion test described in Paragraph 5.2.

c) Not more than one of the five prepared stainless steel coupons shows a crack when examined in accordance with Paragraph 5.22.

d) The actual numerical results of all tests shall have been submitted to the Buyer.

5. QUALITY ASSURANCE REQUIREMENTS

5.1 Sampling.

(a) A lot shall consist of one production batch produced at one time, under the same conditions and from ingredients of the same kind, nature and quality. However, for molded pipe and block insulation produced under the same conditions, from ingredients of the same kind, nature and quality, offered for delivery at one time.

(b) A minimum of three (3) samples shall be taken from each lot as defined in this specification. However, for molded pipe and block insulation which is produced by a continuous process, sampling shall be in accordance with Table 1.

TABLE 1

Lot Size - Pieces	Minimum Number of Samples
Up to 63	1
64 to 160	2
161 to 400	4
401 to 1,000	7
1,001 to 2,500	9
2,501 to 6,300	14
6,301 to 16,000	21
Over 16,000	32

(A piece is defined as one segment, section or block.)

5.2 Quality Assurance Tests

5.21 Water leaching and chemical tests shall be performed in accordance with commercially acceptable practices. Seller shall submit to Buyer a description of tests for approval.

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5.22 Tests to evaluate the stress corrosion effect of the samples of insulation on austenitic stainless steel shall be conducted in accordance with ASTM Standard C-692-77.

6. REPORT OF COMPLIANCE

Seller shall furnish to the Buyer a report of compliance stating that the insulation has been tested in accordance with this specification and complies with all requirements of this specification. The number of copies of the report to be furnished shall be as stated in the subcontract or purchase order.

ATTACHMENT:

Figure 1, Acceptability of Insulation Material on the Basis of the Plot Points of Chlorine and the ($Na + SiO_3$) Analyses.

FORM 283

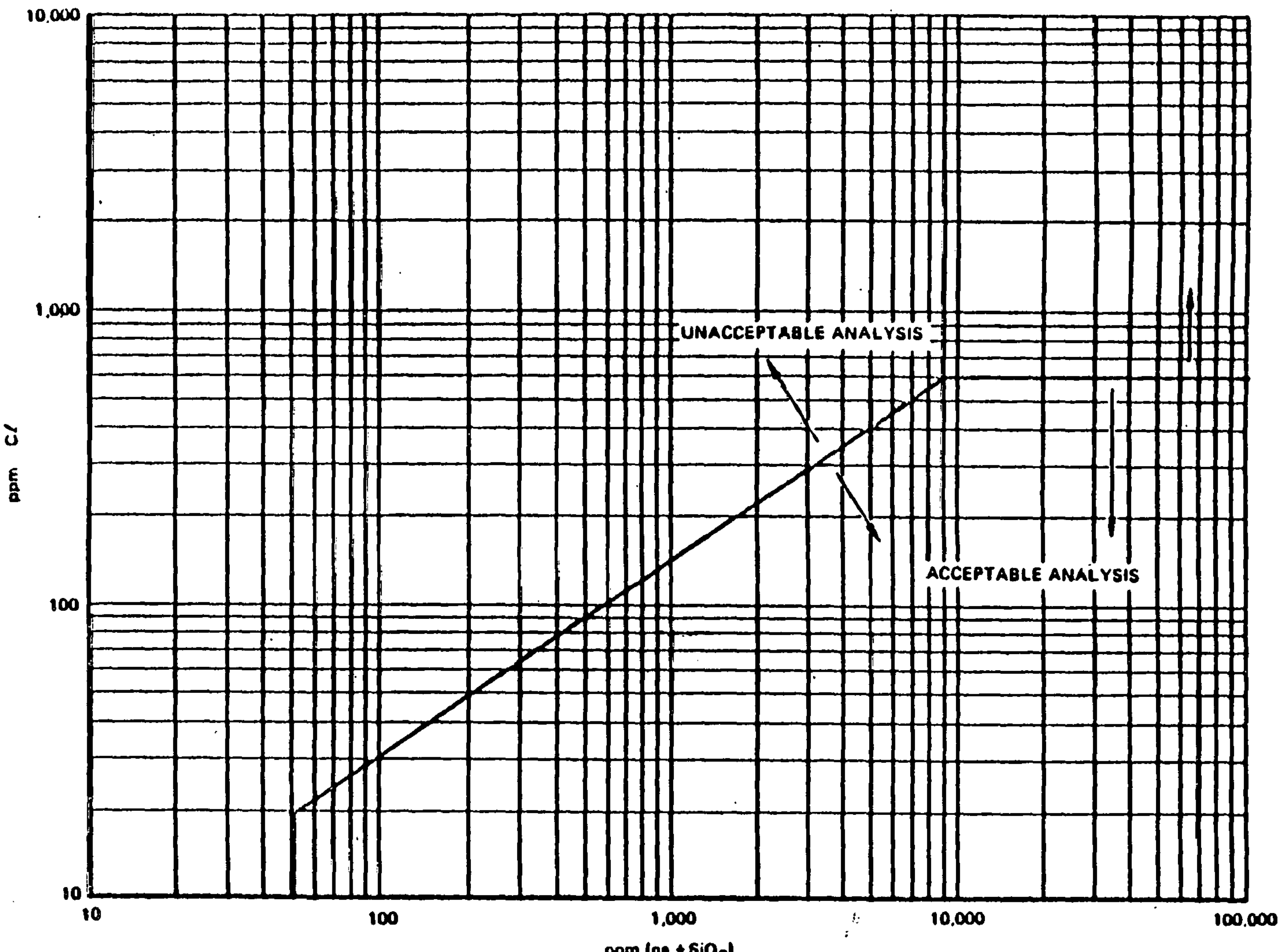

Figure 1 - Acceptability of insulation material on the basis of the plot points of the Cℓ and the ($Na + SiO_3$) analyses.

1. GENERAL

1.1 This specification covers internal castable linings and refractories installed in process vessels, equipment and piping.

1.2 The function of the completed installation is thermal, erosion or corrosion protection of the metal, or the support of catalyst or similar internals.

The details, materials and type of installation shall be as shown on Contractor's drawings. (The work may involve one or more castable components, prefired materials, and hexmesh, V-stud, standard mesh, or unreinforced designs).

1.3 All castable linings shall be applied and cured in accordance with the material manufacturer's recommendations.

1.4 Thermal dryout procedure for castable linings shall be submitted to the Contractor for his use during unit startup, except when dryout is part of the Subcontractor's work per Paragraph 7, or for concrete to be used in wet service.

1.5 Metallic anchors and reinforcing for lining shall be furnished and installed as indicated on the drawings and/or the subcontract.

(Normally, studs, anchors, reinforcing and vapor stops welded directly to the equipment shell, will be furnished in place with the equipment).

2. MATERIALS

2.1 All materials shall be as indicated on Contractor's drawings or schedules, and as specified herein.

2.2 Any substitutions for materials specified must be approved in writing by the Contractor prior to award of work.

2.3 Pneumatically-applied concrete (for corrosion linings) shall consist of a mixture of one part Portland cement to three parts clean, dry sand (ASTM C-35, with maximum moisture content = 40%).

2.4 No rebound materials shall be used.

3. CASTABLE APPLICATION

3.1 The Contractor will clean the surfaces of the equipment to be lined, removing all loose mill scale, rust, oil, grease or other detrimental foreign matter. Minimum surface preparation will be equivalent to "No. 3 Power Tool Cleaning" SSPC-SP3, as published by the Steel Structures Painting Council.

3.2 The Subcontractor shall thoroughly inspect the surfaces before application and accept the condition of preparation as satisfactory for an adequate and guaranteed lining installation.

Note: Surface preparation required other than that noted in Paragraph 3.1 must be defined in the proposal, and approved prior to award of work.

3.3 Castables shall be applied by pneumatic gun, except where impractical because of the material used or details of the installation.

3.4 Before application of castable, all openings, nozzle flanges, etc., shall be adequately protected from gunned or rebound material.

3.5 Application of any one component shall develop the full thickness of the material indicated before proceeding to the next area.

3.6 The inside air temperature and the castable materials must be kept above 40 degrees F, and the metal surfaces above 35 degrees F, while the lining is applied and throughout the curing and dry-out period. Live steam shall not be used for this purpose. (See Paragraph 5.26 for protection of vessel).

3.7 If the temperature of the metal exceeds 100 degrees F, the exterior of the vessel or equipment shall be kept cool by water spray during application and curing.

3.8 If work is interrupted for more than two hours, the following procedure shall be used:

(a) Immediately cut back the castable to where the full thickness of the material has been applied and remove all of this material beyond the cut.

(b) Water cure per Paragraph 4, during the time of interruption.

(c) Thoroughly wet the surface of the castable to which a bond must be made, immediately before resuming application.

4. <u>WATER CURING OF CASTABLES AND CONCRETE</u>

Unless the materials manufacturer specifically does <u>not</u> recommend water curing, the following procedure shall be carried out:

4.1 As soon as the material has set sufficiently to prevent washing away, sprinkle the surface with fresh water. Repeat at intervals as necessary to keep it continually moist.

4.2 Continue curing for at least twenty-four hours after the last portion of the lining has been applied.

4.3 Allow the castable to dry out at atmospheric conditions for at least twenty-four hours after water curing is complete.

5. THERMAL DRYOUT OF CASTABLES

5.1 The Contractor will normally dry out the castable in accordance with the material manufacturer's recommendations, using process equipment at the time of startup of the unit.

5.2 For castable linings that are unusually thick, or will be covered by a metal shroud, the Subcontractor shall use the following procedure when noted on the drawing and/or the subcontract:

5.21 Following atmospheric drying, raise the temperature within the vessel (indicated by the inlet gas temperature in all cases) slowly at a rate of 50 degrees F maximum per hour until the temperature reaches a level of 150 degrees to 200 degrees F. Maintain this temperature for at least ten hours.

5.22 Next, increase temperature at a maximum rate of 50 degrees F per hour to 400 degrees F. Hold at this level for at least six hours.

5.23 Then, reduce temperature to 150 degrees F to 200 degrees F at 50 degrees F maximum per hour. Hold for eight hours.

5.24 Next, increase temperature at a maximum rate of 50 degrees F per hour to 900 degrees F and hold at this level for at least five hours per inch of castable thickness.

5.25 Close the vessel or equipment after the above procedure and allow it to slowly cool until the internal temperature has reached 600 degrees F.

5.26 Under adverse weather conditions, the external surface of the vessel or equipment being cured shall be insulated or shrouded to facilitate drying out of the castable adjacent to the shell. The extent and the amount of such protection shall be determined in the field, considering actual conditions at the time. The Contractor's field representative will review and approve the work required, and provide the labor and materials, or negotiate with the Subcontractor for extra work, whichever is more economical.

5.27 Portable dryout heater shall be of adequate capacity, located external to the equipment, and shall provide proper circulation and control of the hot gases.

Note: A heater rated at approximately 500,000 BTU/Hr capable of circulating approximately 1000 cfm at 1" water pressure, will be considered satisfactory for drying out surface areas up to 1000 square feet. Greater area will require a proportionally larger heater, or the holding time for each dryout step shall be lengthened proportionally.

6. TOLERANCES, INSPECTION AND REPAIRS

6.1 All castable linings shall conform to the thicknesses shown on the drawings within ± 1/4 inch unless otherwise noted.

6.2 Castable lining components shall be tested for voids after curing by striking with a ball point machinists hammer at approximately one-foot intervals over the entire surface. (A dull sound usually indicates a void or dry filled space.)

6.3 Lining that is thermally dried out by the Subcontractor shall be inspected for cracks, voids and unbonded materials after the final dryout. In addition to the requirements of Paragraph 6.2, cracks that are deeper than 25 per cent of the lining or wider than 1/16 inch are unacceptable.

6.4 All voids or large cracks shall be chiseled out completely to the equipment shell and laterally to sound material.

6.5 All major repairs shall be made in the same manner as the original application including curing and dryout.

7. EXCEPTIONS

If any of the procedures herein are in violation of the Subcontractor's standard practice, he shall submit in writing complete details of his recommended procedures for the Contractor's approval prior to the award of work. All such procedures shall be substantiated with a list of successful installations.

FORM 283

1.0 SCOPE

This specification covers materials and methods of fireproofing of vessels and structural steel by any of the following methods:

1.1 By encasing steel work in Portland cement regular concrete.

1.2 By encasing steel work in Portland cement lightweight concrete.

1.3 By encasing steel work in pneumatically placed mortar, commonly known as "Gunite" or "Shotcrete".

1.4 By encasing the steelwork in fire endurance coating.

2.0 GENERAL

2.1 Fireproofing shall be applied to vessel supports and structural steel to protect personnel and equipment from the effects of support failure during a fire. Major consideration shall be given to the possibility of collapse of an adjacent structure, with accompanying dumping of flammable liquids on the vessel and supports.

2 2.2 Fireproofing shall be designed in accordance with Industrial Risk Insurers recommendations. Fire magnitude shall be 2000°F minimum temperature at 40,000 Btu/hr/ft^2 minimum heat release.

2.2.1 Where reinforced concrete is used for structural purposes, there is no further requirement for fireproofing.

2.2.2 Fireproofing needs for each large vessel, each vessel in critical service, and structural steel supporting such vessels shall be evaluated. Longer periods of protection may be necessary.

2.2.3 Wind Bracing and the tie rod bracing, where not contributing directly to load support of equipment, shall not be fireproofed.

2.2.4 Vessel Shells, where specified to be fireproofed, shall be covered on outside surfaces with a minimum thickness of 1½ inches of concrete.

2.2.5 Structural Steel and Vessel Support Skirts, as specified to be fireproofed, shall be covered with a minimum thickness of concrete as shown in the table below:

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3					
2	10-21-81	REVISED SPEC. REFERENCE			
1	10/16/80	ISSUED FOR PHASE ZERO			
0	8/80	ISSUED FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S.DOE COOPERATIVE AGREEMENT NO.DE FC05-8000R20717
PROJECT SPECIFICATION
FIREPROOFING

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

	Member Size (Flange Width or Pipe Dia.)	Lightweight Concrete	Regular Concrete
Beams	6" to 7-3/4"	2"	2½"
	8" and over	2"	2"
Columns	All Sizes	2"	3"
Skirts, Saddles, etc.	All Sizes	2"	3"

2.2.6 Structural members supporting ladders, platforms, storage hoppers, blowers, filters, boilers, and other auxiliary equipment shall not be fireproofed.

3.0 DEFINITION OF FIRE HAZARDOUS AREA AND EQUIPMENT

3.1 A hazardous area is defined as the area inside a battery limit or an area within 20 feet horizontally and to a height of 20 feet from grade, building floor, curbed roof, or curbed solid deck.

3.2 Hazardous equipment and piping is defined as that which contains material that is flammable, toxic or dangerous to personnel. Equipment such as vessels, exchangers, tanks, drums, fin fans, and piping which contain hydrocarbon, acid or caustic is considered hazardous.

Internal combustion engines, pumps, compressors, hydraulic oil drums, knockout and blowdown drums may be considered non-hazardous.

4.0 VESSELS AND EQUIPMENT SUPPORTS

4.1 Fireproofing within Battery Limits shall be provided for the following:

4.1.1 Steel framing and vessel skirts supporting all vessels containing flammable materials.

4.1.2 Large or important vessels containing non-flammable materials which are contained within a unit structure and where failure of the supports could cause severe damage to the unit or to the vessel itself. However, structural members supporting auxiliary equipment such as waste heat boilers and catalyst storage hoppers shall not have the supports fireproofed except if located so that failure of their supports will damage other hydrocarbon handling equipment, thus adding to the duration or severity of a fire.

4.2 Fireproofing outside of Battery Limits shall be provided for steel framing and vessel skirts supporting all vessels, except those containing non-flammable materials, hydrocarbon vapors only, and commercial grade kerosene or heavier products at temperatures below their flash points.

4.3 Fireproofing as specified for structural steel vessel support members shall fully cover all steel columns, beams, and bracing if these members contribute directly or indirectly to vertical load support of the vessel; except that beams providing direct support shall be fireproofed to the top of top flange only.

4.4 All equipment support structures of open rigid frame unbraced design and all members contributing directly to structural stability shall be fireproofed as specified above.

4.5 All lugs, brackets and legs, supporting process equipment located in hazardous areas shall be completely fireproofed.

4.6 Saddles supporting process equipment and measuring more than 1 foot in height at their lowest points shall be fireproofed.

4.7 The outside of skirts supporting process vessels shall be fireproofed.

4.8 The inside of skirts over 4'-0" in diameter and the bottom heads of uninsulated vessels on skirts over 4'-0" in diameter shall also be fireproofed.

4.9 The inside of skirts 4'-0" or less in diameter and the bottom heads of uninsulated vessels on skirts 4'-0" or less in diameter shall be fireproofed only when access opening in skirt is over 16" in diameter or when there is more than one access opening.

4.10 Skirts on process vessels with a design temperature of 850°F. or over which require insulating to maintain a temperature gradient shall be fireproofed on the uninsulated portions only.

4.11 Details of skirt fireproofing shall be in accordance with drawings to be issued in the EPC Phase.

These provisions are not necessarily applicable to vessels in high temperature sevice, e.g., reactors and coking drums. Skirts for such vessels shall receive individual attention as regards the effects of thermal expansion.

5.0 HEATERS

5.1 Main supports and bracing on fired heaters in all locations shall be fireproofed up to the firing floor level.

5.2 Members supporting heavy convection tube banks or stacks shall also be fireproofed.

5.3 For UOP type heaters where casing plate extends to the foundation near grade, no fireproofing is required.

5.4 Structural members supporting heaters above grade shall be fireproofed, except for furnaces handling non-flammable materials or only hydrocarbon vapors in the tubes.

5.5 Fireproofing of fired heaters supports shall cover only vertical support columns from the foundations to the bottom of heater. Horizontal support beams shall not be fireproofed.

6.0 PIPERACKS

6.1 Major piperacks within Battery Limits shall be fireproofed. Off-plot piperacks need not be fireproofed.

6.2 Fireproofing, where used, shall cover the columns and any beams supporting lines carrying flammable material. Fireproofing on beams shall be carried up to the top of top flanges.

6.3 All pipe racks within the fireproofing area which support piping or air coolers shall be fireproofed to the bottom tier load line. Where pipe rack support columns extend to higher tiers fireproofing shall be extended to these higher load lines. Fireproofing for pipe racks shall cover the columns up to the bottom beams and through sides of bottom beam. The top side of the beam will be left uncovered to provide surface for the piping.

6.4 Longitudinal beams shall not be fireproofed unless they are direct loadcarrying members. Structural members supporting air coolers shall be fireproofed.

6.5 Conduit Banks and Cable Trays

6.5.1 Conduit banks and cable trays in process units shall be insulated for fire proofing purposes. The primary fireproofing medium shall be 1½", 8 lb/ft^3 density kaowool blanket insulation with mesh covering, manufactured by Babcock and Wilcox or equivalent. Smooth galvanized steel 0.19" thick over the kaowool will be strapped with ½" stainless steel bands at a maximum of 18" centers.

7.0 FIREPROOFING MATERIALS AND SPECIFICATIONS

7.1 Fireproofing material shall be either lightweight or regular concrete, reinforced with 12 gage wire mesh as explained in Paragraph 7.2, 7.3 of these specifications, or fire endurance coating as specified in Paragraph 7.4.

7.2 Formed Concrete Fireproofing

7.2.1 Reinforced concrete is the normal fireproofing material. Where this would add too great a load to high steelwork, or for ecomomic reasons, lightweight concrete shall be used.

7.2.2 Concrete shall be placed only in contact with clean steel. See Paragraph 7.3.1.

7.2.3 Reinforcement material shall be as set forth in Paragraph 7.2, and located and secured as called for on the drawings.

7.2.4 All materials, including aggregate, shall comform to requirements for Portland Cement Concrete as set forth in Specification 14222-Q-2. Type I or Type III cement should be used.

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7.2.5 Maximum aggregate size in the mix shall not exceed ½ inch.

7.2.6 Minimum compressive strength at 28 days shall be 3000 psi.

7.2.7 Forms shall not be stripped sooner than five days after pouring if Type I cement is used, and not sooner than three days, if Type III cement is used.

7.2.8 Curing shall be in accordance with Paragraph 7.3.8.

7.3 <u>Gunite Fireproofing</u>

7.3.1 If the surfaces to receive fire protection are not primed with one of the following types, they shall be blasted in accordance with SSPC-SP-6 and primed with one coat of epoxy zinc-rich primer at 2.0 to 4.0 mils dry film thickness.

7.3.1.1 Only the following types are compatible with the fireproofing material:

Zinc-rich epoxy
Inorganic Zinc
Epoxy
Vinyl
Galvanizing

7.3.2 Reinforcement shall consist of 2" x 2"/#12 x #12 SWG galvanized welded wire fabric, bent to templates conforming with outlines of finished encasement, and rigidly secured in place by tack welding, or tying with #16 SWG soft galvanized wire to weld studs. Adjacent sheets shall be lapped at least 2 inches, and securely tied together. Fabric shall be located to provide minimum 3/4 inch space from face of steel.

7.3.3 Shooting strips shall be used to obtain proper thickness and true lines over flanges, angles, and re-entrant corners. Strips shall be designed to permit the escape of rebound.

7.3.4 3/4" square or hexagonal steel nuts welded to steel with E60XX-15 or E60XX-16, electrodes shall be used for spacing reinforcement.

7.3.5 Reinforcing shall be attached in a manner approved by ASFI.

7.3.6 Materials, equipment, and method of application shall be in accordance with "Specification for Materials, Proportioning and Application of Shotcrete " (A.C.I. 506.2-77) and "Recommended Practice for Shotcrete" (A.C.I. 506-66). Placement shall be done only by skilled operators.

7.3.7 Immediately after final finishing, surfaces shall be given a heavy sprayed-on coat of approved curing coumpound.

7.3.8 Gunite thus applied shall develop not less than 4500 psi compressive strength in 28 days. Minimum thickness over the steel shall be in accordance with Paragraph 2.2.5. above.

7.3.9 Guniting shall not be carried on in the vicinity of disconnected piping where rebound and spatter can enter important lines, unless the openings in such lines are protected by wood plugs or other suitable shield. Gunite subcontractor shall provide and erect tarpaulins as required to prevent excessive drifting and splattering of adjacent piping and equipment.

7.4 <u>Fire Endurance Coating</u>

7.4.1 The fire endurance coating shall be packaged factory premix consisting of vermiculite and Portland cement with other fillers and agents as determined by the manufacturer.

7.4.2 The fire endurance coating shall be suitable for mixing with clean water at site in a mortar or other suitable mixer. No catalyst or other additives are permitted.

7.4.3 The material shall contain no asbestos.

7.4.4 The material shall be non-toxic before or after cure.

7.4.5 The material shall have been used in exterior hydrocarbon processing plants for a minimum of three (3) years.

7.4.6 The material shall be suitable for spray or hand application.

7.4.7 Reinforcing of the applied material shall be as specified by the manufacturer.

7.4.8 Caution shall be taken to avoid applications on frosted surfaces or those where condensation would affect adhesion.

7.4.9 The material shall be applied as described in Manufacturer's instructions with thickness suitable for required exposure.

7.4.10 The following are approved:

Mandoseal P-50 from Ameron Protective Coating Division or Contractor accepted equivalent.

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8.0 FINISHING AND SEALING

8.1 The applied concrete shall be finished smooth and true by floating or trowelling as required.

8.2 When the final coat of shotcrete is in place, finish shall be made by trowelling smooth.

8.3 All points where fireproofing and metal come together shall be flashed with a mastic weatherproof sealant to prevent the intrusion of moisture. Compatible types are:

Butyl, Acrylic or Silicone.

9.0 INSPECTION

9.1 The Contractor shall provide on site inspection. Should any part of the work fail to meet the acceptance criteria, the Subcontractor shall make good at his expense.

9.1.1 The following random tests shall be carried out by the appointed inspector:

9.1.1.1 Substrate must be clean and free of loose particulate matter. All coating must be intact. Any discrepancies must be rectified before application of the fire endurance coating.

9.1.1.2 Reinforcement shall be of galvanized steel and shall be installed to the supplier's latest instructions.

9.1.1.3 Thickness of spray or trowel finished fire endurance coating shall be determined by using a needle gauge or a twin beam gauge as approved by the Supplier.

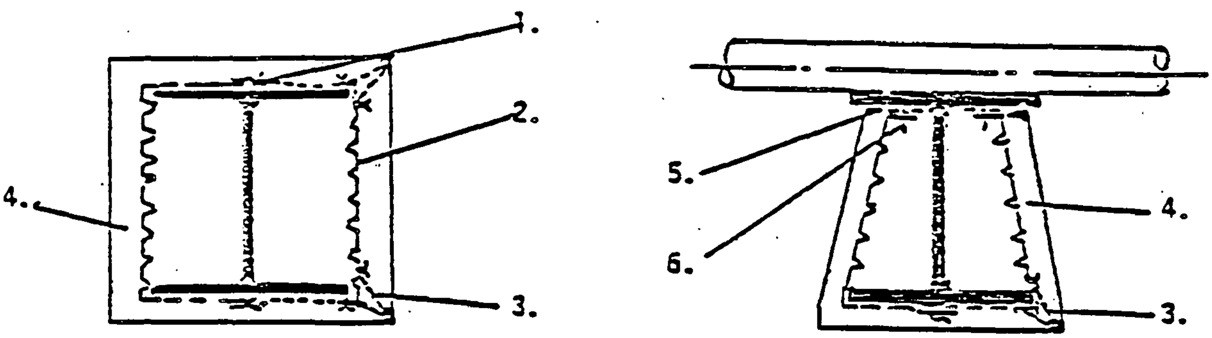
10.0 REFERENCE

10.1 Specifications

14222-Q-2	Plain and Reinforced Concrete
2 14222-A-3	Basic Engineering Data (page 19, Item 2)

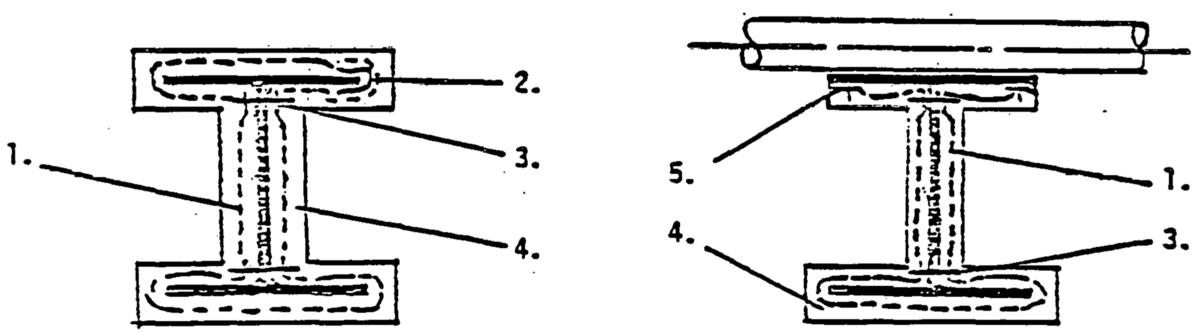
10.2 Reference drawings to be issued in EPC Phase.

BOXED DESIGN - UP TO AND INCLUDING 14 INCH DEPTH



1. 18 Gauge galvanized wire ties at 1½ to 2 inch overlap.
2. 3.4 lb/yd^2 Galvanized expanded metal lath.
3. Corner aid (optional).
4. Rated thickness of fire endurance coating.
5. Mastic Seal
6. Gunned or stud welded pins and clips.

CONTOUR DESIGN - OVER 14 INCHES DEPTH



1. Galvanized 1 or 2 inch hexagonal wire mesh at mid thickness.
2. Optional push-on clips to retain mesh at flange edge.
3. Stud welded or gunned pins with clips.
4. Rated thickness of fire endurance coating.
5. Mastic joint.

Electrical—P

1.0 SCOPE

1.1 This specification covers the design and construction codes, safety rules, standards and procedures to be followed for the engineering, procurement, and installation of the electrical power, lighting, control, instrumentation, and communication systems.

1.2 The following specifications, when they are applicable, are to be considered a part of this specification:

14222-P-2	Induction Motors
14222-P-3	Synchronous Motors
14222-P-5	Packaged Equipment - Electrical
14222-P-6	Thermocouple Extension and Electronic Signal Wire
14222-P-7	Electrical Heat Tracing
14222-P-8	Package Electrical Substation
14222-P-9	Telecommunications

1.3 The following detailed job specifications prepared specifically for the job during Phase 1 shall be considered a part of this specification and, in case of conflict, shall take precedence over provisions of this specification.

14222-P-10	Electric System
14222-P-11	Switchgear 34.5 KV Class
14222-P-12	Switchgear 5 KV Class
14222-P-13	Medium Voltage Metal-Enclosed
14222-P-14	Interrupter Switchgear
14222-P-15	Switchgear 600 Volt
14222-P-16	Power Transformers
14222-P-17	Distribution Transformers
14222-P-18	Motor Control - 2300 or 4160 Volt
14222-P-19	480-Volt Motor Control Centers
14222-P-20	480-Volt Starter Racks
14222-P-21	Static Inverter No-Break Power Supply.

2.0 CODES AND STANDARDS

The codes and standards listed are applicable to installations in the United States.

2.1 The electrical work will be performed in accordance with:

2.1.1 The latest edition of Occupational Safety and Health Administration (OSHA) General Industry Safety and Health Regulations, Part 1910, Sub-part S-Electrical and Section 1910.95 <u>or</u> applicable OSHA state plan if the project is located in a state with an operable OSHA state plan.

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Rev	Date	Description			
1	10/6/80	ISSUED FOR PHASE ZERO	TK	HS	[illegible]
0	5/80	ISSUED FOR APPROVAL	TK	HS	

BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
GENERAL SPECIFICATION
GENERAL - ELECTRIC

JOB NO. 14222
SPECIFICATION 14222-P-1 REV 1

2.1.2 The latest edition of the National Electrical Code.

2.1.3 Applicable local state, county, and city codes.

2.1.4 National Electric Safety Code.

2.2 Design and equipment also will conform to applicable industrial standards of the following:

2.2.1 National Electrical Manufacturer's Association (NEMA).

2.2.2 Underwriters Laboratories (UL).

2.2.3 Insulated Power Cable Engineers Association (IPCEA).

2.2.4 Institute of Electrical and Electronic Engineers (IEEE).

2.2.5 American Petroleum Institute (API).

2.2.6 American National Standards Institute (ANSI).

3.0 SERVICE CONDITIONS

3.1 Installation will be suitable for operation under climatic conditions at the jobsite, as shown in 14222-A-3, "Basic Engineering Data."

3.2 Plant areas will be classified for selection and installation of electrical equipment as required by the National Electric Code, and recommendations of API Standard RP-500A. If applicable, the recommendations of API Standard RP500B, RP-500C, or NFPA Standard 59A will be followed.

4.0 ELECTRIC SYSTEM

The power supply distribution system and general features of the onplot and offplot design will be as described in the job specification 14222-P-10 and one-line diagrams.

4.1 The main substations will include the necessary power transformers and switchgear and normally will be located convenient to the supply lines of the serving utility.

4.2 The distribution system will consist of the feeder circuits from the main substations to area substations which will contain the necessary transformers and switchgear. These area substations will be located in non-hazardous areas as near the centers of area loads as possible. The feeder circuits will be below grade, and will be as described in job specification 14222-P-10.

5.0 EQUIPMENT

5.1 Switchgear

5.1.1 Switchgear of 34.5 KV voltage class will be as described in job specification 14222-P-11 and shown on the job one-line diagram. It will utilize vacuum circuit breakers, specification 14222-P-11.

5.1.2 Switchgear of 5 KV voltage class will be as described in job specification 14222-P-12 and shown on the job one-line diagram. It will utilize drawout circuit breakers per job specification 14222-P-12.

5.1.3 Low voltage 600-volt switchgear will be as shown on the job one-line diagram and described in job specification 14222-P-15.

5.2 TRANSFORMERS

5.2.1 Power transformers will be described in job specification 14222-P-16, with sizes as shown on job one-line diagrams.

5.3 Motors

Motors will conform to standard specification 14222-P-2, Squirrel Cage Induction Motors and 14222-P-3, Synchronous Motors.

5.3.1 In general, motors will be NEMA Design B for across the line starting and will operate at the following voltages:

3/4 HP and smaller

a) Continuous - 115 volts, single-phase, 2-wire.
b) On-Off - 460 volts, three-phase, 3-wire.

1 HP through 150 HP-460 volts, three-phase, 3-wire
201 HP and larger - 4000 volts, three-phase.

5.3.2 Enclosures will be suitable for the environment and in general will be:

200 HP and smaller	TENV or TEFC
250 HP and larger	TEFC, NEMA Weather Protected (WP) Type I or Type II.

In areas classified as hazardous, Division 1, motors will be TEFC - explosion-proof or have suitable pressurized enclosures.

Drip-proof motors will be used where suitable for the environment and if they offer significant economies.

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5.4 Motor Control

5.4.1 2300- or 4000-volt motor control.

Controls for 2300- or 4000-volt motors will be as described in job specification 14222-P-18 and will in general consist of combination current-limiting fuses and contactors, NEMA Class E-2.

Motors larger than the rating of the NEMA Class E-2 starters will be controlled by circuit breakers located in the area substation switchgear.

5.4.2 460-volt motor control.

Controls for 460-volt motors will be as shown on job specification 14222-P-19 and on the job one-line diagram.

In general, if the OA rating of the largest transformer feeding the 480-volt loads does not exceed 1,000 KVA, 460-volt motors will be controlled from circuit breaker-type combination starters in suitable enclosures and located to best suit the installation. Molded case circuit breakers will be used to feed other 480-volt circuits, such as welding outlets

In general, if the OA rating of the largest transformer feeding the 480-volt loads exceeds 1,000 KVA, fused switch-type combination starters will be used and fused switches will be used to feed the other 480-volt circuits. The fuses will be current-limiting type with adequate interrupting rating.

5.4.2.1 In non-hazardous areas, controls will be in indoor or outdoor motor control centers in accordance with job specification 14222-P-19.

5.4.2.2 In Division 1 and 2 hazardous areas, control will be located on switchracks in accordance with job specification 14222-P-20.

5.4.2.3 Motors 2 HP and less may be controlled by manual starters located at or near the motors.

5.4.3 Push-button Stations

5.4.3.1 Control stations with lockout stop and suitable enclosures will be located at the motors.

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5.4.3.2 In general, push-button stations shall be of the heavy-duty, momentary contact, universal type. Exceptions to the above shall be special control circuits which require the use of maintained contact "On-Off" control stations, or "Hand-Off-Automatic" selector switches. Regardless of the type of push-button station, enclosures shall be furnished suitable for the area classification.

5.4.3.3 In general, push-button stations shall be mounted adjacent to, and within sight of, the controlled motor.

5.4.3.4 Air fans on fin exchangers shall have an "On-Off" push-button station located on the operating platform, and at grade, a stop push-button with a green indicating light to indicate motor on.

5.4.3.5 Push-buttons for Class I,Group D Areas shall be Square D Claas 9001, Type GR-206 for "Start-Stop", Square D 9001, Type GR-123 for "Hand-Off-Automatic", or equal.

5.5 Lighting

5.5.1 Lighting Design

5.5.1.1 Lighting fixtures shall not be located directly over equipment with exposed moving parts.

5.5.1.2 In general, circuits shall be switched from lighting panels. The use of local switches shall be kept to a minimum.

5.5.1.3 Lighting fixtures within the process area 16 or more feet above grade and located outside buildings shall be mercury-vapor type. Lighting fixtures below 16 feet or inside buildings shall be of the incandescent type. Other type fixtures will be considered and used as appropriate.

5.5.1.4 Branch circuits using a common neutral conductor shall be arranged for minimum current in the neutral conductor.

5.5.1.5 In addition to interior, lighting shall be provided over stairways, operating platforms, local instrument panels, gauges, etc.

5.5.1.6 Stand-by lighting will be supplied for safe operation. In the event of power failure, emergency lighting will provide for safe evacuation of buildings, and the illumination of the egress signs. The emergency lighting will be battery operated complete with built-in chargers.

5.5.1.7 Transparent-type gauge glasses shall be provided with illuminators. If required, the circuit to the gauge lights shall be separate from normal lighting circuits. No special lighting will be provided for reflex gauges.

5.5.1.8 Street lighting will be installed where required.

5.5.1.9 Aircraft warning lights, if required, will be installed in accordance with FAA regulations.

5.5.2 Lighting Intensities

The lighting system shall be designed for the average initial illumination values tabulated below, measured on the working plane:

Location	Illumination Level Foot Candles	Working Plane Elevation
Control Rooms, General	30	Floor
Control Rooms, Back of Panel	15	48"
Control Rooms, Instrumentation Panels (at Horiz. centerline of vertical surface)	50	Panel Centerline
Locker Room	30	30"
Motor Control Room	30	30"
Pump Row Outdoors	10	floor
Main Operating Platforms	6-8	floor
Ordinary Platforms	3	floor
Exchanger Areas (Tube Bundle Removal)	5	Ground
Heater Area at Grade	10	ground
General Yard Area	2-4	Ground
Other Locations	Recommended Practice of API-RP540	

5.5.3 Transformers

5.5.3.1 Lighting transformers will be standard, outdoor, dry-type compound-filled in all ratings in which this type is available. Larger ratings will be standard outdoor dry type.

5.5.3.2 Voltage rating will be 480-120/208 volts, three phase.

5.5.3.3 Transformers will be supplied with 2-2½ percent full capacity taps above and below rated voltage.

5.5.4 Lighting Panels

5.5.4.1 Local lighting panels for 120-volt receptacles, instrumentation power, and local lighting shall be 3-phase, 4-wire, 120/208 volts with lugged mains and single pole, 20 ampere branch circuit breakers. Quick-make, quick-break type.

5.5.4.2 Each lighting or plug receptacle circuit shall be protected by a circuit breaker of 5000 ampere interrupting capacity. Circuit loading shall not exceed 15 amperes. One spare circuit shall be provided for each five active circuits in the initial design.

5.5.4.3 Lighting panels shall be located outside of buildings if within the hazardous area.

5.5.4.4 Lighting panel enclosures shall be as follows:

Class I, Division 1 and 2..Explosion Proof, NEMA 7
Class II, Division 1 and 2..Explosion Proof, NEMA 9
Outdoor Non-Hazardous Locations..Weatherproof, NEMA 4
Indoor Non-Hazardous Locations..General Purpose, Sheet Steel, NEMA 1.

5.5.5 Lighting Fixtures

5.5.5.1 Lighting fixtures located outside buildings and at 16 or more feet above grade shall be mercury vapor as follows:

a) Local lighting: Crouse-Hinds type VMC, or equal, with 100-watt lamp.

b) Flood lighting: Crouse-Hinds type MV250, or equal, with 250-watt lamp.

5.5.5.2 Lighting fixtures for installation in Division 1 areas shall, in general, be 150 watts minimum size, equal to Crouse-Hinds fixture #EVA-2155.

5.5.5.3 Flood lighting for heaters and ground area shall be provided (mercury vapor).

5.5.5.4 In non-hazardous areas, fluorescent fixtures shall be used for indoor areas requiring high illumination levels.

5.5.5.5 Lighting fixtures shall be mounted no higher than 7'6" above platforms. Reflectors shall be provided as required and guards shall be provided in locations where lighting fixtures may be subject to accidental damage. Where floodlights are used, they shall be made accessible for re-lamping purposes.

5.5.5.6 Explosion proof approved fixtures shall be used for all classified areas inside buildings within process area and outdoor areas up to 16' from grade. Enclosed and gasketed fixtures shall be used for outdoor areas at 16 or more feet above grade.

5.6 Receptacles

5.6.1 Basis of Design

5.6.1.1 Welding receptacles shall be furnished on the basis of reaching any point within the unit where welding will be performed, assuming the use of 150-foot extension cords. Welding receptacles shall not be provided on structures.

5.6.1.2 Welding receptacles shall be rated 60 amperes, 480 volts, 60 Hz or 100 amperes, 480 volts, 60 Hz, 50 percent of the receptacles of each size, and shall be arranged in groups of not more than four outlets for each welding circuit. The size of the welding power supply feeder shall be based on:

One Welding receptacle	40 KVA
Two Welding Receptacle	50 KVA
Three or four Welding Receptacles	80 KVA

Total voltage drop shall be not more than 3 percent.

5.6.1.3 In general, welding outlets shall be located along roadways of the unit, readily accessible by truck. Two welding receptacles shall be furnished within each process area, mounted on pipe rack columns.

5.6.1.4 In process areas, convenience outlets shall be provided on the basis of adequate plant coverage, assuming the use of 50-foot extension cords. Convenience outlets on towers to be provided at each manway only. Each convenience receptacle within the process area shall have its individual circuit breaker rated 20 amperes.

5.6.1.5 All welding receptacles will be phased alike.

5.6.2 Receptacle Types

5.6.2.1 Welding receptacles for Class I, Group C&D and Class II, Group G areas shall be Crouse-Hinds EPC 46042-WT50-3, or equal.

5.6.2.2 Welding receptacles for non-hazardous areas shall be Crouse-Hinds #ARE6424 in combination with a load break safety switch Square D Company #53342D or equal.

5.6.2.3 For Class I, Groups C&D and Class II, Group G locations, convenience receptacles shall be explosion proof, Crouse-Hinds Catalog #FSQC230 or equal, rated 250 volts,30 amperes,2-wire,3-pole for 120-volt service.

5.6.2.4 For indoor non-hazardous locations such as offices, etc, receptacles shall be 120 volts, 20 amperes, 2-wire, 3-pole standard duplex receptacles.

6.0 WIRING

The wiring methods and materials will be as described in the following paragraphs.

6.1 Methods

6.1.1 General

6.1.1.1 Power and lighting feeders and motor feeder and control circuits shall be installed underground. Branch lighting and instrument circuits shall be installed above ground.

6.1.1.2 The wiring method for all areas, hazardous, non-hazardous, above ground or underground shall be cables in conduit.

6.1.1.3 All power wiring shall be run underground whenever possible.

6.1.1.4 All stranded wiring in oil-immersed equipment shall be treated as follows to prevent syphoning:

a) Strip insulation from all wiring immersed in oil.
b) Tin stranded conductor to make it equivalent of solid.
c) Insert oil and moisture resistant plastic sleeve over tinned conductor.

6.1.2 Conduit System Design

6.1.2.1 Minimum conduit size shall be 3/4" for above ground, 1" for underground, except that 1/2" size may be used for instrument control board wiring, instrumentation work, or where the conduit is an integral part of the machine tool equipment.

6.1.2.2 No conduits shall be reduced in size below grade.

6.1.2.3 Conduits shall be located to avoid sub-surface obstructions, furnaces, hot pipelines with outside surfaces continuously operating above 500^{o}F or other places of high ambient temperature. Conduit shall not be installed closer than 12" parallel to those hot surfaces.

6.1.2.4 Underground duct banks shall be encased in red concrete envelopes. The duct bank shall be free of voids and shall have a minimum cover of 3" on all sides, and at a minimum depth of 18".

6.1.2.5 In general, in hazardous areas, above grade pull boxes will be used, where required in underground duct banks. Manholes will be used only in non-hazardous areas.

6.1.2.6 In general, exposed conduit shall run parallel or at right angles to beams and walls and shall be properly fastened to structures. Supports shall not be more than 10 feet apart.

6.1.2.7 Horizontal conduits supporting pendant fixtures shall have conduit clamps installed as near to the fixture as possible.

6.1.2.8 All rigid steel conduit joints shall be weatherproofed, using suitable metal oxide paint for joint makeup.

6.1.2.9 Where flexible connections are required for removing, for adjustment or for vibration of equipment, liquid tight flexible conduit or explosion proof flexible conduit will be used.

6.1.2.10 Conduit systems will be installed to prevent liquids from condensation or leakage, draining into enclosures containing equipment. Overhead conduits will have drain and breather fittings installed to prevent any accumulation of liquid in the conduit system, especially above sealing fittings. Where necessary, Type EYD sealing fittings will be used above equipment.

6.1.2.11 All enclosures in which condensate might accumulate will be equipped with a drain and breather fitting.

6.1.2.12 Area Weatherproof junction boxes with terminal strips will be used for thermocouple wiring system.

6.1.2.13 If shielded wire is necessary, shields will be grounded at only one point in the instrument loop.

6.2 Materials

6.2.1 Conduit and Fittings

6.2.1.1 Conduit installations, underground or overhead, shall be rigid hot-dipped galvanized steel conduit, except rigid conduit and fittings on cooling towers and other extremely corrosive locations will be aluminum, plastic, or plastic-coated steel.

6.2.1.2 In Division 1 locations, explosion proof conduit fittings and junction boxes shall be Crouse-Hinds GUA Series or equal.

6.2.1.3 In Division 2 locations, or areas outside buildings and at 16 or more feet above grade, conduit fittings shall be of the standard threaded type with covers and neoprene gaskets (except the seals and unions shall be explosion proof) Crouse-Hinds Form 8 Series, or equal.

6.2.1.4 In indoor non-hazardous locations, general purpose sheet steel boxes may be used.

6.2.1.5 The installation of seal fittings shall conform to the requirements of Sections 501-5 and 502-5 of the National Electrical Code and as hereinafter described.

6.2.1.6 Seals are not required in conduits to explosion proof motors, junction boxes or terminal boxes located in Class I, Group D, Division 2 locations.

6.2.1.7 Seal and drain fittings shall be provided in conduit lines which start at elevations substantially above grade and terminate in explosion proof equipment, control houses, substations, and similar structures at a point below starting elevation. Drain fittings shall be installed at the low point above grade.

6.2.1.8 Seal fittings shall be filled with an approved sealing compound.

6.2.2 Wire and Cable

6.2.2.1 Basis for Cable Sizing

6.2.2.1.1 The allowable current carrying capacity of cable below 600 volts shall be as specified in the National Electrical Code or by the IPCEA for cable above 600 volts.

6.2.2.1.2 Feeders and sub-feeders shall be sized based upon the maximum demand of initial loads. Feeders shall have a current carrying capacity equal to 125 percent of the maximum demand.

6.2.2.1.3 Cables shall be sized to limit voltage drops due to initial loads as follows:

Feeders and Sub-Feeders	- 1 percent
Motor Branch Circuits	- 3 percent from the power center to the motor but no smaller than the minimum sized permitted by NEC.
Lighting Branch Circuits	- 3 percent from the panel to the farthest outlet.

6.2.2.1.4 For circuits above 600 volts, the minimum size cable shall be the smallest practical size dictated by the short circuit level and the protective devices of the electrical system.

6.2.2.1.5 For lighting and power circuits, 600 volts and below, the smallest wire size shall be #12 AWG, except that #14 AWG may be used if applicable for wiring that is an integral part of machine tools or equipment. For control circuits, the minimum wire size shall be #14 AWG.

6.2.2.2 Cable Construction

6.2.2.2.1 All conductors shall be stranded copper.

6.2.2.2.2 In general, for cable installed in conduit, cable insulation types shall be as follows:

a) Cable for use at 4160 volts shall be cross-linked polyethylene, 5 KV cable, single conductor, shielded, G.E. Vulkene SI-58064 or equal.

b) Cable for use at 2400 volts shall be cross-linked polyethylene, 5 KV cable, single conductor, shielded, G.E. SI-58064 or equal.

c) For services 600 volts and below, cables shall be 600 volts, single conductor, heat and moisture resistant, cross-linked polyethylene insulated, Type XHHW, G.E. Vulkene SI-58053 or equal.

d) For fixture stems #14 AWG, 600 volts, Type SF-2 silicone rubber-stranded fixture wire shall be used.

e) Any deviation from above must be approved by the Buyer.

f) Thermocouple extension wire will be as described in Standard Specification P-6

g) Electronic signal wire will conform to Standard Specification P-6

6.2.2.2.3 All cable shall comply with applicable portions of IPCEA standards.

6.2.2.3 Basis of Design

6.2.2.3.1 Cable for power and control leads to motors shall be installed in the same conduit when power cable is #2 AWG or smaller. For power cable larger than #2 AWG, power and control cable shall be installed in separate conduit.

6.2.2.4 Color Coding

6.2.2.4.1 The color coding for single conductor cables shall be as follows:

a) Power phase leads shall be black.

b) Multi-wire lighting circuits and 2-wire branch circuits connected to the same system shall conform to the following:

Single Phase, 3-wire - Black (L_1), Red (L_2), White (N).

Three Phase, 4-wire - Black (L_1), Red (L_2), Blue (L_3), White (N).

Three Phase, 3-wire - Black (L_1), Red (L_2), Blue (L_3).

c) All control leads for pushbutton stations will be of different colors.

d) Power supplies to instruments shall be Red (live line) and white for the neutral.

e) All ground wires installed in conduit shall be either bare or provided with a green covering.

f) All signal leads will be yellow and common alarm wire will be blue.

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6.2.2.5 Terminations

6.2.2.5.1 All motor terminal connections shall utilize lug type solderless connectors bolted together with brass bolts, nuts, and washers of proper size.

6.2.2.5.2 For lighting, all wires and cables shall be continuous without joints or splices so far as practicable. The necessary taps and joints shall be made with 3M Company "Scotchlock" or equal pre-insulated connectors except for #8 AWG and larger cables where clamp-type connectors shall be used. Splices, taps, and connections shall be taped in accordance with the following:

a) 480 volts - First two layers rubber tape, three complete layers of Scotch #88 tape, or equal.

b) 120 volts - Taped with at least four layers of Scotch #88, or equal.

c) Above 480 volts - Cable manufacturer's recommendations.

7.0 INSTRUMENTATION

7.1 Electrical installation for instruments will meet the requirements of the control system.

7.2 Thermocouple extension wire will be selected as required for the types of thermocouples used as follows:

Iron-Constantan, for Iron-Constantan Thermocouples.
Chromel-Alumel, for Chromel-Alumel Thermocouples.
Copper-Constantan, for Copper-Constantan Thermocouples.

7.3 Instrument Control Panel wiring will be as described in specifications prepared for Phase I of the project.

7.4 Emergency power will be provided as necessary. If static no-break supply is required, it will be in accordance with job specification 14222-P-21.

7.5 Where field instruments may require local power, they shall be supplied from normal lighting panels. No lighting fixtures, convenience outlets or other type of utility outlets shall be connected to the instrument circuits.

7.6 Switches for field assembled instrument panels shall be as follows:

1. An instrument disconnect switch shall be provided in each branch circuit supplying a maximum of six non-potentiometer type instruments or recorders. Each potentiometer type instrument, electronic controller or analyzer shall have an individual disconnect switch.

2. Switches for temperature recorders and indicators shall be located on the back of the panel board.

3. All instrument switches shall be of the thermal overload type, two-pole, connected to interrupt line and neutral wires.

7.7 As far as possible, conduits for instrument wiring shall be installed underground from terminal boxes to the operating equipment room.

7.8 Signal or control information shall, in general, be transmitted via twisted pair cables in conduit.

7.9 Multiconductor cables may be used for electronic instrument wiring where economically feasible.

7.10 At locations where the ambient temperature may exceed 200°F, thermocouple extension wire suitable for the temperature involved shall be run from thermocouple heads to a terminal box at a location where the temperature will not exceed 200°F.

7.11 In general, all duplex general services thermocouple extension wire shall be installed in conduit.

7.12 Conduit for thermocouple wiring shall be sized in accordance with the following schedule:

*ALLOWABLE NUMBER OF DUPLEX LEADS PER CONDUIT

Conduit Size	Table A	Table B
1/2"	1	2
3/4"	3	4
1"	6	8
1-1/4"	11	13
1-1/2"	15	19
2"	24	31
2-1/2"	35	44
3"	54	67

Table A shall be applicable for #16 AWG, teflon asbestos insulation with asbestos yard braid overall.

Table B shall be applicable for #16 AWG, PVC insulation with PVC jacket overall - computer and non-computer use.

*Ten percent spare thermocouple leads shall be furnished in main conduit runs between junction boxes or fittings and control room.

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ALLOWABLE NUMBER OF MULTICONDUCTOR CABLES PER CONDUIT

No. of Pairs	CONDUIT SIZE 1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"
4	1(1)	1(1)	3(1)	6(4)	9(5)	14(9)	21(13)
8	1	1	2	41	6	9	13
10		1	1	3	4	7	11
12		1	1(1)	2(1)	4(1)	6(3)	9(5)
16		1	1(1)	1(1)	3(1)	5(3)	7(4)
20			1	1	31	4	7
24			1	1	1	31	5
36				1	1(1)	2(1)	4(1)

The number in brackets ( ) denotes number of computer type cables that may be installed in that size conduit.

In general, individually shielded pairs are not used but the bundle is shielded.

8.0 GROUNDING

8.1 Main Distribution Substation Grounding

Grounding for power generation facilities and for utility substation and main distribution substations will be as described in Job Specification P-10.

8.2 Grounding System

8.2.1 A grounding system will be installed for protection of personnel and equipment against ground faults in electrical equipment, lightning, and static electricity.

8.2.2 The grounding system will be installed in accordance with Article 250 of the National Electrical Code. At each distribution substation the main grounding electrode for grounding the transformer secondary neutral(s) will be a metallic underground water pipe if available at or near the site. In addition, a supplementary driven ground rod or ground rods interconnected underground by cable will be provided. If the resistance of the first supplementary ground rod exceeds 5 ohms, at least one additional ground rod will be provided. In some cases, additional ground rods or other grounding means will be justified. The need for these will be determined by the combined resistance of all grounding electrodes and by the

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maximum available ground fault current. IEEE Standard No. 142 will be used as a guide. The supplementary ground rods will be connected to the main grounding electrode. Ground rods will be steel core with Type 304 stainless steel cladding. Interconnecting copper cables will be covered with green PVC. Buried connections in the grounding system will be made by thermowelding or die crimped pressure connectors. Connections will be taped.

8.3 Equipment Grounding

8.3.1 All switchgear and motor control centers will have ground buses connected directly to the grounding system.

8.3.2 Metallic conduits will be connected to the ground bus at switchgear, motor control centers, and switchracks.

8.3.3 Motors and all other utilization equipment will be grounded through the conduit system where conduits are metallic. Flexible conduits and fittings 1-1/4" and smaller will be approved for ground continuity. Flexible conduits 1-1/2" and larger will be provided with bonding jumpers. When non-metallic conduits are used, an insulated green grounding conductor will be installed inside the conduit; the grounding conductor will be connected to the ground bus at switchgear, motor control center or switchrack at the supply end, and to the housing of the motor or other utilization equipment. Grounding conductors larger than No. 6 AWG may be black, but must be identifed as grounding conductors at each end and at every point where accessible. Identification will be acommplished by one of the following:

a) Stripping the insulation from the entire exposed length.

b) Coloring the exposed insulation green.

c) Marking the exposed insulation with green-colored tape or green-colored adhesive labels.

8.3.4 Metallic non-current-carrying parts of all major electrical equipment, such as motors, transformers, switchgear, motor starters, etc., shall be grounded by a connection to the ground network, or if such equipment is isolated, to one or more ground rods or other suitable means as required by the National Electrical Code.

8.3.5 In general, a ground network shall be installed around substations, process units, structures, switchracks and other electrical installations. The ground network shall consist of a main cable loop, above-ground connection points, branch cables from loop to individuals grounds, and necessary inspection points on all ground rods. Size of grounding conductors are to be in accordance with NEC and in addition, capable of carrying welding current. Minimum cable size shall be #4/0 AWG for the main loop and #4 AWG for branches except for welding receptacle branches which shall be #4/0 AWG.

8.3.6 Insofar as possible, copper ground conductors shall be laid directly in the ground without breaks or joints, and shall have 12" minimum cover. When unavoidable, underground joints shall be brazed, suitably covered and protected.

8.4 Static Grounding

8.4.1 Frames of large steam turbine drivers will be connected to ground system.

8.4.2 All vessels containing flammable liquids will be grounded.

8.4.3 Steel pipeways will be grounded.

8.5 Lightning Grounding

8.5.1 Frames of buildings and steeel structures will be electrically connected to ground wells in two or more places. These ground wells may be connected by underground cables to other portions of the grounding systems.

8.5.2 Non-metallic structures which are not shielded by other taller structures will be protected with two or more ground cables run to top of structure and connected to air terminals on top.

8.5.3 Electrical equipment and lines will be protected where necessary with lightning arrestors and surge capacitors.

9.0 Telecommunication Systems

Telecommunication systems will be as described in Specification 14222-P-9.

10.0 Stand-By Power

10.1 Stand-by power will be provided for lighting, instruments, and essential apparatus for which a loss of power will create a hazard.

10.2 The stand-by power source will be as described in Design Basis-Plant 31.

11.0 Capacitors

Static capacitors for power factor correction will be considered but gnerally power factor correction will be achieved by use of synchronous motors where suitable.

12.0 Metering

Electric power to the facilities will be metered on incoming lines and each distribution feeder will be provided with watt hour meters with maximum demand attachment.

13.0 Identification of Equipment

13.1 All equipments will be identified by appropriate nameplates.

13.2 All thermocouple extension and control wires will be marked with

FORM 293

"Brady" or equal identification marks or numbers or with heat-shrinkable sleeves. The method used shall be mutually agreed to by Engineering and Construction.

13.3 All wire terminals will be clearly marked.

13.4 Underground conduits will be clearly marked with suitable posts or embossed concrete directional arrows set at grade.

14.0 <u>Tests</u>

Before plant startup, electrical facilites will be tested and checked, as described in job specification to be issued in Phase I.

FORM 283

1.0 SCOPE

1.1 This specification describes electric motors for indoor and outdoor general service use on the Breckinridge Project. Motors which are supplied as component parts of equipment requiring special design are excluded from this specification; however, this specification is to be considered as a minimum standard for such motors.

1.2 Job motor data sheets are part of this specification and in cases of conflict, the job motor data sheets shall be considered correct.

2.0 CODES AND STANDARDS

2.1 All motors shall be manufactured in accordance with the latest edition of the National Electric Manufacturers' Association Standard for Induction Motors, except as modified herein.

2.2 Explosion-proof motors shall be approved by Underwriter's Laboratories (UL).

3.0 SERVICE CONDITIONS

3.1 Motors shall operate at full service factor output under the conditions stipulated by Specification 14222-A-3, "Basic Engineering Data"; and in a 40°C ambient temperature, without exceeding the temperature rise limitation of the motor, including insulation, bearings, lube system, etc. (NEMA MG-1-12.42).

4.0 ELECTRICAL CHARACTERISTICS

4.1 Motors shall be designed for 60-hertz operation at the following voltages or as required by the job data sheets.

3/4 HP and smaller:

115 volts, single phase, 2-wire for continuous duty motors; 460 volts, 3-phase, 3-wire for "on-off" motors is permissible when approved by purchaser

1 HP through 150 HP:

460 volts, 3-phase

Motors above 200 HP:

4160 volts, 3-phase (motors above approximately 6000 HP may be rated above 4160 volts when studies indicate that this is desirable)

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Rev	Date	Description	By	Chk	Appr
3					
2	10-21-81	ATTACHED FORMS REFERENCED			
1	7/22/80	ISSUE FOR PHASE ZERO	CRP	HS	
0	7/17/80	ISSUED FOR APPROVAL	CRP	HS	

ASFI THE BRECKINRIDGE PROJECT AECI	JOB NO. 14222	
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717	SPECIFICATION	REV
GENERAL SPECIFICATION INDUCTION MOTORS	14222-P-2	2

4.2 Motors shall be NEMA Design B for across-the-line starting, unless otherwise specified. Where NEMA Design B has not been established, locked rotor current shall not exceed 6.5 times full load current, unless specifically approved by the purchaser.

4.3 Motors shall have Class B insulation or as specified in requisition or purchase order.

5.0 ENCLOSURES

5.1 Motor enclosures shall be as specified on the job motor data sheets. In general, they will be as follows:

200 HP and smaller	TENV or TEFC for non-hazardous and Div. 2 hazardous areas. TEFC Explosionproof for Div. 1 hazardous areas.
250 HP and larger	TEFC or NEMA Type 1 or Type II Weather-protected for non-hazardous or Div. 2 hazardous areas.
	TEFC Explosionproof, inert gas-filled or externally air-cooled for Div. 1 hazardous areas.

5.2 All TEFC Explosionproof motors shall be equipped with drains and breathers.

6.0 TERMINAL BOXES

6.1 Terminal boxes shall be of cast iron or welded sheet steel construction, located on the right side (when facing the end opposite the coupling) and be adjustable for conduit entrance at four 90° positions. Terminal boxes shall be at least one size larger than standard per NEMA Standard MG-1-20.62.

6.2 Motors 1500 HP and larger shall have one end of each phase winding brought out into a junction box on the side opposite the line leads with provisions for installing current transformers for differential protection. These motors shall also have provision for mounting surge capacitors in the terminal connection box. The surge capacitors shall be insulated from the enclosure and grounded through a removable link.

6.3 Motors with rated voltage above 2KV shall have the power terminal box sized to permit termination of shielded cable (normal length stress cones).

6.4 Separate terminal boxes shall be provided for each service, i.e., space heaters, temperature detectors, etc.

7.0 GENERAL

7.1 Nameplates shall be stainless steel and fans shall be non-sparking types.

7.2 If specified on the motor data sheets, motors shall have space heaters with surface temperature not to exceed 150°C.

7.3 Motor bearings shall be manufacturers' standard,unless specified otherwise on the motor data sheets.

7.4 Motors rated 2500 HP and larger shall have six RTDs embedded in the stator windings with leads brought out to a terminal strip enclosed in a junction box mounted on the exterior of the motor frame.

7.5 Motors shall be treated to resist fungus and shall have hardware and finish for severe chemical service if so specified by the job motor data sheets.

8.0 TESTS

All motors shall receive routine commercial tests in accordance with IEEE test procedure.

9.0 VENDORS DRAWINGS AND INFORMATION

9.1 Job motor data sheets, Form(s) 182A and/or 182B shall be completed by vendor for each motor.

9.2 Certified dimensioned outline drawings are to be supplied for each motor in accordance with Form 15A.

9.2 Speed torque curves shall be supplied by the vendor for all motors 250 HP and larger.

10.0 NOISE

Unless otherwise stated in the material requisition, motors shall comply with noise requirements contained in Specification 14222-A-12 and applicable noise data sheets.

INDUCTION MOTOR DATA SHEET	MOTOR NO.				
	SERVICE				
	P. O. NUMBER				
1. HORSEPOWER					
2. MANUFACTURER					
3. FRAME NO.					
4. SERVICE FACTOR					
5. VOLTAGE					
6. PHASE					
7. FREQUENCY - HERTZ					
8. SYNCHRONOUS SPEED - RPM					
9. FULL LOAD SPEED - RPM					
10. NEMA DESIGN LETTER					
11. TEMP. RISE - °C BY RESIST					
12. FULL LOAD CURRENT					
13. LOCKED ROTOR CURRENT					
14. LOCKED ROTOR TORQUE - %F.L.					
15. EFFICIENCY:	100% LOAD				
	75% LOAD				
16. POWER FACTOR:	100% LOAD				
	75% LOAD				
17. ENCLOSURE*					
18. MOUNTING					
19. BEARING TYPE					
20. SPACE HEATERS - WATTS					
	- VOLTS				
21. O/L DIMEN. DWG. NO.					
22. WEIGHT					
23. FUNGUS TREATMENT					
24. OTHER MODIFICATIONS					
a.					
b.					

*ENCLOSURE XP-EXPLOSION PROOF (CHEMICAL TYPE), DP-DRIP PROOF, SP-SPLASH PROOF, TENV-TOTALLY ENCLOSED NON-VENTILATED, TEFC-TOTALLY ENCLOSED FAN COOLED, WPI-WEATHER PROTECTED-TYPE I, WPII-WEATHER PROTECTED-TYPE II

ALL MOTORS SHALL BE IN ACCORDANCE WITH SPECIFICATION.

No.	DATE	REVISIONS	BY	CH'K	APPR

ORIGIN		JOB No.	
	BECHTEL	DRAWING NO.	REV.

FORM 182A (3/77)

R&C

INDUCTION MOTOR DATA SHEET SPECIAL	MOTOR NO.				
	SERVICE				
	P. O. NUMBER				
1. HORSEPOWER					
2. MANUFACTURER					
3. FRAME					
4. SERVICE FACTOR					
5. VOLTAGE					
6. PHASE					
7. FREQUENCY - HERTZ					
8. SYNCHRONOUS SPEED - RPM					
9. FULL LOAD SPEED - RPM					
10. TEMP. RISE - °C BY RESIST					
11. FULL LOAD CURRENT					
12. LOCKED ROTOR CURRENT					
13. ALLOW. L.R. TIME AT RATED VOLTAGE					
COLD START - SEC.					
HOT START - SEC.					
14. LOCKED ROTOR TORQUE - %F.L.					
15. WK^2 OF ROTOR					
16. EFFICIENCY: 100% LOAD					
75% LOAD					
17. POWER FACTOR: 100% LOAD					
75% LOAD					
LOCKED ROTOR					
18. SPEED VS. TORQUE CURVE DWG. NO.					
19. STATOR TEMP. DETECTOR					
20. DIFF. PROTECTION CT TYPE/QUAN.					
21. SURGE CAPACITORS					
22. SURGE ARRESTORS					
23. ENCLOSURE*					
24. MOUNTING					
25. ROTATION (FROM END OPP. COUPLING)					
26. BEARING TYPE					
27. SPACE HEATERS - WATTS/VOLTS					
28. O/L DIMEN. DWG. NO.					
29. WEIGHT					
30. FUNGUS TREATMENT					
31. OTHER MODIFICATIONS					
a.					
b.					
c.					
d.					

*ENCLOSURE XP-EXPLOSION PROOF (CHEMICAL TYPE), DP-DRIP PROOF, SP-SPLASH PROOF, TENV-TOTALLY ENCLOSED NON-VENTILATED, TEFC-TOTALLY ENCLOSED FAN COOLED, WPI-WEATHER PROTECTED-TYPE I, WPII-WEATHER PROTECTED-TYPE II

NOTE:

ALL MOTORS SHALL BE IN ACCORDANCE WITH SPECIFICATION NO.__________

No.	DATE	REVISIONS	BY	CH'K	APPR

ORIGIN

JOB No.

DRAWING NO. REV.

SHEET 5 OF 6

REC SFE FORM 1828 (3/77)

P.O.	REV.
M.R.	

SECTION 3 - DRAWING AND DATA REQUIREMENTS

TRANSMITTAL REQUIREMENTS	DOCUMENT DESCRIPTION	REQ'D WEEKS ARO	NO. PRINTS	NO. REPRO
OBTAIN BECHTEL REVIEW AND AUTHORIZATION TO PROCEED BEFORE FABRICATION				
TRANSMIT TO BECHTEL BEFORE DELIVERY OF MATERIAL				

1. THIS SCHEDULE OF SUPPLIER'S DRAWINGS AND DATA REQUIREMENTS SHALL BE FULFILLED BEFORE RENDERING FINAL INVOICES.

2. TRANSMIT ALL DOCUMENTS TO:
   BECHTEL
   P.O. BOX 2166
   HOUSTON, TEXAS 77001
   ATTN:

   SEND COPY OF TRANSMITTAL LETTER TO
   BECHTEL
   P.O. BOX 2166
   HOUSTON, TEXAS 77001
   ATTN: JOB EXPEDITER

3. ALL DOCUMENTS MUST SHOW JOB, EQUIPMENT AND PURCHASE ORDER NUMBERS, SUPPLIER'S TITLE, AND DRAWING AND REVISION NUMBERS, ALL PREFERABLY IN THE LOWER RIGHT HAND CORNER.

4. DRAWINGS OR DATA RETURNED TO SUPPLIER FOR REVISION MUST BE RE-SUBMITTED WITHIN 10 WORKING DAYS AFTER RECEIPT. RETAINING ORGINAL DRAWING NUMBER, WITH REVISION NUMBER CHANGED. CORRESPONDENCE ACCOMPANYING REVISED DRAWINGS AND DATA MUST SHOW BECHTEL VENDOR PRINT (V.P.) NUMBER.

5. ALL FINAL DRAWINGS SUBMITTED TO BECHTEL MUST BE CERTIFIED REPRODUCIBLES.

6. INSTRUCTIONS SHALL COVER ALL COMPONENTS OF THE ORDER. IF A SUPPLIER IS FURNISHING SIMILAR EQUIPMENT ON SEVERAL ORDERS FOR THE PROJECT, A COMPOSITE INSTRUCTION MANUAL SHALL BE PROVIDED.

7. RECOMMENDED SPARES MUST BE SPECIFIC LIST IN ACCORDANCE WITH REQUIREMENTS OF FORM 15 S.P. ATTACHED. (IF APPLICABLE)

ITEM NO. ______________________

1.0 SCOPE

1.1 This specification describes brushless synchronous motors to be used as drivers for compressors, etc, on the Breckenridge Project.

1.2 Job Synchronous Motor Data Sheets are part of this specification and in cases of conflict, the Job Synchronous Motor Data Sheets shall be considered correct.

2.0 CODES AND STANDARDS

2.1 Motors shall be manufactured in accordance with the latest standard of the National Electrical Manufacturers' Association, except as modified herein.

2.2 Motors for use in Div. I Hazardous Areas shall be approved by Underwriters' Laboratories (UL) for the service specified.

3.0 SERVICE CONDITIONS

3.1 Motors shall operate at full service factor output in the conditions stipulated by Specification 14222-A-3, "Basic Engineering Data"; and in a 40°C ambient temperature, without exceeding the temperature rise limitation of the motor, including insulation, bearings, lube system, etc. (NEMA MG-1-21.40).

4.0 ELECTRICAL CHARACTERISTICS

4.1 Motors shall be 4000 volt, 3-phase, 60-hertz or as shown on the Job Synchronous Motor Data Sheets.

4.2 Motor shall be rated for 1.0 or unity power factor, unless otherwise specified on the material requisition.

4.3 Motors shall be suitable for across-the-line starting. Maximum motor starting KVA shall not exceed that shown on the Job Synchronous Motor Data Sheet and shall be designed for the system short-circuit capacity and voltage drop specified on these sheets or on the material requisition.

4.4 Motor shall have Class B or higher temperature rated insulation, however, maximum temperature rise shall not exceed 75°C above a 45°C ambient, when operating within the service factor rating.

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3	10-21-81	ATTACHED FORMS REFERENCED			
1	7/22/80	ISSUE FOR PHASE ZERO	CRP	HS	
0	6/80	ISSUED FOR APPROVAL	CRP	HS	

BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL SPECIFICATION
BRUSHLESS SYNCHRONOUS MOTORS

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

4.5 Motor windings shall be protected with a permanent encapsulated type moisture sealed insulation system. A detail description of the sealing method proposed shall be included in the vendor's quotation.

4.6 Motor shall be of the brushless type with a shaft mounted excitation system.

4.7 Motor shall have standard horsepower and speed ratings.

5.0 ENCLOSURES

The motor enclosures shall be as specified on the Job Synchronous Motor Data Sheets.

6.0 TERMINAL BOXES

6.1 Motors shall have cast iron or welded sheet steel terminal boxes adjustable for conduit entrance at four 90° positions. Sheet steel shall be not less than 1/4" thick. Separate boxes shall be provided for each service to the motor, such as power supply, space heaters, temperature detectors, etc.

6.2 A waterproof seal shall be provided between the terminal boxes and stator so that water within the motor cannot enter the terminal boxes.

6.3 Motors rated 1500 HP and larger shall have both ends of each phase winding brought out into a junction box with provision for installing current transformers for differential protection. These motors shall also have provision for mounting surge capacitors in the motor terminal box.

6.4 If surge protection devices are provided (see Motor Data Sheet), they shall be insulated from the enclosure and grounded with a removable link.

7.0 PERFORMANCE

7.1 Motors shall be capable of accelerating the normal WK^2 of the load (NEMA MG1-21.42) from "0" to synchronizing speed and synchronize at the percent of nameplate voltage shown on the Motor Data Sheet(s) at rated frequency, power factor, and ambient temperature without exceeding the rated temperature rise or otherwise damaging the machine.

7.2 The number of starts shall be in accordance with NEMA MG1-21.43. If additional starting capability is required, it will be stipulated in the purchase order documents.

7.3 The amplitude of vibration shall not exceed the values listed in NEMA Standard MG 1-21.53 when measured in accordance with MG1-20.53, unless a lower value is required by the driven equipment or specified in the purchase order documents.

7.4 Efficiency shall be determined in accordance with NEMA MG 1-21.44.

7.5 The motor and driven load shall have a system inertia of suitable magnitude to limit armature current pulsations in accordance with NEMA MG 1-21.84.

7.6 Motor torque for starting, pull in and pull out, shall be as specified by the manufacturer of the driven equipment. Mechanical details shall be as specified by the driven equipment manufacturer.

8.0 EXCITATION

8.1 Motors shall be furnished with a brushless AC exciter, solid-state rectifier, and a solid-state static field control system.

9.0 GENERAL

9.1 Motors shall have lifting devices for installing or removing the motor. The location of lifting points shall be shown on the Seller's drawings.

9.2 If specified on the Motor Data Sheets, motors shall have space heaters with surface temperature not to exceed 150°C.

9.3 Six temperature detectors (RTDs) shall be provided in the motor slots, two per phase, for all motors larger than 2500 hp. Motors 2500 hp and smaller shall be provided with resistance temperature detectors (RTD) if so indicated on the Motor Data Sheet(s).

9.4 Bearing enclosures shall be sealed to keep out water and dirt and shall have an ample oil reservoir designed to ensure against oil leakage.

9.5 Hardware and finish shall be suitable for severe chemical service. Motors shall be treated to resist fungus, if so specified on the Motor Data Sheet(s).

9.6 Drilled and tapped bearing temperature wells shall be provided on each friction bearing.

9.7 Weather-protected motors shall be equipped with the Seller's standard filter.

9.8 Accessories, such as space heaters and temperature detectors shall be wired to separate terminal boxes.

9.9 All motors shall have external provision for frame grounding.

9.10 Current transformers for differential protection shall be supplied if so indicated by the Motor Data Sheet(s).

9.11 Motors shall be cleaned, primed, and finish-painted in accordance with the manufacturer's standard procedures unless otherwise indicated in the purchase order documents.

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10.0 NAMEPLATES

10.1 Each motor shall have a nameplate giving information specified in NEMA MG 1-21.61.

10.2 An arrow shall be provided to indicate the direction of rotation of the motor.

10.3 A nameplate stating the starting duty limitation shall be mounted on the motor adjacent to the standard motor nameplate.

10.4 Nameplates shall be stainless steel.

11.0 TESTING

11.1 All motors shall be given routine tests in accordance with NEMA MG 1 and IEEE 115.

11.2 Current transformers shall be given routine tests in accordance with ANSI C57.13.

12.0 VENDORS DRAWINGS AND INFORMATION

12.1 After issue of purchase order, Buyer will furnish Seller with one copy of "Synchronous Motor Data Sheet," for each size and type of synchronous motor to be supplied. Seller shall enter the appropriate data on these sheets and return them to the Buyer as "Vendors Drawings."

12.2 The Seller shall furnish the following curves for each type and size motor: The curves shall be for 100 percent and a lower percent voltage shown by the purchase order documents. Plot both curves on one sheet.

12.2.1 Speed-Torque - If the motor is being furnished with the driven equipment, the load speed-torque curve shall be superimposed on the motor curve.

12.2.2 Speed-Time for the motor accelerating the specified load.

12.2.3 Current-Speed.

12.3 Certified dimensioned outline drawings shall be supplied for each motor in accordance with Form 15A. Dimensions shall be in English or in the International System of Units. The Purchase Order Documents indicate the preferred system of units.

13.0 NOISE

Unless otherwise stated in the material requisition, motors shall comply with noise requirements contained in Specification 14222-A-12 and on applicable Noise Data Sheets.

BRUSHLESS SYNCHRONOUS MOTOR DATA SHEET	MOTOR NO.		
	SERVICE		
	P.O. NUMBER		

1.	HORSE POWER		
2.	MANUFACTURER		
3.	FRAME		
4.	SERVICE FACTOR		
5.	VOLTAGE		
6.	PHASE		
7.	FREQUENCY - HERTZ		
8.	SYNCHRONOUS SPEED - RPM		
9.	RATED POWER FACTOR		
10.	STARTING VOLTAGE AS % OF MOTOR NAMEPLATE VOLTAGE		
11.	TEMPERATURE RISE °C - STATOR BY RTD		
	" " - ROTOR BY RESISTANCE		
12.	STATOR FULL LOAD CURRENT		
13.	STATOR CURRENT AT SERVICE FACTOR RATING		
14.	STATOR LOCKED ROTOR CURRENT - 100% VOLTS		
15.	% FULL LOAD TORQUE STARTING		
	" " " " PULL IN		
	" " " " PULL OUT		
16.	% FULL LOAD CURRENT PULL IN		
17.	ALLOWABLE STALLED TIME AT FULL VOLTAGE-COLD START-SEC.		
	" " " " " " -HOT START-SEC.		
18.	NUMBER OF ALLOWABLE STARTS AND TIME INTERVAL		
19.	EFFICIENCY - 100% LOAD		
	75% LOAD		
20.	LOCKED ROTOR POWER FACTOR		
21.	WK^2 OF ROTOR, EXCITER, FLYWHEEL, ETC. -LB. FT^2		
22.	SPEED VS. TORQUE CURVE - DWG. REFERENCE		
23.	REACTANCE (P.U.) X d UNSATURATED		
	X'd X'd		
	X''d X''d		
24.	SURGE ARRESTORS		
25.	SURGE CAPACITORS		
26.	STATOR TEMPERATURE DETECTORS		
27.	DIFFERENTIAL PROTECTION - CT TYPE AND QUANTITY		
28.	ENCLOSURE*		
29.	MOUNTING		
30.	ROTATION (VIEW FROM END OPPOSITE SHAFT)		
31.	BEARING TYPE		
32.	SPACE HEATER - WATTS/VOLTS		
33.	O/L DIMENSION DWG. NO.		
34.	WEIGHT TOTAL & MAX. PART.		

No.	DATE	REVISIONS	BY	CH'K	APPR
△					
△					
△					

ORIGIN		JOB No.	
R&C ENG. S.F. ELECTRICAL		DRAWING NO.	REV.

BRUSHLESS SYNCHRONOUS MOTOR DATA SHEET	MOTOR NO.		
	SERVICE		
	P. O. NUMBER		
35. RATED EXCITER FIELD VOLTS - F.L. -RATED P.F.			
36. EXCITER FIELD AMPS.-AT F.L.-RATED P.F.			
37. EXCITER FIELD AMPS.-AT N.L.-RATED P.F.			
38. EXCITER FIELD RESISTANCE AT 25°C			
39. EXCITER FIELD RESISTANCE AT 75°C			
40. FUNGUS TREATMENT			
41. SPECIAL MODIFICATIONS			

*ENCLOSURE

DP - DRIP PROOF
SP - SPLASH PROOF
TEFC - TOTALLY ENCLOSED FAN COOLED
WP I - WEATHER PROTECTED - TYPE I
WP II - WEATHER PROTECTED - TYPE II
TEIGF - TOTALLY ENCLOSED, INERT GAS FILLED
PECR - PRESSURIZED OR EXPLOSION RESISTANT COLLECTOR RING ENCLOSURES
PV - VENTILATED WITH POSITIVE PRESSURE INTAKE FROM OUTSIDE.

NOTE:

ALL MOTORS SHALL BE IN ACCORDANCE WITH SPECIFICATION NO.________

R&C FORM 181 PG 2 (3/77)

P.O.	REV.
M.R.	

SECTION 3 - DRAWING AND DATA REQUIREMENTS

TRANSMITTAL REQUIREMENTS	DOCUMENT DESCRIPTION	REQ'D WEEKS ARO	NO. PRINTS	NO. REPRO
OBTAIN BECHTEL REVIEW AND AUTHORIZATION TO PROCEED BEFORE FABRICATION				
TRANSMIT TO BECHTEL BEFORE DELIVERY OF MATERIAL				

1. THIS SCHEDULE OF SUPPLIER'S DRAWINGS AND DATA REQUIREMENTS SHALL BE FULFILLED BEFORE RENDERING FINAL INVOICES.

2. TRANSMIT ALL DOCUMENTS TO:
   BECHTEL
   P.O. BOX 2166
   HOUSTON, TEXAS 77001
   ATTN:

   SEND COPY OF TRANSMITTAL LETTER TO
   BECHTEL
   P.O. BOX 2166
   HOUSTON, TEXAS 77001
   ATTN: JOB EXPEDITER

3. ALL DOCUMENTS MUST SHOW JOB, EQUIPMENT AND PURCHASE ORDER NUMBERS, SUPPLIER'S TITLE, AND DRAWING AND REVISION NUMBERS, ALL PREFERABLY IN THE LOWER RIGHT HAND CORNER.

4. DRAWINGS OR DATA RETURNED TO SUPPLIER FOR REVISION MUST BE RE-SUBMITTED WITHIN 10 WORKING DAYS AFTER RECEIPT. RETAINING ORGINAL DRAWING NUMBER, WITH REVISION NUMBER CHANGED. CORRESPONDENCE ACCOMPANYING REVISED DRAWINGS AND DATA MUST SHOW BECHTEL VENDOR PRINT (V.P.) NUMBER.

5. ALL FINAL DRAWINGS SUBMITTED TO BECHTEL MUST BE CERTIFIED REPRODUCIBLES.

6. INSTRUCTIONS SHALL COVER ALL COMPONENTS OF THE ORDER. IF A SUPPLIER IS FURNISHING SIMILAR EQUIPMENT ON SEVERAL ORDERS FOR THE PROJECT, A COMPOSITE INSTRUCTION MANUAL SHALL BE PROVIDED.

7. RECOMMENDED SPARES MUST BE SPECIFIC LIST IN ACCORDANCE WITH REQUIREMENTS OF FORM 15 S.P. ATTACHED. (IF APPLICABLE)

ITEM NO. ____________

REC HE FORM 15A(5/80)

1.0 SCOPE

1.1 This specification covers electrical equipment that is supplied as part of a mechanical package. The Material Requisition defines the electrical equipment to be supplied, and the equipment shall conform to applicable sections of this specification.

1.2 Standard Specifications 14222-P-2, Squirrel-Cage Induction Motors, and 14222-P-3, Synchronous Motors, and Job Specifications which may be attached, are included as part of this specification.

2.0 CODES AND STANDARDS

2.1 The electrical equipment shall conform to applicable standards of the following:

2.1.1 National Electrical Manufacturers' Association (NEMA)

2.1.2 Occupational Safety and Health Act - Part 1910, Sub-Part "S" and Section 1910.95 (OSHA).

2.1.3 Underwriters' Laboratories (UL)

2.1.4 American National Standards Institute (ANSI)

2.1.5 Institute of Electrical and Electronic Engineers (IEEE)

2.1.6 National Fire Protection Association (NFPA)

2.1.7 Insulated Power Cable Engineers Association (IPCEA)

2.2 The complete electrical installation shall conform to the National Electric Code and local regulations.

3.0 SERVICE REQUIREMENTS

3.1 Electrical equipment and wiring shall be suitable for operation under climatic conditions at the jobsite, as shown in Specification 14222-A-3, "Basic Engineering Data."

3.2 The purchase order will indicate the classification of the area in which the "Package" is to be located. If hazardous, Equipment, Section 5, and Wiring Methods, Section 7, shall comply with Article 500 of the National Electric Code.

4.0 VOLTAGES

4.1 In general, available voltages will be:

115 volts, single-phase.
460 volts, three-phase, 60 hertz.
4000 volts, three-phase, 60 hertz.

4.2 Confirm voltage characteristics prior to proceeding with design or purchase.

4.3 If DC or other AC voltages are required, rectification and/or transformation equipment shall be supplied by Seller with the mechanical equipment package.

5.0 EQUIPMENT

5.1 Motors

In general, motors shall be squirrel-cage induction as described in Specification 14222-P-2. However, if another type of motor would be more suitable for the application, the vendor shall submit an alternate proposal stipulting precisely what is to be furnished. Further, should the substitution alter one equipment, building space, utilities, supports, etc, such alterations shall be included in the alternate proposal. If synchronous motors are required, they shall comply with Specification 14222-P-3.

5.2 Motor Control

5.2.1 General

Motor control will normally be supplied by the Buyer in NEMA-type motor control centers and/or switchracks.

However, if motor starters are to be supplied by the Seller, they shall conform to Specification 14222-P-18(4000 volt) or 14222-P-19 (600 volt). A copy of the appropriate specification is attached.

5.2.2 Motor Control Panels

5.2.2.1 Where a number of motors or other electrical devices are to be remotely controlled as a unit, a control panel containing all items necessary to operate the equipment, exclusive of motor starters Size 1 and larger, shall be supplied. In general, this control panel will contain push buttons, selector switches, relays, instruments, control transformers, power supplies, indicating lights, nameplates, etc.

5.2.2.2 Control panels shall have a complete metal enclosure wall-mounted or free-standing and suitable for the location. Enclosures shall be suitable for the area.

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5.2.2.3 Pressure-type screw terminal connection blocks shall be provided for all external connections. Connections shall be provided for interlocking of equipment furnished by others. Terminal connections shall be marked with the numbers shown on the wiring diagram. Each terminal block shall have a minimum of 25 percent spares.

5.2.2.4 Units shall be completely factory-wired.

5.2.2.5 Push buttons, selector switches, indicating lights, etc, shall be heavy-duty, oil-tight.

5.2.2.6 Arrangement of devices shall be as shown on the project drawings.

5.2.2.7 Each motor control station, each service unit, and all operating devices shall be provided with phenolic nameplates (white on black) showing equipment controlled and device function. See one-line diagram or nameplate schedule for additional information.

5.2.3 Pushbutton Stations

5.2.3.1 In general, pushbutton stations shall be of the heavy-duty, momentary contact, universal type. Exceptions to the above shall be special control circuits which require the use of maintained contact "On-Off" control stations, or "Hand-Off-Automatic" selector switches. Regardless of the type of pushbutton station, enclosures shall be furnished suitable for the area classification.

5.2.3.2 In general, pushbutton stations shall be mounted adjacent to and within sight of the controlled motor.

5.2.3.3 Pushbuttons for Hazardous Areas shall be Square D Class 9001, Type GR-206 for "Start-Stop," Square D 9001, Type GR-123 for "Hand-Off-Automatic."

6.0 PAINT AND FINISH

In accordance with Specification 14222-X-1.

7.0 WIRING METHODS

7.1 All interconnecting wiring shall be completely enclosed in conduit or in metal raceways, junction boxes, or panelboards. Conduit fittings shall be supplied and installed where required.

7.2 Conduit shall be hot-dipped galvanized rigid steel. Liquid-tight or explosion-proof-type flexible conduit shall be used for connection to motors, switches, etc, where adjustment or vibration require flexible connections.

7.3 Minimum conduit size shall be 3/4" except that 1/2" size may be used for instrumentation work or where the conduit is an integral part of the machine tool equipment.

7.4 All rigid steel conduit joints shall be weatherproofed, using suitable metal oxide paint for joint makeup.

7.5 In hazardous locations, explosion-proof conduit fittings and junction boxes shall be Crouse-Hinds GUA Series or equal.

7.6 In Division 2 hazardous and non-hazardous locations, conduit fittings shall be of the standard threaded type with covers and neoprene gaskets (except the seals and unions shall be explosion proof) Crouse Hinds Form 8 Series or equal.

7.7 The installation of seal fittings shall conform to the requirements of Sections 501-5 and 502-5 of the National Electrical Code and as hereinafter described.

7.8 Seals are not required in conduits to explosion proof motors, junction boxes, or terminal boxes located in Class I, Group D, Division 2 locations.

7.9 Seal fittings shall be filled with an approved sealing compound.

7.10 All conductors shall be stranded copper.

7.11 In general, for cable installed in conduit, cable insulation types shall be as follows:

(a) Cable for use at 4160 volts and 2400 volts shall be cross-linked polyethylene, 5 KV cable, single conductor, shielded, G.E. Vulkene, SI-58064.

(b) For services 600 volts and below, cables shall be 600 volts, single conductor, heat and moisture resistant, cross-linked polyethylene insulated, Type XHHW, G.E. Vulkene SI-58053.

(c) Any deviation from above must be approved by Buyer.

7.12 For fixture stems #14 AWG, 600 volts, Type SF-2 silicone, rubber-stranded fixture wire shall be used.

7.13 The allowable current carrying capacity of cable below 600 volts shall be as specified in the National Electrical Code or by the IPCEA for cable above 600 volts.

7.14 For circuits above 600 volts, the minimum size cable shall be the smallest practical size dictated by the short circuit level and the protective devices of the electrical system.

7.15 For lighting and power circuits, 600 volts and below, the smallest wire size shall be #12 AWG, except that #14 AWG may be used if applicable for wiring that is an integral part of machine tools or equipment. For control circuits, the minimum wire size shall be #14 AWG.

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7.16 The color coding for single conductor cables shall be as follows:

(a) Power phase leads shall be black.

(b) Multi-wire lighting circuits and 2-wire branch circuits connected to the same system shall conform to the following:

Single Phase, 3-wire - Black (L_1), Red (L_2), White (N)
Three Phase, 4-wire - Black (L_1), Red (L_2), Blue (L_3), White (N)
Three Phase, 3-wire - Black (L_1), Red (L_2), Blue (L_3).

(c) All control leads for pushbutton stations will be of different colors.

(d) Power supplies to instruments shall be red (live line) and white for the neutral.

(e) All ground wires installed in conduit shall be either bare or provided with a green covering.

7.17 All stranded wiring in oil-immersed equipment shall be treated as follows to prevent syphoning:

(a) Strip insulation from all wiring immersed in oil.
(b) Tin stranded conductor to make it equivalent of solid.
(c) Insert oil and moisture resistant plastic sleeve over tinned conductor.

7.18 All wiring inside enclosures shall be neatly tied and bundled or supported by plastic conductor racks such as panduit.

8,0 DRAWINGS

8.1 No wiring shall be done on equipment before wiring diagrams have been reviewed by Buyer and authorization to proceed is granted. Wiring diagrams shall use standard symbols per ANSI Standard Y32.2, latest edition.

8.2 Complete detail drawings, including installation and operating instructions, physical arrangement, location, wiring, termination, material, identification, rating, control, instrumentation system, settings, etc, shall be supplied in accordance with the purchase order documents.

9.0 TESTS

9.1 All electrical equipment shall be shop-tested for operation and accuracy prior to shipment.

9.2 The purchase order will indicate if tests are to be witnessed by the customer.

1.0 SCOPE

This specification covers materials and assembly of thermocouple extension wire and electronic signal wire.

2.0 CODES AND STANDARDS

2.1 Thermocouple extension wire shall be manufactured in accordance with NBS Standardized Materials for thermocouple extension wire and shall be calibrated to ANSI Standard C-96-1 for standard limits of error.

2.2 Extension wire color coding shall comply with ANSI-C96-1. In multiple pair cables each pair shall also be number-identified.

2.3 Electronic signal wire shall be copper and shall conform to applicable ASTM and ANSI specifications.

3.0 THERMOCOUPLE EXTENSION WIRE - STANDARD TEMPERATURE

3.1 Duplex

3.1.1 Non-Shielded

a) Individual conductors shall be 16 gauge, solid alloy wire, insulated with 15 mils of 105°C extruded PVC.

b) The pair shall be twisted together, the lay of the twist to be no greater than two inches.

c) The overall jacket shall be 20 mils of 80°C extruded PVC.

3.1.2 Shielded

The shielded duplex shall be as described in Section 3.1.1, except:

a) A bare 18 gauge, solid copper drain wire shall be added to the pair and the triplex bundle shall be protected with an insulated electrostatic shield, consisting of aluminum x mylar tape, helically applied with a 25 percent overlap. The aluminum shall be in contact with the copper drain wire.

3.1.3 Armored

The thermocouple extension wire shall be as described in Sections 3.1.1 and 3.1.2 except an interlocked steel armor shall be added before the overall jacket is applied.

3.2 Multiple Pair

3.2.1 Cable Shield Only

a) Individual conductors shall be 20 gauge, solid alloy wire, insulated with 15 mils of 105°C extruded PVC.

b) The conductors of each pair shall be twisted together, the lay of the twist to be 1-1/2 to 2-1/2 inches, staggered.

c) A bare 20 gauge solid copper drain wire shall be added to the cable and the entire bundle shall be protected with an insulated electrostatic shield, consisting of an aluminum x mylar tape, helically applied with a 25 percent overlap. The aluminum shall be in contact with the copper drain wire.

d) An overall jacket of 80°C extruded PVC shall be applied over the entire assembly. PVC thickness shall be: 45 mils for 4 to 8 pairs; 60 mils for 10 to 24 pairs, and 80 mils for 36 to 48 pairs.

3.2.2 Pair and Cable Shields

a) Individual conductors will be as described in Section 3.2.1 (a).

b) The conductors of each pair shall be twisted together, the lay of the twist to be 1-1/2 inches.

c) A bare 20 gauge, solid copper drain wire shall be added to each pair and the triplex bundle shall be protected with an insulated electrostatic shield consisting of aluminum x mylar tape, helically applied with a 25 percent overlap. The aluminum shall be in contact with the copper drain wire. A separate overlay of 2 mil mylar tape shall be applied to each shielded pair.

d) The cable shielding shall be as described in Section 3.2.1 (c).

e) The overall jacket shall be as described in Section 3.2.1 (d).

3.2.3 Armored

The thermocouple extension wire shall be as described in Section 3.2.1 and 3.2.2 except an interlocked steel armor shall be added before the overall jacket is applied.

4.0 THERMOCOUPLE EXTENSION WIRE - HIGH TEMPERATURE

4.1 Individual conductors shall be 16 gauge, solid alloy wire, insulated with 12 mils of extruded FEP Teflon, covered with 8 mils of carded asbestos, silicone impregnated.

4.2 The individual conductors shall be twisted together, the lay of the twist to be no greater than two inches.

4.3 The electrostatic shield, if specified, shall consist of 34 gauge tinned copper wire served with a 90 percent coverage.

4.4 The overall jacket shall be five mils of braided fiberlass, silicone impregnated. If pair is to be shielded, the overall jacket shall be ten mils of extruded FEP Teflon.

5.0 ELECTRONIC SIGNAL WIRE

5.1 Duplex

5.1.1 Non-Shielded

The construction shall be as described in Section 3.1.1, except individual conductors shall be 16 gauge, solid copper, and the insulation shall be 90°C extruded PVC.

5.1.2 Shielded

The construction shall be as described in Section 3.1.2, except individual conductors shall be 16 gauge, solid copper, with 90°C extruded PVC insulation and the drain wire shall be 18 gauge, solid copper.

5.1.3 Armored

The electronic signal wire shall be as described in Sections 5.1.1 and 5.2.2 except an interlocked steel armor shall be added before the overall jacket is applied.

5.2 Multiple Pair

5.2.1 Cable Shield Only

Construction shall be as described in Section 3.2.1, except conductors and drain wire shall be 20 gauge, solid copper, and insulation shall be 90°C extruded PVC.

5.2.2 Pair and Cable Shielded

Construction shall be as described in Section 3.2.2, except conductors and drain wire shall be 20 gauge, solid copper, and insulation shall be 90°C extruded PVC.

5.2.3 Armored

The electronic signal wire shall be as described in Sections 5.1.1 and 5.2.2 except an interlocked steel armor shall be added before the overall jacket is applied.

5.3 Tests

5.3.1 Prior to assembly, each individual conductor shall be subjected to and pass a spark test of 6,000 volts AC to verify insulation.

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5.3.2 Prior to shipment, each length of finished product shall be checked for continuity of each conductor and shield. Each completed length shall be subjected to a 3,000 volt DC dielectric test, conductor to conductor, and conductor to shield.

FORM II-293 7/66

1.0 SCOPE

This specification covers the furnishing of design calculations, drawings, details, installation procedures, and materials for a complete electrical heat tracing system for piping, valves, vessels, instruments, and equipment to provide freeze protection and/or temperature maintenance within specified limits.

2.0 GENERAL

The design, drawings, and materials supplied are subject to all conditions and instructions in the purchase order. The Seller shall be responsible for complying with all requirements. In the event of conflict between the documents, Seller shall notify Buyer and obtain resolution of the conflict from Buyer.

3.0 CODES AND STANDARDS

All design and materials supplied for electrical heat tracing systems shall comply with the applicable sections of the latest revisions of the following codes and standards:

National Electrical Code	NEC
National Electrical Manufacturers Association	NEMA
Underwriters Laboratories	UL
Institute of Electrical and Electronic Engineers	IEEE
Insulated Power Cable Engineers Association	IPCEA
American National Standards Institute	ANSI

In addition, the design and materials supplied shall be in compliance with any state and local codes in effect in the area where the material is to be installed.

4.0 OCCUPATIONAL SAFETY AND HEALTH STANDARDS

4.1 Electrical equipment, materials, assemblies and subassemblies shall conform to the requirements of the Occupational Safety and Health Standards (OSHA), Subpart S-Electrical of the Code of the Federal Regulations, Title 29, Chapter XVIII, Part 1910, and shall be certified, listed, or labeled by a nationally recognized testing laboratory accepted by OSHA, such as the Underwriters Laboratories or Factory Mutual Engineering Corporation.

4.2 Any assemblies or materials supplied for electrical heat tracing systems that fall within the OSHA definition of "custom-made equipment," shall be factory tested in accordance with OSHA requirements

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Rev	Date	Description			
3					
2		ATTACHED FORMS REFERENCED			
1	7/22/80	ISSUE FOR PHASE ZERO	CRP	HS	
0	6/80	ISSUED FOR APPROVAL	CRP	HS	

BECHTEL

ASFI THE BRECKENRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
GENERAL SPECIFICATION
ELECTRIC HEAT TRACING

JOB NO. 14222
SPECIFICATION 14222-P-7 REV 2

for this type of equipment, Seller shall submit certified test reports to Buyer.

5.0 SERVICE CONDITIONS

5.1 All equipment and materials shall be suitable for operation in climatic and meteorological conditions given in the basic design data sheet, Specification 14222-A-3, "Basic Engineering Data."

5.2 Where corrosive atmospheres are specified in the material requisition or its attachments, materials supplied shall be selected to provide the greatest resistance to the corrosive agent.

6.0 HAZARDOUS AREAS

All materials supplied and the installation design shall meet all NEC requirements for the electrical classification of the area in which the installation is to be made.

7.0 SCOPE OF SELLER'S WORK

7.1 Seller Shall Supply

7.1.1 All materials and equipment required for a complete electrical heat tracing system. These shall include but not be limited to heaters, cold junctions, thermostats, distribution panels, step-down transformers, contactors, and alarm panels. Distribution panels, step-down transformers, contactors, and alarm panels shall be grouped and installed in free standing cubicles or racks as specified in the material requisition. Buyer will provide power feeder to the cubicles and racks.

7.1.2 All drawings, details, and installation instructions necessary for field installation by Buyer. The drawings shall include at least the following:

7.1.2.1 A complete set of isometric drawings showing pipe numbers, heater and its number, thermostats, contactors, etc, for all lines for which Buyer supplies piping isometrics. Cross-reference to installation details shall be shown on the Seller's isometric drawings.

7.1.2.2 A complete set of plan drawings showing the locations of all cold junctions, thermostats, distribution panels, contactors, alarm panels, etc, and the conduit and wiring required to interconnect all heaters and other equipment in the system.

Seller shall show conduit sizes and quantity and size of wires contained therein. Seller shall show heaters on these plan drawings for those lines including field run pipe for which Buyer did not supply isometrics.

Cross-reference to installation details shall be shown for these heaters. The plan drawings shall show the location and size of power services that the Buyer is to supply. Heaters for instruments and equipment also shall be shown on these plan drawings.

7.1.2.3 All details and instructions necessary for Buyer to perform field installation.

7.1.2.4 All field supervision and checkout assistance on a per diem basis as called for in the material requisition.

7.2 Seller shall perform all design calculations necessary to properly size heaters, power feeders to heaters, distribution panels, contactors, and stepdown transformers and shall submit to Buyer one reproducible copy of the calculations.

7.3 Seller shall verify diameter and length at jobsite of all field run pipe requiring electrical tracing before fabricating heater elements. Field run pipe is any pipe for which exact dimensions are not shown on piping drawings.

8.0 INFORMATION SUPPLIED BY BUYER

8.1 It is the Buyer's intention to supply all necessary information and data to Seller. It is the Seller's responsibility to inform the Buyer of any omissions or conflicts in the information and data supplied.

8.2 The Buyer will supply the following drawings to the Seller:

8.2.1 Plot plans showing the physical arrangement and location of equipment pipeways.

8.2.2 Electrical Area Classification drawing.

8.2.3 Piping isometric drawings for those electrically traced lines for which Buyer normally prepares such drawings.

8.2.4 Piping plan drawings or routing drawings showing lines for which Buyer normally does not prepare isometric drawings.

8.2.5 Equipment drawings for vessels and other equipment that require electrical heat tracing.

8.2.6 Installation details for instruments that require electrical heat tracing.

8.3 Buyer will supply the following data to Seller:

△2 8.3.1 Index of electrical traced lines (Form 808), showing line number, size, whether freeze protection or temperature maintenance is required, insulation thickness, and holding temperature. Seller shall complete all information requested under "Heat Tracing Reference Data" on Form 809.

8.3.2 Index of electrical traced instruments.

8.3.3 Index of electrical traced equipment.

8.3.4 Ambient temperature on which electrical heat tracing design is to be based.

8.3.5 Supply voltages available for electrical heat tracing system.

8.3.6 Preferred routing of conduits.

8.4 Buyer will supply the following materials:

8.4.1 All conduit, conduit fittings and wire required to connect the electrical heaters to their power source and to interconnect all thermostats and other control devices and contactors.

8.4.2 All conduit, conduit fittings and wire to provide electrical power to the system at the distribution points specified by Seller.

9.0 EQUIPMENT AND MATERIALS

9.1 Electrical Heaters

Seller shall determine the size and length of each heater cable. Cables shall be fabricated to length and shall have cold junction installed on them in the factory. Each cable shall have a stainless steel tag connected to the cold section with stainless steel wire. The tag shall show the heater number and circuit number to which it is to be connected.

9.2 Thermostats

Thermostats shall be supplied to provide "on-off" control of the tracing system. The number supplied and the location of the temperature sensing bulbs shall be based on providing the best possible temperature control for the electrically traced lines. Thermostats shall be located so as to be readily accessible. Each thermostat shall be marked with the heater numbers that it controls. Thermostats shall be adjustable and shall be provided with enclosures suitable for the area in which they are to be installed.

9.3 Distribution Panelboards

Seller shall provide distribution panelboards circuited to provide power to the individual heater element. Panelboards shall be the circuit breaker type with trip ratings sized to protect the heater elements. Panelboard enclosures shall be suitable for the area in which they are to be installed.

9.4 Step-down Transformers

Seller shall supply all step-down transformers required for the electrical heat tracing system. Transformers shall be enclosed, dry type, compound filled, suitable for the area in which they are to be installed.

9.5 Contactors

Where several heaters on different circuits are controlled by the same thermostat, contactors may be installed to accomplish the on-off control. Contactors shall be heavy-duty industrial type, of adequate rating with enclosures suitable for the area in which they are to be installed.

9.6 Control Centers and Switchracks

In areas outside the process units, where heavy concentrations of electrical tracing load occur, heat tracers, if adequately rated may be operated at the service supply voltage as specified in the material requisition. For these cases, control centers or switch-racks as specified in the purchase order shall be furnished to distribute power to the electrical tracing and to provide the on-off control function demanded by the termostats.

9.7 Alarm Panels

Alarm panels shall be provided with indicating lights. An indicating light shall be provided for each heater. The indicating light shall light when the temperature controller is calling for heat and there is no current flow in the heater. Each panel shall be provided with a test button for checking operation of the lights. Each panel also will have a relay contact that will open if one or more of the indicating lights is illuminated; the relay contact will be used to actuate the Seller's remote alarm. Each indicating light shall be identified by a nameplate specifying the heater number and circuit number to which it is connected.

10.0 DRAWING APPROVALS

The Seller shall submit design drawings and details as called for on Form 15-A to the Buyer for approval before fabrication of any material or equipment supplied under the purchase order. Receipt of approved drawings by the Seller shall constitute a release for fabrication of material covered on the drawings unless otherwise noted.

LINE, EQUIPMENT OR INSTRUMENT NUMBER	LINE SIZE (INS)	INSULATION THICKNESS (INS)	MAX. POSSIBLE LINE TEMP. (°F)	NORMAL OPER. PROCESS TEMP. (°F)	HOLDING TEMP. (S) °F MIN/MAX IF APPLICABLE	P&ID REFERENCE & GRID REFERENCE	PROCESS FLUID	REFERENCE DRAWING NUMBERS ISOMETRIC, ORTHOGRAPHIC, INSTRUMENT, DETAIL, VENDOR PRINT NUMBER, ETC. (IDENTIFY TYPE OF DRAWING, I. E. VP, ISO, ORTHO.)	NOTE REF. NUMBERS

TYPE OF INSULATION:

AMBIENT DESIGN TEMPERATURES: °F LOW, °F HIGH

NOTES

NO.	DATE	REVISION	CHK'D.	ENGR.	PROJ.
0					

BECHTEL

ELECTRIC HEAT TRACING INDEX

JOB NO.	DWG. NO.	SHT.	REV.
		OF	

R & C FORM 808 3/81

LINE EQUIPMENT OR INSTRUMENT NUMBER	TEMP. DIFF. (ΔT) (°F)	HEAT LOSS		HEATER TYPE	HEATER OUTPUT		RATIO/NO. OF HTRS. REQ'D.	VOLTAGE (VOLTS)	HEATER NUMBER	HEATER LENGTH (FT)						AMPS/FT.	TOTAL CURRENT (AMPS)	CONT. WATTS (WATTS)	TOTAL LOOP RESISTANCE (OHMS) (1)	CONTROLLER		POWER POINT LOCATION DRAWING NO.	PANEL DATA		E.H.T. DWG. NO.
		WATTS/FT.	OHMS/FT.		WATTS/FT.	OHMS/FT. (1)				PIPES	VALVES	PIPE SUPPORTS		ALLOWANCE FACTOR	TOTAL	CONT. / START	CONT. / START			TYPE (2)	TEMP. SET POINTS (3) (°F)		PANEL SCHED. DWG. NO.	PANEL & CIRCUIT NUMBER	

NOTES:

(1) HEATER OUTPUT – OHMS/FT. AND TOTAL LOOP RESISTANCE: CALCULATION BASED ON ELEMENT RESISTANCE VALUE AT ______________ °C.

(2) CONTROLLER TYPE: AS – AMBIENT SENSING
LS – LINE SENSING
SUFFIX (C) – CONTRACTOR

(3) CONTROLLER TEMP. SET POINT(S): USE SUFFIX B TO INDICATE BACKUP TEMPERATURE CONTROLLER SET POINT IF REQUIRED.

R & C FORM 809 3/81

NO	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV	ENGR	PROJ ENGR	APPD
△								
△								
△								

SCALE | DESIGNED | DRAWN | CHIEF ENGR

BECHTEL

ELECTRIC HEAT TRACING REFERENCE DATA

JOB NO.	DRAWING NO.	SHT.	REV.
		OF	

P.O.	REV.
M.R.	

SECTION 3 - DRAWING AND DATA REQUIREMENTS

TRANSMITTAL REQUIREMENTS	DOCUMENT DESCRIPTION	REQ'D WEEKS ARO	NO. PRINTS	NO. REPRO
OBTAIN BECHTEL REVIEW AND AUTHORIZATION TO PROCEED BEFORE FABRICATION				
TRANSMIT TO BECHTEL BEFORE DELIVERY OF MATERIAL				

1. THIS SCHEDULE OF SUPPLIER'S DRAWINGS AND DATA REQUIREMENTS SHALL BE FULFILLED BEFORE RENDERING FINAL INVOICES.

2. TRANSMIT ALL DOCUMENTS TO:
BECHTEL
P.O. BOX 2166
HOUSTON, TEXAS 77001
ATTN:

SEND COPY OF TRANSMITTAL LETTER TO
BECHTEL
P.O. BOX 2166
HOUSTON, TEXAS 77001
ATTN: JOB EXPEDITER

3. ALL DOCUMENTS MUST SHOW JOB, EQUIPMENT AND PURCHASE ORDER NUMBERS, SUPPLIER'S TITLE, AND DRAWING AND REVISION NUMBERS, ALL PREFERABLY IN THE LOWER RIGHT HAND CORNER.

4. DRAWINGS OR DATA RETURNED TO SUPPLIER FOR REVISION MUST BE RE-SUBMITTED WITHIN 10 WORKING DAYS AFTER RECEIPT. RETAINING ORGINAL DRAWING NUMBER, WITH REVISION NUMBER CHANGED. CORRESPONDENCE ACCOMPANYING REVISED DRAWINGS AND DATA MUST SHOW BECHTEL VENDOR PRINT (V.P.) NUMBER.

5. ALL FINAL DRAWINGS SUBMITTED TO BECHTEL MUST BE CERTIFIED REPRODUCIBLES.

6. INSTRUCTIONS SHALL COVER ALL COMPONENTS OF THE ORDER. IF A SUPPLIER IS FURNISHING SIMILAR EQUIPMENT IN SEVERAL ORDERS FOR THE PROJECT, A COMPOSITE INSTRUCTION MANUAL SHALL BE PROVIDED.

7. RECOMMENDED SPARES MUST BE SPECIFIC LIST IN ACCORDANCE WITH REQUIREMENTS OF FORM 15 S.P. ATTACHED. (IF APPLICABLE)

ITEM NO. ______________________

1.0 GENERAL

1.1 This specification covers the furnishing and delivery of factory assembled and wired electrical equipment rooms in complete accordance with the material requisition and purchase order.

1.2 The work is subject to all conditions and instructions in the documents listed as attachments to the requisition. The Seller shall be responsible for complying with and shall be governed by all the requirements thereunder. In case of conflict between documents, the more stringent requirements shall apply.

2.0 CODES AND STANDARDS

2.1 Electrical rooms and all equipment and wiring supplied therein shall be in accordance with the applicable sections of the latest revisions of the following codes and standards.

National Electrical Code	NEC
National Electrical Manufacturers Association	NEMA
Underwriters Laboratories	UL
American National Standards Institute	ANSI
American Society for Testing Materials	ASTM
Institute of Electrical and Electronic Engrs.	IEEE

2.2 Electrical equipment, material, assemblies, and sub-assemblies shall conform to the requirements of the Occupational Safety and Health Standards (OSHA), Subpart S-Electrical of the Code of the Federal Regulations, Title 29, Chapter XVIII, Part 1910, and shall be certified, listed, or labeled by a nationally recognized testing laboratory accepted by OSHA, such as the Underwriters Laboratories or Factory Mutual Engineering Corporation.

2.3 For those portions of the electrical rooms and the equipment installed therein that fall within the OSHA definition of "custom-made equipment" sufficient tests shall be made and certified test data submitted to fulfill all OSHA requirements for this type of equipment.

3.0 SERVICE CONDITIONS

The electrical rooms will operate under the climatic and meterological conditions given in Specification 14222-A-3, "Basic Engineering Data." For general design loadings and criteria refer to Specification 14222-M-1.

FORM 11-292 7-66

Rev	Date	Description	By	Chk	Appr
△					
△	10-21-81	ATTACHED FORM 15-A	RP		
△	7/22/80	ISSUED FOR PHASE ZERO	CRP	HS	
△	6/80	ISSUED FOR APPROVAL	CRP	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL SPECIFICATION
PACKAGE ELECTRICAL SUBSTATION

JOB NO. 14222
SPECIFICATION 14222-P-8 REV 2

4.0 DEFINITION OF VOLTAGE LEVELS

The following definition of voltage levels applies to this specification. The Seller must refer to the material requisition and its attachment for exact voltage levels.

Low Voltage	600 volts and less
Medium Voltage	601-5,000 volts
High Voltage	5,001 volts and higher

5.0 OUTLINE OF WORK

The Buyer will install at the jobsite completely factory assembled, wired and tested electrical rooms made of structural steel, plates, and panels. These rooms may contain high-, medium-, and low-voltage switchgear, medium- and low-voltage motor control centers, lighting and control transformers, batteries, metering and relaying instruments, alarms, control panels, and any other equipment shown on the drawings or called for in the material requisition. The electrical rooms shall be air conditioned and pressurized. The Seller of the electrical rooms will be required in some instances to install other devices, components, or instruments furnished by the Buyer.

6.0 WORK INCLUDED

6.1 Furnish all material, equipment, and the performance of all operations and incidentals necessary for designing, detailing, furnishing, fabricating, shop finish painting, and delivery of electrical rooms in accordance with this specification and the attached material requisition. Shipping sections or modules shall be completely assembled, wired, and tested at the factory. Electrical room modules and sections shall be assembled at the factory to such extent as to check the alignment.

6.2 Where specified, furnish bus duct that connects equipment installed within electrical rooms to Buyer's transformers installed adjacent to electrical equipment rooms. The Buyer will supply transformer throat details to the Seller of the electrical equipment rooms.

6.3 Provide technical assistance, if requested, during field checkout on a per diem and travel expense basis.

2 6.4 Provide instruction manuals and drawings as required on Form 15-A.

6.5 No later than two weeks after award of the purchase order for the electrical rooms, the Seller shall send to the Buyer's engineering office from which the order originated, technically qualified representatives for discussions regarding design and fabrication details of the elctrical rooms and their components and compliance with the specifications. All costs of the trip shall be to the Seller's account.

7.0 WORK NOT INCLUDED

7.1 Foundation and anchor bolts.

7.2 Installation of electrical rooms at jobsite.

7.3 Field connections to equipment wiring terminals within the rooms.

7.4 Field installation of external bus ducts.

8.0 DRAWING STANDARDS

The Seller shall use graphic symbols in accordance with the American National Standards Institute Standard ANSI Y32.2.

9.0 BUYER'S DRAWINGS

Refer to drawings, as listed under attachments in the material requisition, for single lines and preferred arrangements of main equipment contained in the electrical rooms. The Seller shall propose his own physical arrangement of principal equipment groups other than the main incoming switchgear groups whose location is determined by the outdoor transformers.

10.0 INFORMATION WITH PROPOSAL

The Bidder shall submit drawings and data as requested in the Form of Proposal, in the instructions to Bidders, and in this specification.

The following drawings and data shall be submitted with the bid:

a. Proposed arrangement of components within an electrical room based on Bidder's standard equipment while allowing 30 percent empty space for future use.

b. Front views of all switchgear.

c. An isometric drawing of a typical room module.

d. A complete list of equipment the Seller intends to supply and the manufacturer thereof.

e. Dimensions and weights of equipment.

11.0 DESIGN AND CONSTRUCTION OF ELECTRICAL ROOMS

11.1 Structure

Electrical rooms shall have overall inside width of 10 to 14 feet. The width shall be consistent with the minimum requirements of the equipment to be mounted in the rooms, and the aisle space needed for breaker or starter withdrawal. Height shall be 12'-6" minimum and shall be such as to provide adequate wiring space on top of the switchgear and motor control centers. The total length shall be as shown on the drawings. Electrical room sections or modules shall be standardized on a maximum practical length. The base shall be made of structural steel members and shall withstand the live and dead weight of all equipment when mounted on pier-type foundations. Foundation piers shall be at 10-foot maximum centerline spacings unless otherwise specified. Particular attention must be placed on floor bracing where drawout breakers or starters may be removed from the cubicles or from the electrical rooms. Floor shall be made of quarter-inch, minimum, steel plate. Sidewalls and roof shall be of 2-inch insulated aluminum or steel panel-type sandwich construction. Doors shall be of #12 gauge steel, fire door construction type, with integral frame and complete with interior panic bar, hinges, and locks. All nuts and bolts used in the structure shall be stainless steel.

Electrical room sections, doors, and openings shall be gasketed for weather protection and for supporting an inside positive pressure of 1/4-inch water column. Lifting and jacking facilities shall be provided for each shipping section or module. Lifting facilities, in the form of spreader bars or equivalent, shall be arranged for lifting by a single crane.

11.2 Painting

All steel members including steel siding shall be painted with one coat of inorganic zinc primer and two coats of a normal build, white vinyl paint.

Floors shall have a non-skid vinyl finish.

Equipment and electrical room components shall have manufacturer's standard exterior finish.

11.3 Electrical Room Facilities

11.3.1 Electrical rooms shall be provided with a closed-loop heating and air conditioning system for the control of temperature, humidity, and cleanliness of the air within the electrical rooms. Inside design conditions shall be as follows:

Summer - 80-90°F - 45%-55% relative humidity
Winter - 50-60°F

Outside design conditions are given in Specification 14222-A-3, "Basic Engineering Data."

For the design of the air conditioning system, the Seller shall consider the amount of heat generated by the various equipment mounted inside the electrical rooms while operating at full nameplate rating. The air conditioning failure alarm contact shall be wired to the electrical room annunciator.

Power for the heating and air conditioning equipment shall be obtained from the low-voltage motor control centers. Provisions shall be made to accept Buyer's temporary power supply to operate this equipment prior to electrical room commissioning.

11.3.2 Electrical rooms shall be pressurized with at least 1/4-inch water column. On loss of pressure, an alarm at the electrical room annunciator shall indicate that condition. This alarm shall have an adjustable time delay.

11.3.3 A complete interior fluorescent lighting system, 120/240V, single-phase, shall be provided. It shall be controlled by three-way switches located near the doors. The lighting level shall be minimum 25-foot candles. Duplex receptacles, 120V, two-pole, three-wire, shall be installed in convenient locations inside the rooms.

Outdoor lighting fixtures shall be installed above each access door, and as requested on the material requisition. They shall be 120V, 175W, mercury vapor, weather protected, and controlled by a common photoelectric cell. The same photo cell shall operate the outdoor area lighting system supplied from the electrical room through lighting contactors.

11.3.4 If specified, bus duct from transformers shall enter the electrical room through the side wall nearest to the transformers at a height which will allow the shortest bus duct run with the minimum number of bends.

11.3.5 Buyer's conduits and/or cables will enter the electrical rooms through the sides, ends, and/or bottom as called for in the material requisition and its attachments.

Removable #12 gauge gasketed steel plates, suitable for field drilling of conduit and cable entrances, shall be provided in the floor under the cable entrance sections of all floor-mounted equipment. In addition, removable plates as described above, shall be provided on side and end walls of electrical rooms if called for in the material requisitions or its attachments. Separate plates shall be provided for each cubicle of switchgear and medium voltage starters and for each two vertical sections of low-voltage motor control centers.

Interconnecting wiring between equipment installed in electrical rooms shall be installed in rigid conduit or surface metal raceway. Cable tray shall not be used unless specifically called for in the material requisition or its attachments.

Seller shall install a surface metal raceway system for Buyer's wiring from low voltage motor control centers to conduit and/or cable entrances in walls of electrical room.

The space between the top of a motor control center or switchgear and the roof of the room shall be enclosed with removable plates extending along the front of the equipment up to the roof. Openings shall be provided for penetrations of raceways and conduit crossing the aisle. The space behind the plates shall contain the raceway and conduit system for interconnecting wiring and the raceway system for Buyer's low-voltage wiring.

11.3.6 A bare 250MCM stranded copper ground cable shall be installed around the perimeter of the electrical room. Each equipment ground bus shall have two #4/0 AWG connections to this ground cable. The electrical room structure shall also be connected to this ground cable. Provision shall be made at two diagonally opposite corners of the electrical room for Buyer's connection to the ground cable.

Where modules or sections require a split of the ground cable, suitable pressure-type connectors shall be supplied by Seller for field assembly of the ground bus cable.

11.3.7 All internal wiring within an electrical room shall be furnished and installed at the factory. Interconnecting wires and cables between room modules shipped separately shall be disconnected at one end, tagged, and protected from damage during shipment.

All motor starters, breakers, switches, or panels shall be completely wired. All control and relaying circuits requiring field connections shall be wired to terminal blocks. Wiring for control circuits within an electrical room component shall be single conductor stranded copper having heat resistant type insulation. Conductors shall be neatly trained and grouped together using wire cleats or straps supported along equipment wireways.

All control terminal blocks shall have pressure-type screw terminals. A minimum of 20 percent spare terminals shall be provided on every terminal block.

Power cables between low-voltage switchgear and motor control centers shall be as shown on the single-line drawings. They shall be Type XHHW or THW unless otherwise specified.

11.3.8 Nameplates shall be provided for each piece of equipment or device mounted inside the electrical rooms. Nameplates shall be lamicoid engraved on black face to white core.

The size of the nameplate, the height, and spacing of the lettering shall be Seller's standard but not less than 1/4" high. The description of the engraving will be given to the equipment Seller with the purchase order.

12.0 MAIN EQUIPMENT SPECIFICATIONS

For detailed design and construction specifications for equipment such as switchgear, motor control, etc, to be installed in electrical room, see the material requisition and its attachments.

13.0 MISCELLANEOUS EQUIPMENT SPECIFICATIONS

13.1 Bus Ducts for High-, Medium-, and Low-Voltage Services

When specified, connections between the switchgear and outdoor power transformers shall be made with bus ducts and shall be supplied by the Seller. Bus ducts shall be suitable for the current ratings indicated in the drawings. The conductors are to be copper or aluminum bars and all joints are to be electrolytically silver plated. Cable bus shall not be used.

The metal enclosed bus shall be of non-segregated, three-phase, non-ventilated construction, vermin-proof type with suitable interior non-ferrous fire barriers at the penetration through the electrical room wall.

Bus duct shall be suitable for outdoor service and shall be protected with space heaters supplied from the switchgear control power distribution panel. These heaters shall prevent condensation when the transformers are out of service. Suitable removable covers shall be provided at appropriate locations to permit installation and maintenance.

Each metal enclosed bus shall have a suitable clamp-type lug for grounding with 4/0 AWG copper conductor, mounted at each end of the housing.

The metal enclosed bus bracing shall match dynamically and thermally the momentary rating of the switchgear it supplies. Each metal enclosed bus shall be supplied with flanges at the electrical room wall entrances. They shall seal the entrances and shall be suitable for installation after the bus housing has been put in place. The design of the bus ducts and terminal connectors shall be such that two inches of relative movement between the room and the transformer, in all three axes, is possible without damage to the transformer, bus duct, or switchgear. Flexible connectors for this purpose shall be used. Transformer low-voltage throat location and dimensions will be given to the electrical room Seller with the purchase order.

13.2 Control Power Panels and Supply

Each double ended substation shall be provided with a control power distribution panel fed from either one of two control power transformers by means of an automatic throwover device.

Distribution panel shall be single-phase, three-wire 120/240V. At least 30 percent spare breakers shall be provided.

Control power transformers shall be dry type and of sufficient capacity with primary fuses and secondary circuit breaker. Secondary winding shall be 120/240V.

Unless noted on the material requisition, the above equipment will be used only for the control and accessory needs including lighting, of each double-ended substation and its switchgear.

13.3 Batteries and Battery Charger

Tripping and unlatch-to-close power for all switchgear shall be as shown on material requisition and shall be supplied from individual batteries located in a special compartment of each switchgear assembly.

Batteries shall be alkali type. Battery capacity shall permit at least one simultaneous tripping of all breakers (including four future), followed by a sequential reclosure of all breakers.

Batteries shall be furnished complete with battery racks, intercell connectors and all other standard accessories necessary for satisfactory operation. Each battery shall be provided with a constant voltage full-wave rectifier type battery charger. Silicon-controlled rectifiers shall be employed as power control elements. Sensing, control, and firing modules shall be of the plug-in type. Charger shall be connected to the single-phase, switchgear control panel.

The following accessories shall be mounted on each charger:

One dc output voltmeter
One dc output ammeter
One ac input circuit breaker
One dc output circuit breaker
One ac power "on" pilot light
One ac Failure alarm relay
One dc low-voltage alarm relay
One float and equalize switch
One equalize pilot light
Two ground detector lights
One ground detector switch

13.4 Annunciators and Alarms

When specified, each electrical room shall be provided with a wall-mounted modular annunciator panel located within sight of the door. Annunciator shall operate on 120V ac.

Alarm signals will originate from the conditions indicated in the drawings. Each annunciator shall have a "first-out" feature and shall transmit a common alarm to a master annunciator remotely located.

The annunciators shall be furnished complete with an exterior alarm horn located on top of the room, local acknowledge, reset, and test pushbuttons. Annunciators shall be of a quality comparable to Scam "Series 70."

The sequence of operation of an annunciator shall be as follows:

Condition	Reset	Acknowledge	Test	Audible Alarm Outside Room	Local and Remote Lamp
On-Normal	Off	Off	Off	Off	Off
Off-Normal	Off	Off	Off	On	Flashing
Off-Normal	Off	On	Off	Off	Steady
On-Normal	Off	Off	Off	Off	Steady
On-Normal	On	Off	Off	Off	Off
Test	Off	Off	On	Off	All Lamps Steady

Buyer reserves the right to determine the annunciator supplier to match annunciators used elsewhere in the plant.

13.5 Protective Relays

All protective relays indicated in the drawings shall be provided by Seller.

13.6 Instruments

Indicating ammeters, voltmeters, and wattmeters shall be four-inch size with expanded scale and taut-wire suspension. All instruments shall be flush or semiflush mounted.

13.7 Test Terminals

Current and potential circuits shall be provided with test blocks for connection of test or metering equipment.

13.8 Communication Facilities

All communication facilities within the electrical equipment rooms will be supplied by the Buyer. Seller of electrical rooms shall accommodate the Buyer's needs for space during the course of detail design.

13.9 Accessories and Tools

The Seller shall furnish for each electrical room one complete set of accessories and special tools other than those normally available for use in assembly, repair, and maintenance of the switchgear and components of the electrical room.

The accessories shall include, but shall not be limited to, the following:

4.16KV breaker manual closing device and insertion mechanism operating handle. (one set for each electrical room)

Test plugs for drawout meters and relays. (one set only)

Breaker and starter removal devices or tools.

High- and medium-voltage breaker external test control boxes.	One set for each electrical room including lifting device, when required.

In addition to the above, Seller shall furnish two test and calibration kits for the low voltage switchgear static trip devices, when such devices are used.

13.10 Ground-Fault Protection

Ground sensor current transformers and the corresponding solid state drawout type ground relays shall be installed in the equipment as shown in the one-line diagrams. Control power for the ground relays shall be 48V or 125V dc in the medium- and low-voltage switchgear, and 240V ac at the medium-voltage starters. Vendor shall supply a completely coordinated high-resistance ground protection and detection system based on ground sensing CTs and relays. For the 480V system, a portable ground detection device shall be provided for individualizing a MCC feeder ground fault.

14 TESTS

In addition to the test required under Sections 2.2 and 6.1, all equipment shall be tested for proper operation in Seller's plant. These tests will be witnessed by the Buyer.

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M.R.	

SECTION 3 - DRAWING AND DATA REQUIREMENTS

TRANSMITTAL REQUIREMENTS	DOCUMENT DESCRIPTION	REQ'D WEEKS ARO	NO. PRINTS	NO. REPRO
OBTAIN BECHTEL REVIEW AND AUTHORIZATION TO PROCEED BEFORE FABRICATION				
TRANSMIT TO BECHTEL BEFORE DELIVERY OF MATERIAL				

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2. TRANSMIT ALL DOCUMENTS TO:
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   P.O. BOX 2166
   HOUSTON, TEXAS 77001
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5. ALL FINAL DRAWINGS SUBMITTED TO BECHTEL MUST BE CERTIFIED REPRODUCIBLES.

6. INSTRUCTIONS SHALL COVER ALL COMPONENTS OF THE ORDER. IF A SUPPLIER IS FURNISHING SIMILAR EQUIPMENT ON SEVERAL ORDERS FOR THE PROJECT, A COMPOSITE INSTRUCTION MANUAL SHALL BE PROVIDED.

7. RECOMMENDED SPARES MUST BE SPECIFIC LIST IN ACCORDANCE WITH REQUIREMENTS OF FORM 15 S.P. ATTACHED. (IF APPLICABLE)

ITEM NO. ______________________

I. The project telecommunications and associated facilities shall be classified and defined in three separate categories. These are as follows:

- Pioneer Development
- Construction
- Plant Operations

Pioneer Development requirements will identify those telecommunications services and facilities required to support pioneer operations at the plant site office or nearby temporary offices leading up to kick-off of the construction phase.

The construction phase will specify telecommunications services and facilities required to support all aspects of the construction effort throughout the life of the project. Construction telecommunications systems shall be time-phased with relation to the work being performed so that optimum utilization of all sub-systems can be efficiently realized.

The plant operational phase shall set forth and define all telecommunications sub-systems required by the plant operator to effectively operate and maintain the overall plant complex.

During the course of the,preliminary engineering phase, a close evaluation will be made of those telecommunications sub-systems required for the construction phase and their application, expansion,and convertability to the plant operational phase. This will ensure the engineering uniformity of equipment for conversion and integration into the operational phase and will prevent duplications in all cases.

A typical list of telecommunications systems which shall be considered during the preliminary engineering phase and their association to the various project activities are set forth below:

A. <u>PIONEER DEVELOPMENT</u>

1. Telephone services available from local telephone company
2. Local area mobile radio service
3. Telex service
4. Facsimile terminal
5. Computer remote access terminal.

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△					
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△	9/26/80	ISSUED FOR PHASE ZERO	ELG	HS	
△	9/19/80	ISSUED FOR APPROVAL	ELG	HS	

ASFI	THE BRECKINRIDGE PROJECT	JOB NO. 14222
	U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717	SPECIFICATION / REV
	GENERAL SPECIFICATION TELECOMMUNICATIONS	14222-P-9 / 1

B. CONSTRUCTION SUPPORT

1. Job site direct dial telephone switching system (PABX):

   Located in the main construction office, to be used for all telephone traffic at the job site in all construction offices as required. The PABX will also switch construction computer data traffic (such as the R&C IBM job site Sys. 34 Information Services Network) telex, and facsimile traffic.

2. Outside cable plant:

   Includes all direct buried telephone cable, computer cable connecting the job site System 34 CPU with all work stations, cross-connect pedestals, manholes, handholes, pole lines, grounding systems, and all other telecommunications facilites installed outside buildings at the job site.

3. Land mobile radio system:

   Includes radio base station in the main construction office, mobile radios, hand held portables, cross-connect for access into the PABX network as may be required for all job mobile radio services.

4. Land mobile radio telephone system:

   Mobile radio telephone typically GE MASTR II IMTS, Motorola PULSOR IMTS, or similar units for key job site personnel.

5. Radio paging system:

   Radio base station, pocket pager units with single and multiple unit battery chargers, for calling selected personnel in the job site area.

6. Emergency medical system:

   Ambulance installed and first aid unit installed life sign telemetering systems for land mobile radio transmission and telephone channel transmission.

7. Computer data terminal circuits for 1200/2400/4800 baud rates:

   Computer data channel for R&C Information Services System 34 or System 38 networks.

8. Telex terminal:

   For all job site telex traffic.

9. Facimile terminal:

   For all job site facimile service.

10. Security telecommunication channels:

Delicated telephone channels or other wire line channels for security status at key points, alarm signals, and controlled remote gate access as required.

C. PERMANENT PLANT OPERATIONS

1. Direct dial telephone system with PABX:

Permanent installation for direct dial telephone circuits in various facilities such as:

- Administration building offices
- Laboratory
- Fire station
- First aid unit
- Security office
- Central control room
- Area control rooms
- Operating equipment rooms
- Tank farm
- Main sub station
- Cooling Tower
- Flare areas
- Utility plant
- Process areas
- Storage receiving and shipping areas
- Maintenance shop
- Warehouse
- Cafeteria facilities
- Change house
- Channels for computer data transmission
- Channels for facimile and telex service
- Delicated channels for security status points
- Security gate houses

2. Mobile radio telephone system:

(same equipments and system as for construction)

3. Maritime mobile radio:

For radio traffic with shipboard radios aboard river tug boats and associated barge trains.

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4. Land mobile radio services:

Radio base station with vehicle mounted radios and hand held portables for:

- Plant operations and maintenace
- Fire and safety
- Security
- Emergency medical system
- Railroad operations

5. Radio paging system:

(same equipment and system as for construction)

6. Telex and facimile service:

(same equipment and system as for construction)

7. Administration Teleconferencing system:

Equipment such as speaker telephone sets or custom teleconferencing equipment for teleconference needs as required.

8. Security Channels:

Telephone channels, dedicated wire lines, for security status and alarm at selected security points with same equipment and systems as used for construction.

9. Intra-plant page party system:

Multichannel page party system for plant operations in all control rooms, operating equipment rooms, storage shipping and receiving areas, flare areas, process areas, and sub station.

10. Outside Cable Plant:

(same equipment and systems as for construction)

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Concrete—Q

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Rev	Date	Description			
	9/23/80	ISSUED FOR PHASE ZERO	FB	HS	ZBT
0	9/8/80	ISSUED FOR APPROVAL	FB	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
PROJECT SPECIFICATONS
FOUNDATIONS

JOB NO. 14222
SPECIFICATION 14222-0-1 REV 1

1.0 SCOPE

1.1 This specifications covers the basic requirements relative to the design, details, materials and construction of all foundations.

1.2 In case of conflict between the requirements of this specification and the drawings, the drawings shall govern.

2.0 CODES, STANDARDS AND SPECIFICATIONS

Design, materials, fabrication, and erection of the structures as a whole, and all structural elements and connections thereof, shall conform to the requirements of the following codes, standards, and specifications, except as modified or otherwise specified hereinafter.

2.1 Abbreviations as used in this specification shall have the following definitions:

ACI - American Concrete Institute

ASTM - American Society for Testing and Materials

2.2 Codes and Standards

ASTM A36	Specification for Structural Steel, 1977a.
ASTM A307	Specification for Carbon Steel Externally Threaded Strandard Fastener, 1978.
ASTM A615	Deformed and Plain Billet-Steel Bars for Reinforcement, 1979.
UBC	Uniform Building Code of the International Conference of Building Officials, 1979.
ANSI A58.1	Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, 1972.
ACI 318	Standard Building Code Requirements for Reinforced Concrete, 1977.

2.3 Reference Specifications:

14222-M-1 Design Structures

14222-Q-2 Plain and Reinforced Concrete

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3.0 GENERAL

3.1 Definitions

3.1.1 Owner -Ashland Synthetic Fuels, Inc. and Airco Energy Co., Inc. or their designated representative.

3.1.2 Buyer - Bechtel or their designated representative.

3.1.3 Engineer - Owners or Buyer designated Engineering Representative.

3.2 Types of Foundations

3.2.1 Foundation types shall be determined by data developed through soils investigation.

4.0 DESIGN

4.1 General Design

4.1.1 Design shall be based on recommended allowable loadings and predicted settlements, as developed by the soils investigation.

4.1.2 Design loads and loading combinations on foundations shall be as set forth in Specification 14222-M-1, "Design of Structures".

4.1.3 Minimum stability ratios of foundations shall be as set forth in Specification 14222-M-1. In computing stability ratio, the weight of soil and pavement lying directly above any individual footing may be taken into account. Stability ratio is defined as stabilizing moment divided by overturning moment.

4.1.4 Foundations for loads of 2000 pounds or less in paved areas or on floor slabs may be made integral with the slab. Provision shall be made to distribute such loads properly.

4.2 Rotating Equipment Foundations

4.2.1 The ratio of foundation to equipment weight shall be at least 3:1 this applies to foundations for small equipment with the combined weight of the rotating parts less than 3000 lbs or pumps below 500 horse power.

These limits do not apply to compressors, these shall be assessed individually as to the necessity for dynamic analysis of the foundation. But in any case shall have a minimum foundation to equipment weight ratio of 5:1.

4.2.2 Foundations for heavy rotating equipment including, but not limited to, reciprocating and centrifugal compressors, and large pumps, shall be investigated for response to the imposed cyclic loadings and unbalanced forces and moments. Such foundations shall be analyzed by recognized dynamic methods and in accordance with the dynamic soil characteristics given in the soils data. The foundation shall be so proportioned as to assure safe, smooth, trouble-free behavior under operating conditions.

5.0 GENERAL DESIGN REQUIREMENT

5.1 Details

5.1.1 The depth of soil bearing foundations must extend to a minimum of 1'-6" below finished grade level. The bottom of foundation shall be located below the frost line to prevent frost heave.

5.1.2 The elevation of the top of grout shall be a minimum of 1'-0" above high point of paving or of finish grade.

5.1.3 In cryogenic service "permali" insulating blocks are to be used.

5.2 Anchor Bolts

5.2.1 Anchor bolts are to be galvanized in accordance with ASTM A153.

5.2.2 In all foundations, care shall be taken to provide adequate lateral support for anchor bolts in the form of adequate ties and/or appropriate distance to edge of concrete.

The minimum distance from the edge of the concrete to the centerline of the bolt shall be 3½ inches or 4 bolt diameters, whichever is greater, unless each anchor bolt is tied back with the equivalent of the 90° corner of a tie, as follows:

BOLT DIAMETER	MINIMUM SIZE OF REINFORCED BAR TIE
UP TO 1"	NO. 3
1-1/8" to 1½"	NO. 4
1-3/4" & OVER	NO. 5

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Provide 3" minimum clearance between the edge of the foundation and face of the anchor bolt sleeve.

Note: Bolts spaced less than 12 diameters with an edge distance less than 6 diameters shall have reduced shear and tension values per UBC.

Paticular attention is called to the case of piers supporting exchangers and horizontal vessels where anchor bolts are subjected to large lateral loads, such as thermal expansion. In this case, complete ties shall be used near the top of the pier to prevent spalling.

On foundations for small equipment, the requirements of this Paragraph may be ignored when it is apparent that normal treatment is adequate.

5.2.3 For column, vessel and stack foundations requiring more than 7 anchor bolts, 1¼" diameter or larger, sleeve nut type anchor bolts shall be used. For column, vessel and stack foundations requiring smaller and/or fewer anchor bolts than stated above, regular type anchor bolts, placed with a uniform projection, shall be used. (See 6.3.1 for anchor bolt standard).

5.3 Vertical Vessel Foundations

5.3.1 Generally, all foundations for vertical vessels with a skirt diameter of 6'-0" and above are to be octagonal.

When ground bearing pressures dictate the octagon size to be greater than the vessel diameter plus 3'-0", a double octagon plinth type foundation is to be used.

The minimum size of the top octagon measured across the flats is to be calculated using the skirt bolt circle diameter plus 1'-6".

5.3.2 The top of grout elevation shall be 1'-0" above high point of paving and the top of grout elevation of the top of the bottom octagon is to be a minimum of 2'-6" below high point paving.

5.4 Foundation for Horizontal Vessels and Exchangers

5.4.1 Usually horizontal vessels are to be supported at their saddle positions on independent foundations, unless economic considerations justify a combined footing.

5.4.2 Slide plates must be provided for both fixed and free ends of vessel supports.

5.5 Foundations for Piperacks

5.5.1 The minimum size of the pier in plan area is to be calculated from the plan area of the steel base plate plus 1½" projection all round.

6.0 MATERIALS

6.1 Concrete

6.1.1 All concrete materials, testing, furnishing, proportioning and construction shall be in accordance with Specification 14222-Q-2.

6.1.2 Minimum compressive strength of concrete at 28 days shall be 3000 psi, unless otherwise specified on the drawings.

6.2 Rebar

6.2.1 Reinforcing steel shall be ASTM A615, grade 60 using the allowable stresses as stated in the ACI Specifications "Standard Building Code Requirements for Reinforced Concrete".

6.3 Anchor Bolts

6.3.1 Anchor bolt material shall be ASTM 36. Anchor bolts shall be in accordance with Specification 14222-~~M~~-1, Table 1 unless otherwise detailed on the drawings.

6.4 Slide Plate

6.4.1 Slide plate material shall be ASTM 36.

7.0 CONSTRUCTION

7.1 All foundations shall be placed on undisturbed soil. Where excavations are made too deep, they shall be filled to the level of bottom of foundation with lean concrete (3 sacks per cubic yard). Earth or sand backfill compacted to 95% maximum density, in accordance with the modified AASHTO method, may be used if approved by the Engineer.

7.2 No concrete shall be placed on frozen subgrade or one that contains frozen materials. Concrete shall not be placed in standing water on subgrade or in excavations.

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7.3 In clay soils where drying shrinkage of soil may occur, foundations to be soil-supported shall be poured within 36 hours after excavation is completed. If a delay beyond this time in pouring foundation should be necessary, a lean concrete seal slab of 2 inches minimum thickness shall be poured in the bottom of the excavation immediately after excavation is completed. Top of this slab shall be at the designated elevation of bottom of foundation.

7.4 Heavy eauipmemt shall not be set sooner than 10 days after pouring of foundations.

7.5 All earth backfill shall be thoroughly compacted around foundations or other substructures. Special care shall be taken to ensure that maximum density of fill is obtained around reciprocating compressor or other equipment foundations subject to vibratory forces. Fill around foundations shall be placed in loose layers of 8" maximum thickness and each layer thoroughly consolidated by mechanical tampers to the density requirement stated on the drawings or as otherwise specified.

7.6 All anchor bolts shall be protected against corrosion and damage during construction.

7.7 Water shall be removed from sleeves around anchor bolts before grouting. Where frost damage to the concrete may occur the measures shall be taken to prevent water from collecting in the sleeves during construction.

Special care shall be taken to assure that sleeves around anchor bolts are, in all cases, completely filled with grout before grouting under base and ring plates.

7.8 Refer to Specification 14222-Q-2, Plain and Reinforced Concrete, for materials and procedures to be employed in grouting under equipment.

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Rev.	Date	Description			
1	9/23/80	ISSUED FOR PHASE ZERO		HS	
0	9/80	ISSUED FOR APPROVAL		HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
PROJECT SPECIFICATIONS
PLAIN AND REINFORCED CONCRETE

JOB NO. 14222
SPECIFICATION 14222-0-2 REV 1

1.0 SCOPE

1.1 This specification covers materials, proportioning, mixing, placing, testing, curing, and other related requirements for all concrete used in structures, foundations, floors, and paving.

1.2 In case of conflict between the requirements of this specification and the drawings; the drawings shall govern.

2.0 CODES, STANDARDS AND SPECIFICATIONS

Design, materials, fabrication, and erection of the structures as a whole, and all stuctural elements and connections thereof, shall conform to the requirements of the following codes, standards and specifications, except as modified or otherwise specified hereinafter.

2.1 Abbreviations as used in this specification shall have the following definitions:

ACI - American Concrete Institute

ANSI - American National Standards Institute

ASTM - American Society for Testing and Materials

UBC - Uniform Building Code of the International Conference of Building Officials

OSHA - The Occupational Safety and Health Act

2.2 Codes and Standards

ACI 318	Standard Building Code Requirements for Reinforced Concrete, 1977.
UBC	Uniform Building Code of the International Conference of Building Officials, 1979.
ANSI A58.1	Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, 1972.
OSHA	The Occupational Safety and Health Act, 1978.
ACI 305	Hot Weather Concreting, 1977.
ACI 306	Recommended Practice for Cold Weather Concreting, 1972.

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ACI 311.1R	Manual of Concrete Inspection, 1975.
ACI 347	Recommended Practice for Concrete Form Work, 1978.
ASTM A82	Standard Specification for Cold-Drawn Steel Wire for Concrete Reinforcement, 1979.
ASTM A185	Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement, 1979.
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, 1979.
ASTM C31	Standard Method of Making and Curing Concrete Test Specimens in the Field, 1975.
ASTM C33	Standard Specification for Concrete Aggregates, 1978.
ASTM C94	Standard Specification for Ready-Mixed Concrete, 1978 a.
ASTM C150	Standard Specification for Portland Cement, 1978 a.
ASTM C171	Specification for Sheet Materials for Curing Concrete, 1975.
ASTM C260	Specification for Air Entraining Admixtures for Concrete, 1977.
ASTM C494	Standard Specification for Chemical Admixtures for Concrete, 1979.

2.3 Reference Specifications

14222-M-1	Design of Structures
14222-N-6	Fireproofing of Vessels and Structural Steel
14222-Q-1	Foundations

3.0 GENERAL

3.1 Definitions

3.1.1 Owner — Ashland Synthetic Fuels, Inc. and AIRCO Energy Co., Inc. or their Designated Representative

3.1.2 Superintendent — Bechtel's Project Field Superintendent

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3.1.3 Engineer Bechtel's Project Engineer

3.1.4 Inspector Owner's or Bechtel's Designated Representative

3.1.5 The word "approved" as used herein shall mean as approved by the Engineer.

4.0 CONCRETE MATERIALS

4.1 Portland Cement shall conform to the "Standard Specifications for Portland Cement", ASTM C150. Type I cement shall be used in all cases except the following:

4.1.1 For high early strength use Type III.

4.1.2 Type II shall be used where installation will be in contact with salt water, or soil or water which contains harmful sulphate concentrations.

4.1.3 Type II shall be used for massive structures, and in cases where drying shrinkage must be controlled.

4.1.4 Types IV and V, or other special type cements shall be used only as specifically called for on the drawings.

4.2 All aggregates, unless otherwise specified, shall conform to the "Standard Specifications for Concrete Aggregate", (ASTM C33). Fine aggregate shall consist of clean, washed, natural or crushed sand of uniform gradation. Coarse aggregate shall consist of washed gravel or washed crushed stone, having hard, strong, durable pieces, free from adherent coatings, or other weak deleterious substances.

4.3 Concrete aggregates shall not be delivered to the mixing plant until the Superintendent has approved the pit source, the plant and its capacity and ability to produce a uniform and continous product. Certified copies of satisfactory tests by an approved testing laboratory will be accepted for aggregate quality requirements. The source of aggregate supply shall not be changed during the course of the job without approval of the Engineer.

4.4 Water for mixing concrete shall be clean, and free from injurious amounts of soil, acid, alkali, organic matter, sulphates, or other substances that can adversely affect concrete strength or durability.

4.5 Dry-Pack mortar, as referred to in Section 17.2, and when called for on the drawings, shall consist of 1 part of Portland cement to 2-½ parts sand by volume mixed with just sufficient water to produce a stiff consistency that can be efficiently rammed into place without sagging. One hundred percent of the sand shall pass a No. 16 screen.

4.6 For equipment bearing grout materials, see Section 17.0.

5.0 <u>REINFORCEMENT</u>

5.1 Metal reinforcement shall conform to the requirements of the "Standard Specifications for Billet-Steel for Concrete Reinforcement", ASTM A615, Grade 60, unless otherwise specified.

5.2 Welded wire fabric or cold-drawn wire for concrete reinforcement shall conform to the requirements of the "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement", ASTM A185, or "Cold-Drawn steel Wire for Concrete Reinforcement", ASTM A82.

5.3 General construction details and workmanship relative to reinforcement, including bar bends, lap splices and installation, shall be in accordance with ACI 318, Chapter 7 and Chapter 12.

5.4 Metal reinforcement, at the time concrete is placed, shall be free from oil or grease, loose rust or scale, or other coatings that will impair the bond.

5.5 Metal reinforcement shall be accurately placed in accordance with the plans and shall be adequately secured and held in position by metal chairs and spacers. Ties at intersections shall be made with No. 12 annealed wire. Wherever conduit, piping inserts, sleeves, etc., interfere with placing of reinforcement as called for, proper adjustment shall be made as directed by the Inspector, before concrete is placed.

5.6 Splices in reinforcement shall be made and located only as called for on the drawings, in the construction notes, or as otherwise approved by the Engineer.

5.7 Minimum concrete coverage over reinforcement shall conform to ACI 318, Section 7.71, unless otherwise called for on the drawings.

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6.0 ADMIXTURES

6.1 Chemical admixtures shall be used in concrete to improve its characteristics in one or more respects including economy, strength and durability, workability, watertightness, drying shrinkage behaviour, and increased resistance to damage from cyclic freezing and thawing.

6.2 The selection of the admixture(s) to be used in the mix shall be based on an appropriate evaluation of its effects which shows it to be desirable for use in the particular concrete and under conditions of use intended. The admixture to be used shall be selected by the Engineer or subject to his approval. Unless otherwise specified, use shall be limited to the types generally recognized as a) water reducing, b) set-controlling, c) air entraining, or combinations of these functional types.

6.3 Water reducing and set-controlling admixtures shall conform to ASTM C-494, Chemical Admixtures for Concrete.

6.4 Concrete subject to cyclic freezing and thawing shall contain an air entraining admixture conforming to ASTM C-260 and capable of entraining 3 to 6% of air.

7.0 MIXING PLANT

Concrete may be obtained from a mixing plant at the jobsite or from a ready-mix plant. In either case, concrete production and delivery shall meet the requirements of the "Specifications for Ready-Mixed Concrete" ASTM C94 in addition to the provisions of this specification.

8.0 PROPORTIONING OF CONCRETE

8.1 The proportions of water, cement and aggregate, as determined by the testing laboratory, and/or approved by the Engineer, shall be carefully maintained. No deviation from these proportions, especially by addition of water, shall be made without approval of the Inspector.

8.2 When duplicating the selected trial batch for the project, the moisture content of the aggregate under job conditions shall be determined. This quantity shall be included in the amount of water required by the selected water-cement ratio. The final concrete mix shall have the same weight proportions of cement, fine aggregate, coarse aggregate and water as the approved selected mix.

8.3 Solid materials shall be measured by weighting. One cubic foot of Portland cement, weighing 94 pounds equivalent to one sack or ¼ barrel, shall be the reference unit for all proportions established by selected trial mix. The apparatus provided for weighing the aggregate and cement shall be suitably designed and constructed for this purpose. Fine aggregate, coarse aggregate, and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. Cement furnished in standard packages (sack) need not be weighed. Proper control of mixing water shall be maintained at all times. Mixers with automatic water measuring drums, equipped with control devices, accurate to plus or minus ½ percent of the capacity of the tanks, shall be used.

8.4 The mixing equipment shall be capable of combining the aggregates, cement, and water within the specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. Mixing shall be done in a batch mixer of approved type. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the solid materials are in the mixer drum, provided that all of the mixing water shall be introduced before one-fourth of the mixing time has elapsed.

Mixing time shall be as follows:

a) For mixers of one-yard capacity - 1-½ minutes.

b) For mixers of capacities larger than one cubic yard, the time of mixing shall be increased 15 seconds for each additional half cubic yard capacity, or fraction thereof.

Ready-mixed concrete conforming to ASTM C94, may be furnished to the jobsite, contained in a truck mixer of the revolving drum type,watertight, and so constructed that the concrete can be mixed to insure a uniform distribution of materials throughout the mass. The concrete shall be discharged from the truck mixer within 1-½ hours after introduction of the water to the cement and aggregate, or the cement to the aggregate and in any event, prior to onset of initial set.

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9.0 FORMS

9.1 Concrete shall, in every case, be carried to the minimum dimension lines called for on the drawings.

9.2 Forms shall be of sufficient strength and rigidity to maintain their position and shape under loads incidental to placing concrete.

9.3 Tolerances for Concrete Construction

9.3.1 General

The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits so as to ensure completed work within the tolerances specified herein. Concrete work that exceeds the tolerance limits specified herein shall be remedied or removed and replaced at the expense of and by the Contractor.

9.3.2 Table of Tolerances for Placing Reinforcement Steel

See Section 7.5 of ACI 318.

9.3.3 Table of Tolerance for Reinforced Concrete Structures

ITEM	DISTANCE	PERMITTED TOLERANCE
Variation from the plumb in the lines and surfaces of columns, piers and walls	In any 10 ft. of length	$\pm \frac{1}{4}$ in.
Variation from the level or from the grades indicated on the drawings	Maximum for entire length	$\pm$ 1 in.

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ITEM	DISTANCE	PERMITTED TOLERANCE
In floors	In any 10 ft. of length	± ½ in.
	In any bay or in any 20 ft. of length	± 3/8 in.
	Maximum for entire length	± 3/4 in.
<u>Variations in the thickness of slabs and walls and in the cross-sectional dimensions of columns and beams</u>		- ¼ in. + ½ in
<u>Footings, variation of dimensions</u>		
Misplacement or eccentricity	2 percent of width in the direction of misplacement but no more than 2 in.	2 in.
Decrease of specified thickness	Less than 5% of specified thickness	

Tolerances shall be kept within the limits shown in "Recommended Practice for Concrete Form Work" (ACT 347) Section 3.3.

9.4 Forms ties, or tying methods, which can cause rust or discoloration on concrete exposed to view, shall not be used. Spreaders and tie wires shall be cut back at least ½ inch from surface and damage to concrete neatly patched.

9.5 Forms for concrete above grade shall be of plywood, metal, or "Sonotube" type preformed cylinders.

9.6 Forms for surfaces which will be exposed, except those surfaces to receive special finishes, shall be coated with approved parting agent before the reinforcement is placed. Surplus coatings on the forms shall be removed prior to concrete placement. Care shall be taken that the parting agent does not get on concrete or reinforcement which is to bond with new concrete. Forms for exposed concrete surfaces to receive paint or similar coating shall be sprayed with lacquer, shellac, paint or other approved preparations that will leave the concrete surface free from oil or grease.

9.7 The treated surfaces of forms shall be protected against direct exposure to the sun while not in use. Wood forms for surfaces which will not be exposed may be thoroughly wetted with water in lieu of form coating, except that in cold weather with probable freezing temperatures, coating shall be used.

9.8 All edges and corners of exposed concrete shall have a one-inch chamfer, except the following:

a) Tops of piers supporting horizontal vessels.

b) Concrete edges providing direct support for flooring, or to which steel will be attached for flooring support.

9.9 Side forms shall not be removed for 3 days after placing unless otherwise approved by the Engineer.

9.10 Forms and supports for bottom of slabs, beams and watertight basins shall not be removed for 7 days after placing unless otherwise approved by the Engineer.

10.0 <u>CONCRETE PROPERTIES</u>

10.1 Concrete shall be furnished for the indicated use and location, as specifically called for on the drawings or as otherwise specified or approved by the Engineer.

10.2 Standard grout for use at construction joints shall be of the same mix type and have the similar sand/cement proportions as the concrete with which it will be used.

10.3 No gap graded concrete shall be permitted in the work. Concrete mixes shall contain all aggregate size groups up to and including the maximum size used.

10.4 Slump & Consistency

10.4.1 In general, the quantity of total mixing water shall be limited to an amount producing the lowest slump concrete that can be properly consolidated under existing placing conditions.

10.4.2 The "Average Slump" shall be less than the "Working Limit" where the "Working Limit" is the maximum slump for estimating the quantity of mixing water to be used in the concrete. The "Inadvertency Margin" is the allowable deviation from the "Working Limit" for such occasional batches of concrete as may inadvertantly exceed the "Working Limit". These requirements are summarized in Table 1.

10.4.3 Upon discovery of slump falling in the "Inadvertency Margin", immediate steps shall be taken to reduce slump to within the "Working Limit", and succeeding batches shall be checked for slump until the "Working Limit" is achieved. Concrete of lower than specified slump may be used provided it can be properly placed and consolidated.

10.4.4 The Inspector shall verify the quantity of mixing water to assure conformance with the various limits on slump specified in Table 1, and to assure that the water cement ratios established by laboratory tests for the approved mixes are not exceeded.

10.4.5 Consistency shall be uniform from batch to batch. The quantity of mixing water shall be varied from batch to batch as necessary to offset variation in moisture content or grading of the aggregate, but the total mixing water shall not exceed the water-cement ratio established for any specified design mix type.

10.4.6 Concrete that has been rejected for failure to meet slump limits shall not be salvaged for use in the work. Increased mixing time, addition of dry materials, or similar modifications of a rejected limits shall not be permitted.

10.4.7 Slump readings shall be taken at not less frequent intervals than consitent with the following events:

a) At changes in moisture content of aggregate.

b) Whenever cylinders are made for testing.

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c) Every 100 cubic yards produced under conditions of consistent mix characteristics.

d) Each batch delivered following a slump test falling in the "Inadvertency Margin".

11.0 PLACING CONCRETE

11.1 Before placing concrete, all equipment for mixing and transporting the concrete shall be cleaned. All debris, mud, snow and ice shall be removed from spaces to be occupied by the concrete. Immediately prior to placing concrete, all form and soil surfaces shall be thoroughly wetted.

11.2 Aluminium and aluminium alloy material shall not be used in conveying equipment including pump lines tremies and chutes.

Short chutes used to remove concrete from transit truck mixers are excluded from this restriction.

11.3 Concrete shall be deposited as nearly as praticable in its final position to avoid segregation due to rehandling or flowing. The concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the spaces between the bars. No concrete that has partially hardened or has been contaminated by foreign material shall be deposited on the work, nor shall retempered concrete be used. Concrete shall not be deposited during rain unless adequately protected from rain until it has hardened sufficiently so that it will not be damaged.

If conditions make it necessary to drop concrete more than five feet when placing, it shall be chuted.

11.4 All ends of chutes, hopper gates, and other points of concrete discharge shall be so designed or fitted with suitable baffles that concrete passing from them will not segregate during its free fall into place.

11.5 As concrete is placed, it shall be adequately vibrated with internal vibrators to the point of consolidating into a dense homogenous mass thoroughly embedding the reinforcement, and filling all corners and angles. At the same time, it shall be worked with suitable tampers, or other tools to accomplish this purpose. Care shall be taken not to vibrate concrete excessively, or to otherwise work it in a manner that causes segregation of its constituents.

11.6 When concreting has started, every effort shall be made to carry it on as a continuous, uninterrupted operation until the scheduled pour is completed.

11.7 In pouring walls, the concrete surface shall be brought up as nearly level as possible in order to prevent the formation of unsightly inclined joints. Freshly placed columns or walls 12 feet or more in height shall be allowed to set for at least two hours before pouring beams or slabs thereon. Joints at these locations shall be cleaned in accordance with Paragraph 15.3.

11.8 Where concrete is placed on soil it shall be placed only on firm undisturbed ground or engineered fill. Concrete shall not be placed in standing water on subgrade or in foundation excavations.

12.0 <u>COLD AND HOT WEATHER CONCRETING</u>

12.1 <u>Moderate Weather Precautions</u> (45°F to 70°F)

During moderate weather (air temperature above 45°F), fresh concrete shall not be placed at a concrete temperature lower than 40°F unless provision is made for protection against air temperature variations below 40°F for not less than 72 hours after placing.

12.2 <u>Cold Weather Concreting</u>

Cold weather concreting shall conform to the "Recommended Pratice for Cold Weather Concreting" (ACI 306) and as follows:

12.2.1 Concrete as deposited in the forms during cold weather shall have a temperature not lower than the followign °F·

Air Temp. °F	Thin Sections Less Than 2-½ feet in Least Dimension	Mass Concrete 2-½ Feet or More in Least Dimension
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

Maximum temperature of concrete at time of placement in above air temperature ranges shall be 90°F.

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12.2.2 Before concrete is placed, all ice, snow, and frost shall be completely removed form surfaces which will be in contact with the concrete. These surfaces shall be raised to a temperature above 35°F. No concrete shall be placed on a frozen subgrade or one that contains frozen materials.

12.2.3 Concrete shall be protected from freezing by adequate covering and heating for seven (7) days. Adequate equipment for protecting concrete from freezing shall be available at the jobsite prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing. Forms shall be removed and the concrete member shall be completely enclosed in an ambient air temperature not more than 10°F above or below the placing temperature of the concrete. No curing water will be required if steam is employed. If heat is used, care shall be taken to insure that no part of the concrete becomes dried out or is heated to temperatures above 90°F. When dry heat is used, the concrete shall be adequately cured by one of the methods specified in Section 13.0. The housing, covering, or other protection used shall remain in place and intact at least 24 hours after the artificial heating is discontinued.

12.2.4 Calcium chloride shall not be used as an accelerator except with the approval of the Engineer.

12.3 Hot Weather Concreting (Air temperature above 70°)

12.3.1 Hot weather concreting shall conform to "Hot Weather Concreting" (ACI 305R) and as follows:

12.3.2 Unless otherwise specified, all concrete members 2-½ feet or more in thickness shall have a placing temperature of not more than 75°F, and all other concrete shall have a maximum placing temperature of 85°F. To prevent the temperature of the concrete from exceeding these limits during warm weather, effective measures shall be employed for reducing the temperature of the concrete, such as: (1) cooling the aggregate; (2) shading materials and facilities from direct rays of the sun; (3) insulating water supply lines; (4) cooling of mixing water; (5) introduction of flaked ice into the mix; or other effective methods.

13.0 CURING

13.1 Concrete shall be cured by any of the following methods unless specified otherwise.

13.1.1 MOIST CURING

Newly placed concrete shall be kept wet by the continuous application of water with a nozzle, soakers, or wet burlap for the first 7 days after the concrete has been placed. This curing water shall be clean and free of contaminating substances that will discolor the concrete.

13.1.2 BLANKETING METHOD

The entire surface shall be covered with a blanket of sand or earth not less than 2 inches in thickness. Immediately after placing, the blanket shall be thoroughly wetted and kept saturated for not less than 7 days after being placed.

13.1.3 COTTON MAT METHOD

The entire surface shall be covered with heavy cotton mats laid directly upon the concrete. Immediately after placing, the mats shall be thoroughly wetted and kept saturated for not less than 7 days.

13.1.4 WATERPROOF PAPER OR PLASTIC MEMBRANE METHOD

The entire surface shall be covered with waterproof paper or plastic sheet laid directly upon the concrete. The material shall conform to ASTM Designation C-171. The sheets shall be lapped not less than 4 inches at edges and ends,, and be sealed with adhesive or pressure-sensitive tape no less than 1-1/2 inches in width. The membrane shall be weighted to prevent displacement. Holes appearing in the membrane during the curing period shall be immediately patched. The membrane shall remain intact for not less than 7 days after placing.

13.1.5 LIQUID MEMBRANE METHOD

Unless otherwise specified, the liquid membrane-curing compound shall be Clear Seal NO. 150 as manufactured by Grace Construction Materials Co., Cambridge, Massachusetts, or approval equal. Application shall be in accordance with manufacturer's instructions.

13.2 Liquid Membrane (13.1.5) shall not be used on surfaces to receive special protective coatings, applied toppings, architectural plaster, paint finishes, or similar high bond coatings, except as specifically called for on the drawings.

14.0 SLAB FINISHES

Finished slab surfaces shall be true plane surfaces, with a tolerance of 1/8 inch in 10 feet unless otherwise indicated. Surfaces shall be pitched to drains as required. The dusting of finished surfaces with dry materials other than for abrasive finish shall not be permitted. Finish to be provided shall be as called for on the drawings and shall conform to the following requirements.

14.1 STEEL TROWEL FINISH

Surfaces indicated to have steel trowel finish shall be finished by tamping the concrete with a mesh tamper to depress the coarse aggregate sufficiently to bring the matrix fines to the surface, then screeding and striking with straight edges to bring the surface to the required finished level. While the concrete is still green, but sufficiently hardened to bear a man's weight without excessive imprint, it shall be floated either by hand or mechanical means to a true, even plane with no coarse aggregate visible. Sufficient pressure shall be used on the float to bring moisture to the surface. After surface moisture has disappeared, the surface shall be machine or hand troweled to a smooth even finish.

14.2 WOOD FLOAT FINISH

Surfaces indicated to receive wood float finish shall be screeded to the required level with a straight edge and finished with a wood float.

14.3 SCREEDED FINISH

Surface indicated to receive screeded finish shall be screeded to the required level with a straight edge only.

14.4 BROOMED FINISH

Surfaces indicated to have broomed finish shall be as specified for steel trowel finish and the surface shall be broomed after completion of the troweling with a horsehair bristle brush or broom in a direction perpendicular to the main line of traffic.

14.5 ABRASIVE FINISH

Surfaces indicated to have abrasive finish shall be finished as specified for trowel finish, immediately following which, an abrasive material shall be evenly applied to the surface at a rate of not less than 1/4 pound of abrasive material to each square foot of suface. The surfaces shall then be hand steel troweled. The abrasive material shall be Sonneborn Building Products, Inc., "Frictex NS" or approved equal.

14.6 HARDENERS AND COLORING AGENTS

Hardeners and/or coloring agents shall be applied as called for on the drawings, and in accordance with the manufacturer's instructions.

15.0 JOINTS

15.1 Joints shall not be made in horizontal framing members unless called for on the drawings. For treatment of horizontal joints in columns and walls, see Paragraphs 15.3 and 15.4.

15.2 Joints called for on the drawings are mandatory. Where not so called for, they may be provided at the option of the Superintendent. In general, continuous pours of slabs on grade should not exceed 25 feet in either dimension without jointing. Joints in elevated slabs should be located preferably at midspan between adajcent supporting members.

15.3 Construction joints in main structures shall be prepared by any of the following described methods in which all laitance shall be removed down to sound mortar matrix, leaving clean, sound aggregate exposed over the entire joint surface, but not undercutting the large aggregate particles. These procedures do not apply to joints in floors or pavement slabs or in secondary structures, e.g. manholes or minor foundations.

15.3.1 SANDBLASTING OR WATERBLASTING

Wet sandblasting or high pressure waterblasting shall be performed before placing forms. The operation shall be continued until all unsatisfactory concrete and all laitance, coating, stains, debris and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose material.

15.3.2 SURFACE RETARDANT COATINGS

Surface retardant coatings for unformed surfaces shall be "Rugasol-C" (as manufactured by Sika Chemical Corporation), or " or "Rugasol-FD" for formed surfaces, or approved equals. Manufacturer's instructions for application and cleaning shall be followed. Joints prepared in this manner shall be equal to those obtained by wet sandblasting. Precautions shall be taken to prevent any retardant coating material from getting on reinforcement steel.

15.3.3 AIR-WATER CUTTING OF HORIZONTAL JOINTS

Air-water cutting (green cutting) of a construction joint shall be performed after initial set has taken place but before the concrete has obtained its final set. The surface shall be cut with a high pressure air-water jet to the prepared condition specified in Section 15.3. After cutting the surface it shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, debris and other foreign material, sandblasting or waterblasting, bush hammering or other means shall be employed immediately before placing the next lift to supplement air-water cutting.

15.4 All concrete joint surfaces to receive new concrete shall be free of surface water but shall be in a saturated surface dry condition. All horizontal surfaces shall be covered immediately before the concrete is placed with 1/2 inch of grout thoroughly broomed into the surface. For congested areas where brooming is impossible, the grout shall be forced ahead of the concrete. The grout may be eliminated on minor foundations where neither high strength nor water-tightness is a requirement, or where regular concrete can be worked into a readily accessible joint surface.

16.0 WATERSTOPS

16.1 Waterstops shall be installed and located as called for on the drawings.

16.2 Waterstops shall be accurately cut, fitted, and fully and integrally jointed at sectional joints and angular junctions to provide a continuous, watertight diaphragm at all points.

16.3 Adequate provisions shall be made for the support and protection of waterstops during the progress of the work. Damaged stops shall be replaced and/or repaired as required before embedment in concrete.

17.0 BEARING GROUTS AND GROUTING

17.1 In general, grouting beneath base, bed, and ring plates should be done with sand/cement base materials. Epoxy base materials may be used under service conditions noted below.

17.2 Grouting of non-critical equipment, e.g. column base plates, small pumps, vessesls, etc., where high-strength and no-shrink properties are not of prime importance, may be done with Dry-Pack mortar as described in Section 4.5.

17.3 Precision grouting of major maechanical and other critical equipment shall be done with a proprietary product specially formulated for this use and having the following chemical and physical characteristics.

a) Non-rusting or staining

b) No-shrink dimensional stability

c) Compressive strength, 9000 psi at 7 days

d) Flowable placing consistency and fully self-leveling characteristics

e) No generation of expansive forces during setting

f) No continuous confinement required during setting period

g) Unaffected by exposure to the service temperatures

Some high-performance pre-mixed grouting materials and the maximum continuous temperatures to which they can be exposed in service are:

"Embeco 636", Mfg. by Master Builders 300° F.

"F-100" Mfg. by Sauereisen Cements Co. 750° F.

"Five Star Grout" Mfg. by company of same name 300°F.

17.4 Epoxy resin base, aggregate filled, proprietary grouts may be used provided that the grout will not be exposed to temperatures exceeding 200°F for general use, or 150°F for precision grouting of major mechanical equipment, including vessels.

17.5 The handling and placing of pre-mixed proprietary grouts shall be done strictly in accordance with the manufacturer's recommended procedures.

17.6 Heavy equipment shall not be set sooner than 10 days after pouring of supporting elements.

17.7 Foundation surfaces on which grout is to be placed shall be provided with a rough, clean surface such as obtained by one of the methods specified in Section 14. All loose material and laitance shall be removed from such surfaces before equipment to be grouted is placed.

17.8 Special care shall be taken to ensure that sleeves around anchor bolts are, in all cases, completely filled with grout before placing grout under base and ring plates.

18.0 <u>REPAIR OF CONCRETE</u>

18.1 Repair of voids, honeycomb, sandpockets, excessive finning, and other similar gross imperfections, shall be completed as soon as practical after removal of forms. Curing procedures shall not be delayed or interrupted while making such repairs.

18.2 Honeycomb, voids, sandpockets, and damaged areas shall be cleaned out to sound concrete by chipping so as to provide a square shoulder not less than 1 inch deep all around.

18.3 Dry-Pack, shall be used to fill cleaned-out voids nominally not exceeding 6" in depth or 1 cu. ft. in volume. Concrete of the same mix characteristics as the concrete to be repaired shall be used to fill larger voids where, in the opinion of the inspector, a sounder patch can be achieved than by the use of Dry-Pack. Procedures shall be employed that will assure complete filling of the void with dense Dry-Pack or concrete and, on exposed surfaces, result in an appearance acceptable to Company. For Dry-Pack mix proportions refer to Section 4.5.

18.4 For large repairs generally exceeding 6" in depth or 1 cu. ft. in volume, a coating of an epoxy resin concrete adhesive shall be neatly applied over the surface of void to be patched immediately before placing Dry-Pack or repair concrete. The adhesive compound shall be Thiopoxy 62, A.C. Horn product as manufactured by Grace Construction Materials, or approved equal. Application shall be in accordance with the manufacturer's instructions.

18.5 Voids not requiring epoxy adhesive as specified in Section 18.4, shall be wetted and be in a surface damp condition at time of placing Dry-Pack.

19.0 TESTING LABORATORY

An approved testing laboratory shall be retained by Bechtel to perform the following work:

19.1 Confirm the quality and determine the proportions of materials which must be used to furnish concrete having the required compressive strength at the age of 28 days, and other properties conforming to the requirements of this specification. Final mixes shall be approved by the Engineer prior to placing of concrete. Seven-day compression tests on the trial mixes shall be performed before such approval is given.

19.2 Make routine laboratory compression tests of concrete test cylinders and render test reports on same. Test reports shall show location where specimens were taken, dates taken, ultimate compressive strength and remarks on characteristics of cylinder. Copies of reports shall be furnished to the Engineer, the Superintendent, and the Company. These tests shall be made in accordance with the "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders", ASTM 039.

19.3 To make other tests of materials as required by the Engineer or Inspector.

20.0 INSPECTION

20.1 Inspector shall be invested with full authority to control proportioning, mixing, handling, placing, and curing of all concrete, and shall verify that all concrete materials and work conform to the requirements of this specification.

20.2 Inspector shall verify that the proper ingredient proportions, correct time of mixing and other specified procedures are maintained at the concrete batching plant.

20.3 Inspector shall take the concrete samples and make a minimum of four test cylinders from every sample, as described in Section 20.3.1. Each cylinder shall be dated, given a number, and the point in the structure from which the sample was taken noted thereon. Test cylinders shall be made at the job and stored in accordance with the "Tentative Method of Making and Curing Concrete Compression and Flexure Field Specimens in the Field", ASTM C31. These cylinders shall be tested as follows: a) One at 7 days; b) One at 28 days; c) Two cylinders to be stored in the field and cured in the same manner as poured concrete and be tested at the discretion of the Engineer.

20.3.1 Samples shall be taken from each complete pour for individual foundations or structures supporting main processing units, heavy mechanical equipment, buildings storage tanks, and from other important concrete structures, in accordance with the following schedule:

No. of Cubic Yard In Any Individual Foundation or Structure	No. of Samples To be Taken
0 - 50	One for each 25 Cu. Yds.
51 - 200	One for each 50 Cu. Yds.
201 - 350	One for each 75 Cu. Yds.
351 - Over	One for each 100 Cu. Yds.

20.4 The Inspector shall make other tests on concrete delivered to the work including, but not necessarily limited to, slump, air content and temperature.

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20.5 Inspection and field tests shall conform to ACI Manual of Concrete Inspection, ACI 311, and to the applicable ASTM specifications referenced therein.

TABLE 1

CONSISTENCY REQUIREMENTS

SLUMP REQUIREMENTS

MIX f'c.(psi)	WORKING LIMIT AT POINT OF PLACEMENT (in.)	INADVERTENCY MARGIN (in.)	REJECTION LIMIT (in.)	MAXIMUM AGGREGATE SIZE (in.)	USE AND LOCATION
2000	5	1½	6½	3/4	ELECTRICAL DUCT ENVELOPE
2000	6			1½	LEAN CONCRETE BACKFILL
3000	3½	2	5½	3/4	CONGESTED REINFORCEMENT STRUCTURAL WALLS AND SLABS LESS THAN 12" THICK
3000	3	2	5	1½	MASS FOUNDATION, WALLS AND ELEMENTS OVER 12" THICK
4000	3	2	5	3/4	SAME AS FOR 3000 f'c
4000	3	1½	4½	1½	SAME AS FOR 3000 f'c
5000	3	1½	4½	3/4	SAME AS FOR 3000 f'c
5000	2½	1½	4	1½	SAME AS FOR 3000 f'c

* f'c NORMALLY AT 28 DAYS UNLESS OTHERWISE SPECIFIED.

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△	10-21-81	ATTACHED SPECIFICATION S-522	[illegible]	[illegible]	[illegible]
△	11/19/80	ISSUE FOR PHASE ZERO	FB	HS	[illegible]
△	3/21/80	ISSUE FOR APPROVAL	FB	HS	

BECHTEL	ASFI THE BRECKINRIDGE PROJECT AECI U.S. DOE COOPERATIVE AGREEMENT NO.DE-FC05-80OR20717 PROJECT SPECIFICATIONS DESIGN OF SEWERS AND DRAINAGE	JOB NO. 14222 SPECIFICATION: 14222-S-1 REV: 2

1. GENERAL

1.1 SCOPE

This specification establishes the design requirements for sewers and drainage. Extent of work shall be as shown on Bechtel proposal drawings. Supplemetal or modifying requirements to this specification shall be as shown on Bechtel project drawings or specifications, or addendum hereto.

1.2 RELATED DOCUMENTS

Refer to applicable sections of following documents for additional requirements:

Bechtel Construction Specification S-522 - Sewer & Drains
Project Specification 14222-S-2 - Design of Roads & Paving
National Plumbing Code - ANSI A40.8
Local Building Codes

1.3 BASIC DESIGN DATA AND FORMULAS

The following formulas and procedures shall be used in the design of sewer and drainage systems.

1.3.1 Design rainfall rate shall be as shown in Technical Paper No. 25, U.S. Department of Commerce, "Rainfall-Intensity-Frequency Curves", for the ten year return period storm for nearest weather station of similar climate. Minimum design concentration time shall be 10 minutes.

1.3.2 Surface runoff shall be calculated by Rational Formula Q=CIA in which C = 1.0 for paving and roofs, 0.50 for gravelled areas. Other areas shall have C determined by their characteristics.

1.3.3 Capacity of ditches and head loss in sewer pipes shall be calculated by Manning Formula:

$$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$$

n = 0.013 for sewer pipe, 0.018 for lined ditches, and 0.025 for unlined maintained ditches. The coefficient of roughness may be revised to suit varying local conditions.

Q = volumetric flowrate, ft^3/sec.

A = duct cross-sectional area, ft^2.

R = hydraulic radius, ft.

S = friction loss per pound of fluid flowing per foot of duct length, lb force/lb mass.

1.3.4 Rate of sanitary flow shall be calculated on basis of the number and type of sanitary facilities provided, with the daily volume of sewage being calculated on the basis of 35 gal/person/shift. Design BOD_5 shall be 0.05 lbs/person/ 8 hour shift.

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1.4 DEFINITIONS

1.4.1 Drain Line - Connects drain hubs with a catch basin or manhole.

1.4.2 Sublateral - Connects a catch basin with a lateral or main.

1.4.3 Lateral - Connects two or more drain lines or sublaterals.

1.4.4 Main - Collects from 2 or more laterals.

1.5 FIREWATER QUANTITIES

2 For sewers subject to firewater loads, design quantities, based on the Breckinridge Project fire control water distribution system design, shall be used as follows:

1.5.1 500 gpm to the first catch basin.

1.5.2 250 gpm to each subsequent catch basin on the same lateral.

1.5.3 1,000 gpm maximum to a lateral.

1.5.4 3,000 gpm maximum to a main. 10,000 gpm shall be considered as the maximum firewater load to the sewer system at any time.

2. GENERAL DISIGN AND LAYOUT

The following general procedures shall be used in the design of sewer systems in normal conditions.

2.1 Storm and process sewers shall be sized as flowing full with future requirements to be included in design quantities. Minimum size for sewers leaving catch basins or area drains shall be 6 inches.

2.2 Minimum allowable velocity at design flow shall be 2.5 ft/sec for sanitary sewers and 2 ft/sec. for other sewers. Maximum allowable velocity at design flow shall be 8 ft/sec. Where large quantities of sediment or sludge are expected, minimum allowable velocity at design flow shall be increased to minimize deposition.

2.3 Minimum cover for sewers shall be 18 inches or maximum depth of frost line, whichever is greater. Under primary and secondary roads, cover shall be as required for H-20 loading. Under railroads, cover shall be as required by A.R.E.A. Manual of Recommended Practice.

2.4 Pipes may be laid on curves in systems where clogging due to debris or other material is improbable and where sutiable materials and methods of construction are used. Degree of maximum curvature shall be as specified by the manufacturer.

2.5 Manholes shall be provided at maximum 400 ft. distances. All sanitary sewers 15 inches or greater in size, shall have manholes at following locations.

2.5.1 Junctions of mains.

2.5.2 Dead ends of mains.

2.5.3 Changes of grade or size of mains other than conditions described in section 2.4.

2.5.4 Junctions of laterals and mains where the run of the lateral downstream of the last cleanout exceeds 100 feet.

2.6 Cleanouts will be located so that rodding can be performed in direction of flow and will be furnished at the following locations.

2.6.1 Dead ends of laterals.

2.6.2 Where a drain line, sub lateral or lateral makes a 90° turn in direction, except where turn is within 10 feet of its downstream termination at a catch basin or manhole.

Where a sewer in essentially a horizontal plane makes a 45° turn in direction if the length of line exceeds 50 feet from the last upstream cleanout.

2.7 Drain Lines

2.7.1 Individual drain hubs projecting approximately 2 inches above paving shall be furnished at certain pumps and equipment as shown on Bechtel drawings.

2.7.2 Drain lines serving equipment will be sized for the anticipated flow with the following minimum sizes:

a. Drains serving one hub and less than 20' long - 4".

b. Drains serving two or more hubs, or over 20' long - 6".

2.7.3 Where steel pipe is used to recover special liquid or is buried in concrete, the minimum size will be as follows:

a. Drains serving one hub or stub-up and less than 20' long - 2".

b. Drains serving two or more hubs, or over 20' long - 3".

2.8 P-traps, running traps or bell traps shall not be used. Trapping of gas shall be accomplished by a minimum 6" liquid seal at seal boxes or catch basins.

3. SANITARY SEWER

Sanitary sewers shall collect waste from toilet facilities, lavatories, building floor drains, etc.

3.1 Design quantities shall be as specified in 1.34 herein. Minimum size sewer main shall be 6 inches.

3.2 Acids, caustics, hydrocarbons or similar contaminants shall not discharge to this system.

3.3 Sanitary sewage shall discharge to a municipal sewer, treatment plant or septic tank.

3.4 Septic tank effluent shall discharge to a tile field or industrial sewer. Septic tank effluent shall be discharged into industrial sewage which is treated by a biological system only where adequate provision for controlling bacteria of the final effluent exists.

3.5 Septic tanks and tile fiels shall be designed according to provisions of National Plumbing Code, ASA A40.8. Septic tanks discharging to industrial sewers shall have 8 inch liquid seal and effluent shall normally be chlorinated before discharging to the industrial sewer. Septic tanks shall be vented.

3.6 A minimum 0.1 ft. drop shall be provided between inlet and outlet invert elevations of manholes.

4. INDUSTRIAL SEWER SYSTEMS

Industrial sewers shall collect process wastes, storm and firewater from areas handling contaminating materials such as hydrocarbons.

4.1 General

4.1.1 Industrial sewage shall discharge to an existing industrial sewer, an oily water separator or other treating facility.

4.1.2 Drains serving pumps or equipment shall discharge to nearest catch basin or seal box.

4.1.3 Sewers serving areas handling hydrocarbons or similar hazardous materials shall have liquid sealed manholes and catch basins. A maximum of seven unsealed drain hubs from the same general grouping of equipment may be served by a drain line sealed at a catch basin or manhole.

4.1.4. Drain hubs in areas not draining to the same catch basin shall not be joined to a common drain line.

4.2 Process Areas

4.2.1 Catch basins shall be provided for surface drainage as specified in Project Specification 14222-S-2, Section 7, Area Paving.

4.2.2 Sewers shall be designed for the larger of the sum of the rain and process water or the sum of fire and process water. Storm and process water shall be cumulative throughout the system.

4.2.3 Sewers leaving process areas shall have a sealed manhole near the battery limits.

4.2.4 Sealed manholes shall have solid vapor proof covers and vents.

4.3 Non Proceas Areas

4.3.1 Sufficient catch basins or area drains shall be provided to handle surface drainage from areas subject to contamination.

4.3.2 Sewers shall be designed for the sum of storm and process water or fire and process water whichever is greater. Storm and process water shall be cumulative. Quantities for areas within tankage firewalls or other controlled release areas shall not be included.

4.4 Tankage Areas

4.4.1 Storm water from areas within tankage firewalls shall be collected in one or more catch basins located near firewalls, Discharge flow shall be controlled with a normally closed valve located outside the firewall.

4.4.2 Water drawoff from storage tanks shall be discharged to an underground sewer system controlled by a valve or gate outside the firewall.

4.4.3 Sewage from 4.41 amd 4.42 above shall discharge to an industrial sewer or open ditch outside the firewall.

4.4.4 Minimum size storm water sewer shall be 8 inches. Minimum size water drawoff sewer shall be 6 inches.

5. CLEAN WATER SEWER AND DITCH SYSTEMS

Clean water systems shall collect storm and firewater from areas not ordinarily subject to contamination.

5.1 General

5.1.1 Liquid seals shall not be required for manholes or catch basins.

5.1.2 Natural drainage courses shall be utilized whenever possible.

5.1.3 Ditches shall normally be trapezoidal in cross section with a minimum bottom width of two feet. The side slope shall normally be 2 horizontal to 1 vertical, but may be 1-½ horizontal to 1 vertical if space is limited and soil conditions permit.

5.1.4 Vee ditches may be used for laterals not exceeding 200 feet in length. The side slope shall normally be 1 horizontal to 1 vertical. Minimum gradient shall be .005 ft/ft., minimum depth shall be 6 inches and maximum depth shall be 2 feet.

5.1.5 Shallow swales may be used within or adjacent to process units. Minimum gradient shall be .01 ft/ft for unlined, .003 ft/ft for lined gutters. Minimum depth shall be 3 inches, maximum depth shall be 1 foot.

5.1.6 Maximum velocity in unlined ditches of low capacity shall be as indicated in the soils report. In the absence of this information, velocity should not exceed the following:

a.	Fine sand or silt	2.5 (feet per second)
b.	Coarse sand to sandy loam	2.5
c.	Sandy clay	3.5
d.	Clay	5.0

5.1.7 Headwalls shall not be used for culverts unless shown on Bechtel drawings.

5.2 Process Areas

5.2.1 Open areas not subject to hydrocarbon contamination shall normally drain to open ditches or gutters. Deep open ditches between process areas and adjacent roads shall be minimized. Shallow perimeters gutters or streets with integral rolled curbs and gutters may be used.

5.2.2 Sewers may be used when open ditches or gutters are impratical. Sewers shall normally drain to nearest open ditch or natural drainage course.

5.3 Non-Process Areas

5.3.1 Sewers shall be kept to a minimum and shall drain to nearest open ditch or natural drainage course.

5.3.2 Areas to be landscaped shall normally have sewers with area drains or depressed streets with curbs and gutters.

6. SUBSURFACE DRAINAGE SYSTEMS

Subsurface drainage systems shall be used for the removal of detrimental amounts of ground water from beneath roads, railroads or paving when indicated on Bechtel drawings.

6.1 Underdrains shall normally consist of perforated pipe at the bottom of a nearrow trench backfilled with filter material.

6.2 The system may consist of a single underdrain, or several underdrains in a herringbone or other effective pattern depending on the quantity of water and type of material to be stabilized. Surface drainage shall not be collected in the system.

6.3 Minimum size for lengths of 500 feet or less shall be 6 inches, and for longer lengths shall be 8 inches. Minimum slope for 6" subdrains shall be 0.3% and for 8", 0.2%.

1. GENERAL

1.1 Scope

This specification establishes the construction requirements for sewers, culverts, drains and underdrains. Extent of work shall be as shown on Bechtel drawings, and construction shall be true to the line and grade as shown on the drawings and as described herein. Supplementary or modifying requirements to the specification shall be as defined on Bechtel project drawings, or addenda hereto.

1.2 Related Documents

Refer to applicable sections of following documents for additional requirements:

Bechtel Design Specification S-501 - Sewers and Drainage
Bechtel Construction Specification S-521 - Site Preparation and Earthwork
National Plumbing Code - ANSI A40.8
Cast Iron Soil Pipe & Fittings Handbook - Cast Iron Soil Pipe Institute
Clay Pipe Engineering Manual - National Clay Pipe Institute
Handbook of Steel Drainage and Highway Construction Products - American Iron and Steel Institute
Concrete Pipe Handbook - American Concrete Pipe Association

1.3 Definitions of Terms Used

1.31 Percent Relative Compaction: The ratio, expressed as a percentage, of the dry unit weight of the material in place to the maximum unit weight of the material as determined by the methods in ASTM D1557, "Moisture Density Relations of Soils Using 10 lb. Rammer and 18" Drop", or for non-cohesive soils by the methods in ASTM D2049, "Relative Density of Cohesionless Soils".

1.32 Engineer: The Bechtel Project Engineer or his authorized representative.

2. GENERAL CONSTRUCTION PROCEDURES FOR SEWERS, CULVERTS AND DRAINS

2.1 Excavation

2.11 Trench shall be excavated to the minimum width sufficient to allow satisfactory jointing of pipe and tamping of backfill under and around pipe. Recommended trench width is external diameter of pipe plus 20 inches for 30-inch internal diameter and smaller pipe, and external diameter plus 24 inches for larger pipe.

No.	DATE	REVISIONS	BY	CH'K	APPR
2					
1	4/71	GENERAL REVISION			
0	6/4/63	ISSUED AS A STANDARD SPECIFICATION			

2.12 Adequate measures shall be taken to prevent slips, cave-ins and slides. Do not store excavated or other material within two feet of the edge of the excavation.

2.13 In trenches requiring side slopes for stability, the slope shall not be carried below a plane level with the top of the pipe.

2.14 Where pipe is to be placed in embankments, pipe trenches shall be excavated only after the embankment is completed to a level not less than 6 inches above the top of the pipe to be laid.

2.15 Tunnelling shall not be allowed unless approved by Engineer.

2.16 If a trench is overexcavated, the overexcavated portion shall be replaced with compacted backfill. Minimum relative compaction of the backfill shall be 85%.

2.2 Foundation

2.21 The foundation surface shall provide a firm foundation of uniform density. Where bell and spigot pipe are used, holes shall be dug for each bell sufficiently deep so that bell does not bear on bottom of hole.

2.22 Where rock, hardpan or other unyielding material is encountered, the bottom of the trench shall be overexcavated to a distance below the pipe of one-fourth the pipe internal diameter but in no case less than 8 inches. Overexcavation shall be centered about the pipe and one foot wider than the pipe outside diameter. The overexcavated portion of the trench shall be backfilled with a granular backfill compacted to an 85% minimum relative compaction.

2.23 If unsuitable material such as muck, peat or similar material is encountered at the bottom of the trench, the unsuitable material shall be removed to a width of at least one diameter on each side of the pipe and to a depth as determined by Bechtel Inspector. Backfill shall be made with gravel or other suitable selected material and compacted as required to provide adequate support for the pipe. For extensive deposits of unsuitable material, the use of concrete cradles, piles or similar foundations shall be investigated.

2.3 Bedding

Bedding shall conform to the requirements given below for Class A,B,C or D bedding, whichever is shown on the project drawings or specification. When the class of bedding is not shown Class C bedding shall be used.

2.31 For Class A bedding, the lower part of the pipe exterior shall be bedded in a continuous cradle of 2,000-pound concrete, having a minimum thickness under the pipe of one-fourth the nominal inside diameter and extending up the sides of the pipe for a height equal to one-fourth of the inside diameter. The cradle shall have a width at least equal to the outside diameter of the barrel of the pipe plus 8 inches and shall be constructed monolithically without horizontal construction joints.

2.32 For Class B bedding, the pipe shall be carefully placed on a minimum 4-inch thickness of fine granular material, over an earth foundation shaped to conform to the lower part of the pipe exterior for a width of at least 60 per cent of its external diameter. Granular material shall be placed and compacted in 6-inch layers to fill completely all spaces under and adjacent to the pipe to a distance of at least 12 inches above the top of the pipe.

2.33 For Class C bedding, the pipe shall be bedded with "ordinary" care in an earth foundation shaped to fit the lower part of the pipe exterior for a width of at least one-half its external diameter. Granular material shall be placed and tamped to the level of the top of the pipe, so that all spaces under and adjacent to the pipe are filled and were compacted.

2.34 For Class D bedding, no special care is required in shaping the bed. Pipe bells shall not bear directly on the ground and the barrel shall be supported for its full length. Backfill shall be as for Class C bedding.

2.4 Laying Pipe

2.41 Pipe shall be protected during handling against impact shocks and free fall. Proper facilities shall be provided for lowering the sections to prevent disturbances of the bed and sides of the trench.

2.42 The pipe shall be carefully laid, starting at the downstream end, with the tongue or spigot end pointing in the direction of flow. Pipe shall be kept clean at all times.

2.43 Pipe shall be set firmly according to line and grade. Prior to making joints, all surfaces shall be thoroughly cleaned and prepared as required for the type of joint to be made. Pipe shall be carefully centered so that the completed sewer will have a smooth uniform invert.

2.44 The barrel of the pipe shall be in contact with the quadrant shaped bedding throughout its full length, exclusive of the bell.

2.45 To prevent shear failure the branches of all fittings shall be supported by granular material backfilled in the trench to provide support equal to that furnished the barrel of the pipe.

2.5 Jointing and Finishing

2.51 Joints shall be as specified on the project drawings and specifications and as described herein.

2.52 Joints shall be made tight to prevent excessive infiltration or exfiltration. Testing shall be as specified on the project drawings and specifications and as described herein.

2.53 At all joints not using a flexible gasketed joint (push-on), the inside surface of the pipe shall be cleaned after the joint is made and each section shall be swabbed to prevent the joint material from projecting into the pipe. When pipe laying is suspended for any cause, the ends of the pipe shall be kept closed to keep out dirt, mud and foreign substances. Adequate provision shall be made to prevent floating of pipe in the event the trench is flooded.

2.6 Pumping and Bailing

2.61 Provision shall be made to remove any water which accumulates in the trenches. No manhole, concrete structure, or sewer pipe shall be installed in water without prior approval by the Bechtel Inspector.

2.62 Water shall be removed by pumping or or other methods approved by the Engineer, and shall be discharged to natural drainage courses, plant ditches or other sewers, in such a manner that other work will not be affected.

2.7 Backfilling

2.71 Trenches shall be backfilled immediately after the pipes have been laid and inspected, except that 24 hours shall be allowed for cement mortar joints to set before beginning backfilling. The following requirements do not apply to Class D bedding.

2.72 Refilling of the trench around the pipe shall be with a granular compactible material free from stones exceeding 3 inches in largest dimension, frozen lumps, chunks of highly plastic clay or other deleterious material.

2.73 Fill material for the area above a plant 12 inches above the top of the pipe may contain gravel and stones under 6 inches in diameter except as governed by other applicable sections of this or applicable specifications.

2.74 Backfill material shall be placed equally along both sides of the pipe, in uniform layers not exceeding 6 inches loose depth, and compacted by hand, pneumatic tamper or other approved means, to a height equal to the top of the pipe for Class C bedding and 12 inches above the top of the pipe for Class A and B bedding. The remainder of the trench shall be backfilled and compacted to a density equal to the specified for the particular area, or equal to that of the in-situ material.

2.75 Compaction by water jetting or flooding may be used for trench backfill where approved by the Bechtel Inspector. Soils compacted by water jetting or flooding shall produce a minimum relative compaction of 85% of maximum density as determined by ASTM D2049 for cohesionless free draining soils and ASTM D1557 for other soils. Compaction by water shall not be permitted for the top 4 feet of trench backfill under paving, roads or railroads.

2.76 For pipe in an embankment or fill, material above the top of the pipe shall be placed in accordance with the requirements for placement of the embankment or fill.

2.77 No construction machinery or vehicles shall be allowed to pass over the trench until the trench is backfilled and compacted sufficiently to prevent damage to the pipe.

3. CULVERTS

3.1 Multiple installations of pipes shall be laid with the center line of individual barrels parallel. Unless otherwise indicated, the clear distances between outer faces of adjacent pipes shall be as follows:

Nominal Inside Diameter of Pipe	Clear Distance Between Pipes
18" and under	0'-9"
21" and 24"	0'-11"
27" and 30"	1'-1"
33" and 36"	1'-3"
36" and 42"	1'-5"

3.2 Corrugated metal pipe shall be laid with the separate sections joined firmly together and without side laps or circumferential joints pointing upstream and with longitudinal laps on the sides.

3.3 If paving of inverts, bituminous coating or bituminous lining is required for corrugated metal pipe, it shall be in accordance with the provisions of AASHO Designation M190, "Standard Specifications for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches."

3.4 If headwalls or flared end sections are not required for corrugated metal pipe, the ends of all 14- and 16-gage installations shall be reinforced. Reinforcement shall consist of a galvanized steel rod not less than 7/16-inch diameter rolled in the sheet, or by a galvanized metal band equivalent in cross-section to 3/8-inch thick by 1-1/2 inches wide, or by increasing the outer one foot of 16-gage and 14-gage pipe to at least 12-gage material. Bands shall be fastened to the pipe at maximum intervals of 10-inches on each edge of the band.

3.5 Culverts without headwalls or flared end sections, and located so that the culvert invert is at the toe of a slope, shall be installed so that the end of the culvert will extend at least one foot beyond the toe of slope. Culverts located so that the invert of the culvert is above the toe of a slope at the discharge end, shall be protected against erosion by headwalls, flared end sections, rip-rap or similar methods, as shown on the drawings or as approved by Engineer.

3.6 All backfill for culverts shall be selected fine compressible material, such as silty clay or loam, and shall not contain stones or lumps or earth over 3 inches in largest dimensions. Backfill material shall be compacted in maximum 6-inch layers to the density specified for the surrounding embankament or fill. Water tamping of backfill will not be permitted. Where fine compressible material is not readily available, a granular backfill may be used for all but the outer 3 feet at both ends of the culvert which shall be backfilled with selected fine compresible material.

4. UNDERDRAINS

4.1 Underdrains shall be perforated corrugaged metal pipe, AASHO Designation M-36. Field joints shall be made with bands of the same base metal as the pipes.

4.2 If paving of inverts, bituminous coating or bituminous lining is required by the project specifications then it shall be in accordance with the provisions of paragraph 3.3 of these specifications.

4.3 Filter material for underdrains shall be placed on all sides of subdrains. There shall be 2 inches of filter material placed below the subdrain and a minimum of 6 inches on each side and above the subdrain.

4.31 Where grain size distribution curves are available for the soils to be drained, the filter material shall meet the following criteria:

($D_{15}S$ - The grain size in mm where 15 percent by weight of the material is finer than in size for the soil to be drained.

$D_{15}F$ - The same for the Filter material)

The ratio $\frac{D_{15}F}{D_{15}S}$ is greater than 4 and less than 20

The ratio $\frac{D_{15}F}{D_{85}S}$ is greater than 5

The ratio $\frac{D_{50}F}{D_{50}S}$ is less than 25

The shape of the grain size distribution curve for the filter material shall approximate that for the soil to be drained. Where a multiple layer filter is required, the above criterion shall apply to each adjacent layer.

4.32 Where grain size distribution curves are not available for the soil to be drained the following filter material shall be used.

For fine-grained soils or silty and clayey sands, the filter material shall be a well graded fine aggregate conforming to the requirements of ASTM C33, Concrete Sand.

For non-plastic silt or clay with sand or silt lense, the filter material shall be a well graded fine aggregate conforming to the requirements of ASTM D1073, Asphalt Sand.

4.4 Width of trenches shall not be greater than required for installation of pipe and tamping of backfill but shall not be less than the outside diameter plus twelve inches. The bedding surface shall provide a firm foundation of uniform density for the full length of the pipe.

4.5 The pipe shall be imbedded firmly in the filter material, and laid with the perforations down and centered about the flow line. Separate sections shall be firmly jointed with metal bands.

4.6 Trenches in open areas shall be backfilled with the excavated material to an elevation one foot below finish grade. The top one foot of the trench shall be backfilled with impervious material. Compaction of the backfill shall be greater than the existing material in place, and the relative compation shall be a minimum of 85%.

4.7 Where drains are located under other construction, trench backfill above the filter material shall meet the requirements of section 2.7 of these specifications.

5. REINFORCED CONCRETE PIPE

5.1 Materials

5.11 Pipe shall be as specified in "Reinforced Concrete Culvert Pipe", ASTM Designation C-76 and as specified herein. All pipe under 60 inches in diameter shall be machine-made. The manufacturing equipment used shall provide uniform and continuous placement of the concrete in the forms. Concrete shall be consolidated by mechanical devices, other than hand tamping, which shall provide a dense concrete without disturbing or displacing the steel reinforcement. The pipe shall be substantially free from fractures, large or deep cracks, laminations and surface roughness. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis. The pipe shall be such that when laid, the pipe sections shall form a continuous conduit with a smooth and uniform interior surface.

5.12 Rubber gaskets shall conform to the requirements of ASTM C-443. The basic polymer for gaskets to be used in industrial sewers shall be resistant to attacks by hydrocarbons, acids, caustics or other material to be carried by the sewer.

5.13 Cement for mortar shall conform to the "Standard Specifications for Portland Cement", ASTM C150-60, for type I or IA. Fine aggregate for mortar shall consist of sands conforming to the "Standard Specifications for Concrete Aggregates", ASTM Designation C33, except that the sand shall be uniformly graded and shall meet the following grading requirements.

Sieve Designation	3/8"	No. 4	No. 16	No. 50	No. 100	No. 200
Percent Passing	100	95-100	45-80	15-40	0-10	0-5

5.2 Joints

Joints shall be made with (a) Rubber gaskets, (b) Portland cement mortar.

5.21 Rubber Gasket Joints

The rubber gasket shall be a continuous rubber ring fitted snugly between the tongue and groove ends to form a flexible water-tight seal, Pipe ends shall be formed on machined rings to insure accurate joint surfaces. Joints shall remain water tight after a section is deflected so that one side of the annular space is a half-inch wider than the normal opening. Joints shall be so designed to prevent the gasket from supporting the wieght of the pipe or external loads.

Gaskets shall be stored in as cool a place as practicable and in no case shall be exposed to the sun for more than seventy-two hours. Joints shall be made according to the gasket manufacturer's recommendations.

5.22 Mortared Joints

The mortar mixtures shall be one part Portland cement, and two parts of sand. Quantity of water shall be sufficient to produce a stiff, workable mortar but shall not exceed 5-1/2 gallons per sack of cement. Pipe ends shall be thoroughly cleaned and wetted with water before the joint is made. Stiff mortar shall be placed in the lower half of the bell or groove of the pipe section already laid, and on the upper half of the spigot or tongue of the section being laid. The two sections shall then be tightly joined with their inner surfaces flush and even.

5.23 Finishing Joint

5.231 The intent for all joints using cement mortar or cement grout is to have the joint completely filled and to have a smooth interior surface of the conduit.

5.232 After the joints have been made as specified in 5.21 and 5.23 above, the inside surface and annular recess shall be cleaned. For small pipes a tight stopper of burlap or equivalent material shall be dragged past the new joint.

5.233 Voids occurring in the outer and inner annular sealing material shall be completely filed with the same type sealing material used for the joint and the inside of the joint finished smooth. For pipe over 30 inches in diameter the inside of the joint shall not be finished until all fill over the pipe has been completed.

5.234 For bell and spigot pipe, a bead shall be formed on the outside by adding mortar and troweling smooth from the outer edge of the bell at a 45° angle with the adjoining pipe. For tongue and groove pipe, a bead shall be formed extending at least one inch on either side of the joint and of approximately semi-circular or triangular cross-section.

5.235 After the initial set, the mortar on the outside shall be protected from air and sun, and kept wet for a minimum of 48 hours or until backfill is completed. No jointing shall be done when the temperature is below 40°F unless approved by the Engineer.

5.236 Joints made with flexible gaskets shall be installed and gasket placement checked in accordance with the manufacturer's recommendations.

6. VITRIFIED CLAY PIPE

6.1 Materials

6.11 Pipe shall be as specified in ASTM Designation C-200, "Specifications for Extra-Strength Clay Pipe".

6.12 Factory-made compression joints shall be as specified in "Vitrified Clay Pipe Joints Using Materials Having Resilient Properties", ASTM Designation C-425. Jointing materials for industrial or special sewers shall be resistant to attack from the materials carried by the sewer.

6.13 For chemical resistant joints where compression joints are not suitable for the required service, joints shall be made using corrosion proof materials such as the Alkor-Vitrobond 120 joint. Joining material shall be Sealite 310 asbestos-fiberglass yarn. This joint is rigid and, when used, adequate measures shall be taken to prevent joint deflection after installation.

6.2 Joints

Joints shall be made from (a) factory-made compression joints or (b) chemical-resistant joints. Factory made compression joints shall be in conformance with ASTM C425, "Compression Joints for Vitrified Clay Bell and Spigot Pipe". Where a compression type gasket is not available for pipe which is field cut to length, a coupling which conforms to the requirements of ASTM C594, "Compression Couplings for Vitrified Clay Plain End Pipe", shall be used.

7. CAST IRON SOIL PIPE

7.1 Materials

7.11 Pipe and fittings shall be extra heavy cast iron soil pipe as specified in Commercial Standard CS-188.

7.12 Rubber gaskets for compression joints shall be as specified in ASTM C564, Rubber Gaskets for Cast Iron Soil Pipe and Fittings. Gaskets shall be compatible with the pipe furnished and be supplied by the same manufacturer as the pipe.

7.2 Joints

Joints shall be made from a) compression joints or b) hot poured lead and oakum joints. The compression joint shall be used whenever it is available and suitable for the service required.

7.21 Compression joints shall be installed in accordance with Section 9c - "Joining of Push-On Joint Pipe" of AWWA C600.

7.22 Hot poured lead and oakum joints shall be made in accordance with the applicable provisions of Section 9a - Joining of Bell and Spigot Pipe", except that the minimum required depth of lead in the joint shall be one inch and the yarning material may be oakum.

8. ASBESTOS-CEMENT PIPE

8.1 Materials

8.11 Non-pressure sewer pipe, fittings and couplings shall be as specified in ASTM C428,"Asbestos-Cement Nonpressure Sewer Pipe" and shall be of the sizes and classes as shown on the construction drawings and specifications.

8.12 Pressure pipe, fittings and couplings shall be as specified in ASTM C296, "Asbestos-Cement Pressure Pipe", and shall be of the sizes and classes as shown on the construction drawings and specifications.

8.13 Rubber rings used to the seal the joints for both non-pressure and pressure pipe shall be as specified in ASTM D 1869,"Rubber Rings for Asbestos Cement Pipe,"and shall be resistant to damage from the material carried in the sewer. Rubber rings shall be furnished with the couplings.

8.14 Linings for pipe fittings and couplings shall be in conformance with the requirements in ASTM C 541,"Linings for Asbestos Cement Pipe." Specific requirements for linings to meet predicted service conditions in addition to, or in lieu of, those in ASTM C 541 may be called for and shall be as stated in the materials requisition or purchase order for the lined pipe and fittings. Lined couplings shall be furnished with rubber gaskets suitable for the predicted service conditions.

8.2 Joints

8.21 Joints shall be installed in accordance with manufacturer's recommendations.

8.22 Couplings shall not bear directly on the trench bottom prior to backfilling operations.

8.23 The location of rubber rings shall be checked at each coupling with a suitable gage to verify that each rubber ring is in the required position.

9. TESTING

9.1 Testing of sewers and drains will not be required unless indicated in the project plans and specifications. If testing is required for the project, the following procedures shall be used.

9.2 Where sewer lines are below the ground water level, the system shall be tested for infiltration by sealing off all but the discharge end of the line being tested, and measuring the rate of discharge of infiltrated water.

9.3 Where sewer lines are above the ground water level, the system shall be tested by sealing off the section of sewer line to be tested, and filling this section of line with water to a minimum head of six feet above the upstream invert of the line. After a maximum absorption period of four hours, refill the line to a 6-foot head of water and measure the loss for the next two hours.

9.4 For pipes joined with compression joints, the allowable leakage or infiltration shall not exceed 0.6 gallons per hour per inch diameter per 100 lineal feet.

9.5 For pipes joined with cement mortar or grouts the allowable leakage or infiltration shall not exceed 1.2 gallons per hour per inch diameter per 100 lineal feet.

10. CLEANING AND REPAIRING SEWERS

10.1 The system shall be kept clean during construction, and as construction nears completion, it shall be systematically cleaned and any needed repairs completed.

10.2 Dirt, mortar, other joint material and foreign matter shall be cleaned from the system before the system is placed in service.

11. PAVING, RESTORING, AND CLEANING UP AREA

11.1 As soon as the work is completed and approved, the area or roadway surface shall be restored to the equivalent of the original condition.

11.2 Surplus soils shall be removed to approved spoils disposal areas.

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1C-21-81	ATTACHED SPECIFICATIONS S-521 & S-523			
11/19/80	ISSUE FOR PHASE ZERO			
8/80	ISSUE FOR APPROVAL			

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
PROJECT SPECIFICATIONS
DESIGN OF ROADS AND PAVING

JOB NO. 14222
SPECIFICATION 14222-S-2 REV 2

1. GENERAL

1.1 This specification establishes the design requirements for roads and paving. Extent of work shall be as shown on Bechtel proposal drawings. Supplemental or modifying requirements to this specification shall be as shown on Bechtel project drawings or specifications, or addenda to this specification.

1.2 Supplementary Bechtel Specifications

Refer to the following standard specifications for material and construction requirements.

14222-S-1	Design Specification - Design of Sewers and Drainage
S-521	Construction Specification - Site Preparation
S-523	Construction Specification - Concrete Pavement
14222-Q-2	Construction Specification - Plain and Reinforced Conc.

1.3 Related Documents

Structural design of pavements shall be in accordance with applicable sections of the following documents:

1.3.1 Thickness Design for Concrete Pavement, Portland Cement Association

1.3.2 Joint Design for Concrete Pavement, Portland Cement Assoc.

1.3.3 Thickness Design, Asphalt Pavement Structures for Streets and Highways, The Asphalt Institute

1.3.4 Construction Specifications for Asphalt Concrete (SS-1), The Asphalt Institute

1.3.5 Standard Specifications for Highway Bridges, The American Association of State Highway and Transportation Officials (AASHTO), 1977

1.3.6 Kentucky Standard Specifications for Road and Bridge Construction. Dept. of Transportation Bureau of Highways Frankfort, Kentucky, 1979

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1.4 Design Information

1.4.1 The following road classifications shall be used for the design of roads within the plant site.

Primary Road - A main traffic arterial or a tanker truck or semi-trailer truck route.

Secondary Road - A road subject to regular operational or maintenance traffic but not subject to high traffic volume.

Service Roads - A road which serves remote areas or provides access for firefighting equipment.

Accessways - A road or distinctly delineated travelled way which provides access to equipment in congested areas.

1.4.2 Geometric design of roads within plant limits shall be based on the following design speeds.

Primary Roads for semi-trailer truck traffic - 30 mph
Other Primary Roads - 25 mph
Secondary Roads - 20 mph
Service Roads - 15 mph

Passing sight distance shall not be used as limiting design criterion

1.4.3

Grade Limitations	Maximum	Minimum
Primary Roads	5.0%	-
Secondary Road	7.5%	-
Service Roads	10.0%	-
Accessways (Ramps)	10.0%	-
Parking Areas	5.0%	flat
Area Paving	3.0%	1.0%

1.4.4 Minimum radii to edge of paving or surfacing for 90° intersection.

Primary roads for semi-trailer truck traffic - 40.0 ft.

Other primary roads and secondary roads - 15.0 ft.

Service Roads and Accessways - 10.0 ft.

1.4.5 Horizontal and Vertical Clearances

At roads without raised curbs a horizontal clearance of 3 feet shall be maintained between the edge of paving, or travelled way in the absence of paving, and any structure projecting above shoulder grade. However, for guard rails and traffic signs the minimum horizontal clearance shall be 2 feet from edge of paving travelled way.

At roads with raised curbs the minimum horizontal clearance shall be 2 feet from the face of curb.

Horizontal clearances shall be maintained to the required vertical clearance for the road classification.

Minimum vertical clearance over roads shall be 15 feet.

1.4.6 Minimum lane and shoulder widths shall be as listed below. Shoulder and/or gutter widths shall be added to the lane widths to obtain minimum roadway widths.

Classification	Lane Width	Shoulder
Primary	12'	4'
Secondary	11'	3'
Service - 2 lane road	10'	2'
Service - 1 lane road	12'	2'

2. PRIMARY ROADS

2.1 Primary roads shall be designed for AASHO H20-S16 wheel loading. All primary roads shall be paved using either concrete or hot-laid plant mixed asphalt surfacing.

2.2 Portland cement used in concrete pavement shall have a minimum 28 day compressive strenght of 3,000 psi. For this concrete a maximum 90 day modulus of rupture of 500 psi may be used for pavement thickness design.

2.3 Structural design of pavement shall be based on stabilometer "R" values and expansion pressures, CBR values, or local practice.

3. SECONDARY ROADS

3.1 Secondary roads shall be designed for AASHO H15 wheel loading. All secondary roads shall be paved with hot-laid plant mixed asphalt surfacing. Areas subject to major hydrocarbon spillage shall be paved with concrete and suitable drainage shall be installed to prevent damage to adjacent asphalt paving.

3.2 Paving shall be designed as specified in paragraph 2.3.

4. SERVICE ROADS

4.1 Service roads shall not normally be paved except where conditions are such that an unpaved surface will not provide satisfactory service. Service roads shall be designed in accordance with local practice.

4.2 An asphalt single surface treatment or an asphalt penetration macadam surface shall be used where an unpaved surface is unacceptable. In areas subject to excessive hydrocarbon spillage, concrete pavement designed for AASHTO H10 wheel loading shall be used.

5. ACCESSWAYS

5.1 Accessways shall be designed for ASSHO H15 wheel loadings. Concrete pavements shall be used in areas subject to excessive hydrocarbon spillage. Hot-laid plant mixed surfacing shall be used in other accessway areas.

5.2 Paving shall be designed as specified in paragraph 2.3.

6. PARKING AREAS

6.1 Parking areas serving cars or light trucks only shall be surfaced with 6" of gravel road base material.

6.2 Parking areas serving H10 or heavier trucks shall have a pavement structure equal to the road(s) serving the parking area. Concrete paving shall be used in areas subject to excessive hydrocarbon spillage.

6.3 Automobile parking lot layout shall be based on the following minimum dimensions. Parking stall: width = 9' and length = 19'. Driveway widths for various angles of parking shall be 90^{o} = 24 feet; 60^{o} = 18 feet; 45^{o} = 13 feet.

7. AREA PAVING

Area paving is paving which is provided around or beneath equipment or is used as a work area or storage area.

7.1 Minimum paving as required for access or work space around equipment shall be installed.

7.2 Flexible pavement shall be used in open areas and concrete paving shall be used in congested areas or areas subject to drips or spills harmfull to asphalt. Areas used by mobile equipment, shall be designed as accessways.

7.3 In operating areas paving shall be divided into areas of 80' x 80' maximum size and sloped to catch basins set 6" $\pm$ below high point of finish grade. Operating areas shall not drain into areas beneath pipeways. Gravelled or unsurfaced areas shall not drain across paving in operating areas.

7.4 For reinforced concrete pavement not subject to wheel loads 4-inch thick pavement reinforced with 6" x 6" x 10 ga. wire mesh shall be used.

7.5 Concrete pavement shall be provided at shell and tube exchangers where hydrocarbon spillage during maintenance operations is expected. Pavement shall extend a minimum of 6 feet into the bundle pulling area as measured from the center of channel.

7.6 Graded areas not indicated as being paved on the drawings, and not required by the specifications to be paved, shall be constructed as indicated on the drawings, but shall receive no further surface treatment.

7.7 Control joint spacing in concrete paving shall not exceed 20' unless otherwise noted on the drawings.

8. MISCELLANEOUS

8.1 Walkways and pedestrian paths at grade shall be a minimum of 3' wide.

1. GENERAL

1.1 Scope

This specification establishes the construction requirements for site preparation and earthwork. The extent of work for each project shall be as shown on Bechtel drawings. Construction shall be true to the line, grade and cross-sections as shown on the drawings, and as described herein. Supplementary or modifying requirements to this specification shall be as defined on Bechtel project drawings, or addanda hereto.

1.2 Related Documents

Refer to the following standard specifications for additional information and requirements:

S-522 Construction Specification - Sewers and Drainage

S-523 Construction Specification - Roads and Paving

S-525 Construction Specification - Railroads

1.4 Tests and Inspection

1.41 Compaction (relative compaction) shall be determined by the methods described in "Moisture Density Relations of Soils Using 10-lb. Rammer and 18-in. Drop", ASTM D 1557.

1.42 All work done by sub-contract shall be subject to inspection, testing and approval by a Bechtel Inspector or his authorized representative.

2. CLEARING AND GRUBBING

2.1 Clearing

The entire area within the limits of clearing, indicated on the drawings, shall be cleared of all materials above or at the natural ground surface. Materials to be cleared include trees, down timber, brush, rubbish and vegetation.

2.2 Grubbing

The entire area within the limits of clearing shall be grubbed of all stumps, large roots and buried logs having a diameter larger than 3 inches, and other objectionable material and/or decayed vegetable matter, to a depth of not less than 12 inches below natural grade. Any exceptions to this will be indicated on the drawing.

NO.	DATE	REVISIONS	BY	CH'K	APPR
2					
1	5/71	General Revision			
0	12/62	Issued as a Standard Specification			

ORIGIN			JOB No. STANDARD	
R&C ENG. SF CIVIL/STRUCT	BECHTEL	CONSTRUCTION SPECIFICATION SITE PREPARATION AND EARTHWORK	SPEC. DES. GUIDE No. S-521	REV. 1

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2.3 Disposal

Debris from clearing operations shall be burned, or stockpiled for future burning. Debris shall be burned as soon as possible. Material too wet to burn shall be piled in windrows for later burning. Material from grubbing operations shall be removed to the spoils disposal areas as designated by the inspector.

3. STRIPPING

3.1 The area within the limits of stripping indicated on the drawings shall be stripped of all top soil containing organic matter, debris, and other material which, in the opinion of the inspector, is not suitable for permament engineered fills.

3.2 All stripped material shall be removed to designated disposal areas.

4. BORROW PITS

Borrow pits, other than those shown on Bechtel drawings, shall not be used unless approved by Bechtel Project Engineer, or his representative.

5. ROCK EXCAVATION

Rock excavation shall consist of the excavation of boulders 1/2 cubic yard or greater in volume, and all rock in ledges, bedded deposits, and conglomerate deposits so firmly cemented as to present all the characteristics of solid rock, and which could not be removed by means other than drilling and blasting.

6. GENERAL SITE WORK

6.1 Excavated material from the site shall be used if suitable for fills and embankments. Fill material shall be from deleterious matter and shall be subject to the approval of Bechtel Inspector.

6.2 All unsuitable or excess excavation shall be removed to disposal areas, as shown on Bechtel drawings, or as agreed upon with Bechtel.

6.3 Good drainage shall be maintained at all times.

6.4 Subcontractor shall nofify Bechtel Inspector if sand or other highly erosive soil concentrated ground water or other potentially unstable condition is encountered on the face of a cut slope.

6.5 In-place material shall be compacted as specified in Section 8 of this specification.

6.6 Fill material, unless otherwide indicated on the drawings or specifications, shall be compacted to a minimum relative compaction of 90%.

6.7 Tolerance for this work shall be plus or minus one-tenth of a foot to required elevation.

7. DITCHES, DEPRESSED PIPEWAYS, PONDS AND BASINS

7.1 Overexcavation of ditches and depressed pipeways shall be avoided. Overexcavated areas shall be brought to the required grade with compacted fill material.

7.2 Acceptable excavated material shall be used for fill material. Unsuitable or excess excavated material shall be removed to disposal areas.

7.3 Tolerance for excavation for ditches and depressed pipeways shall be plus or minus three-tenths of a foot to required line, and to the required grade.

7.4 Tolerance for ponds and basins shall be plus or minus five-tenths of a foot to required line, and plus or minus two-tenths of a foot to required grade. Any required volumes of ponds or basins shall be maintained irrespective of the allowed tolerances for location.

8. COMPACTING ORIGINAL GROUND

8.1 After stripping is completed, if the upper six inches of in-place material has a relative compaction of less than 90%, it shall be compacted until a minimum relative compaction of 90% is attained.

8.2 All in-place material within 18 inches of finish grade for roads, railroads, or paving subject to wheel loads shall have a minimum relative compaction of 90%. Material within this area having less than 90% relative compaction shall be removed and replaced, or compacted in place to attain a minimum relative compaction of 90%.

9. ROADS, RAILROADS AND EARTH FIREBANKS

9.1 All rocks that protrude above final subgrade for roads and railroads shall be removed.

9.2 In-place material shall be compacted as specified in Section 8 of this specification.

9.3 Embankments shall be compacted as specified in Section 11 of this specification. Road and railroad embankments shall be compacted to a minimum relative compaction of 90%; earth firebanks to a minimin of 85%.

9.4 Embankments shall be compacted in successive layers for the full width of the cross-section, and in lengths to suit the sprinkling and compaction methods utilized. Layers shall be constructed paralled to the finish grade, with a minimum cross slope of 1/4" per foot.

9.5 Tolerances for road and railroad embankments shall be plus or minus two-tenths of a foot to the required line and shall be to the required grade.

9.6 Tolerances for earth firebanks shall be plus or minus three-tenths of a foot to the required line, and plus or minus one-tenth of a foot to the required grade.

10. METHOD OF COMPACTION

10.1 Material for fill or embankment construction shall be spread in uniform, level layers not to exceed six inches in loose depth, except that layers for earth firebanks may be 12 inches loose depth.

10.2 All clods or lumps shall be broken up and the material shall be mixed by blading, harrowing, or similar methods until a uniform layer of uniform density is obtained. Each layer of material shall be uniform as to material, density, and moisture content before beginning compaction.

10.3 Prior to compacting, the moisture content of the material shall be brought within plus or minus two per cent of the optimum moisture content as described in ASTM D1557. The moisture content shall preferably be on the wet side for potentially expansive soils.

10.4 All material containing excessive moisture shall be dried by manipulating with harrows, cultivators, rotary speed mixers, or similar equipment, and all material containing insufficient moisture shall be sprinkled until the moisture content is within specified limits.

10.5 A uniform surface shall be maintained during compacting order to insure uniform compaction of the entire layer.

10.6 Each layer shall be brought to the required density, and checked by appropriate field tests before proceeding with the next layer. If the material fails to meet the required compaction rework or replace the material, and alter the construction methods as necessary to obtain the required compaction.

Continuous testing of each layer shall be done until test results indicate a satisfactory method of constructing a consistently acceptable fill has been established. Subsequent layers shall be spot checked as deemed necessary by the soils engineer or Bechtel Inspector to insure the fill constructed continues to meet specified requirements. When testing indicates fill is not being placed correctly, continuous testing, in addition to necessary corrective work, shall be instituted. Continuous testing of each layer shall be done whenever a change in construction methods or materials occurs.

10.7 Excess material shall be removed as directed, and finished to a tight uniform surface.

11. EROSION CONTROL

Upon completion of finish grading, earth firebanks and slopes shall be temporarily protected against erosion by applying a coat of liquid asphalt to the surface, as indicated below:

11.1 Tightly bonded surfaces: 0.3 gal/S.Y. of MC-30.

11.2 Loosely bonded fine-grained surfaces: 0.5 gal/S.Y. of MC-70 or SC-70.

11.3 Loosely bonded coarse-grained surfaces: 0.3 gal/S.Y. of MC-250 or SC-250.

FORM 283

1. GENERAL

1.1 Scope

This specification in conjunction with Standard Specification Q-503, "Plain and Reinforced Concrete" establishes the material and construction requirements for constructing Portland cement concrete pavement for roads, accessways and area paving. The Engineer may alter the requirements of this specification as required to meet the project conditions. Special requirements called for on the drawings shall govern over the provisions of this specification. Specific requirements set forth herein shall govern over any conflicting provisions of Specification Q-503.

1.2 Definitions

Engineer - Bechtel's Project Engineer.
Inspector - Bechtel's Field Engineer.

1.3 Codes

1.31 All design, construction and materials shall be in accordance with the American Concrete Institute's Standard Building Code Requirements for Reinforced Concrete, ACI 318-71.

1.32 Supplemental requirements are listed as American Society for Testing and Materials (ASTM), or American Association of State Highway Officials (AASHO) Standards, most recent editions.

2. TESTING LABORATORY

See Standard Specification Q-503.

3. INSPECTION

See Standard Specification Q-503.

4. MIXING PLANT

See Standard Specification Q-503.

5. MATERIALS FOR CONCRETE

5.1 See Standard Specification Q-503.

No.	DATE	REVISIONS	BY	CH'K	APPR
2	9/72	General Revision.			

ORIGIN			
R&C ENGR. S.F. STRUCT.		STANDARD SPECIFICATION CONSTRUCTION OF CONCRETE PAVEMENT	JOB No. STANDARD; SPEC S-523; REV. 2

Form no. A-1

5.2 Air entrained concrete shall be used in areas subjected to severe frost action for concrete pavement of primary and secondary roads, area paving, and for access ways. The amount of entrained air, by volume, shall be between four (4) and seven (7) percent. Air entrainment may be by use of air entraining Portland cement, Type IA or IIA, as specified in ASTM C260, or by use of suitable admixtures (See Paragraph 8).

6. REINFORCEMENT STEEL (See Standard Specification Q-503).

7. PROPORTIONING OF CONCRETE (See Standard Specification Q-503).

8. ADMIXTURES (See Standard Specification Q-503).

9. FORMS (See Standard Specification Q-503)

10. PLACING CONCRETE (See Standard Specification Q-503).

11. FINISHING CONCRETE

11.1 General

Sequence of operations shall be: first, "strike-off and consolidation"; second, "longitudinal floating" and removal of laitance, followed by "straightedging", and final finish by brooming. Either the machine methods or hand methods may be used; however, only the hand methods are described in this Specification. Machine methods shall be as approved by the Inspector.

11.2 Strike-Off and Consolidation

11.21 Concrete shall be struck-off and screeded to cross section shown on the drawings and to such elevation that when consolidated and finished the surface of the pavement shall be to required grade.

11.22 The strike-off screed shall be moved forward with a combined longitudinal and transverse shearing motion, moving always in the direction the work is progressing, maintaining the template in contact with the forms, and keeping a slight excess of material in front of the cutting edge.

11.23 The concrete shall be tamped with an approved tamping template to compact the concrete thoroughly and eliminate surface voids: and the surface screeded to required section.

11.3 Longitudinal Floating

11.31 The hand-operated float shall not be less than 12 feet in length and 6 inches in width, properly stiffened to prevent flexibility and warping.

11.32 The float shall be worked with a sawing motion while held in a floating position, parallel to the center-line of road for road work, and passing gradually from one side of pavement to the other.

11.33 Movement ahead shall be in successive advances of not more than one-half the length of the float. Excess water or soupy material shall be wasted over the side forms.

11.4 Straight Edging

11.41 After the longitudinal floating has been completed and excess water removed, but while the concrete is still plastic, the slab surface shall be tested for trueness with a straight edge.

11.42 Any depressions found shall be immediately filled with freshly mixed concrete, struck-off, consolidated, and refinished. High areas shall be cut down and refinished.

11.5 Brooming

11.51 After floating and as soon as any surplus water has risen to surface, the pavement shall be given a broom finish.

11.52 Brooming shall produce corrugations in the surface of uniform appearance and not more than 1/16 inch in depth.

11.53 Surface when finished shall be free from rough and porous areas, or irregularities or depressions.

11.6 Edging

After brooming is completed, but before concrete has its initial set, the edges of the slab shall be carefully finished with an edger of the radius required by the drawings, and the pavement edge shall be left smooth and true to line.

11.7 Surface Test

Plane surfaces shall be checked with an approved 10 foot straight edge. No more than 1/8" total deviation in 10' from a true plane will be acceptable. Repairs shall be as directed by the Inspector.

12. SURFACE DEFECTS (See Standard Specification Q-503).

13. CURING OF CONCRETE

13.1 Moist Method

Concrete shall be kept wet by the continuous application of a fine water spray or covered with burlap or suitable cotton mats which shall be kept wet continuously for 72 hours. Curing shall commence as soon as concrete has hardened sufficiently to prevent marring of the surface.

13.2 Waterproof Paper or Plastic Membrane Method

The entire surface shall be covered with waterproof paper, white burlap-polyethylene sheet or plastic sheet laid directly upon the concrete. The material shall conform to ASTM Designation C171. The sheets shall be lapped not less than 4 inches at edges and ends, and be sealed with adhesive or pressure-sensitive tape not less than 1½ inches in width. The membrane shall be weighted to prevent displacement. Holes appearing during the curing period shall be immediately patched. The membrane shall remain intact for not less than 72 hours after placing.

13.3 Curing Compound Method

A liquid membrane forming compound conforming to the requirements of ASTM C309 may be used where approved by the Engineer.

14. BEARING GROUTS AND GROUTING (See Standard Specification Q-503).

15. WATERSTOPS (See Standard Specification Q-503)

16. COLD AND HOT WEATHER CONCRETING (See Standard Specification Q-503)

17. CONSTRUCTION JOINTS (See Standard Specification Q-503)

18. EXPANSION JOINT MATERIALS

18.1 Expansion Joint Filler

Expansion joint filler shall conform to the requirements of ASTM D1751 for bituminous filler and ASTM D994 or D1752 for non-bituminous filler.

18.2 Joint Sealing Compound

Joint sealing compound shall conform to the requirements of either ASTM D1854 Jet Fuel Resistant Concrete Joint Sealer, Hot Poured Elastic Type; ASTM D2628, Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements; or ASTM D1850, Concrete Joint Sealer, Hot Poured Elastic Type.

19. CONCRETE CURBS AND SIDEWALKS.

19.1 For curbs, expansion joints 1/4 inch wide shall be constructed at 20 foot intervals and at the end of curb returns, and shall be at right angles to the curb.

19.2 The surface of sidewalks shall be marked into rectangles of not more than 16 square feet with a scoring tool, which will leave the edges rounded.

19.3 For sidewalks, expansion joints 1/4 inch wide shall be constructed opposite expansion joints in an adjacent curb, or if curb is not adjacent, at intervals of 20 feet.

19.4 Sidewalks shall be broom-finished, with brooming being transverse to direction of traffic.

REFERENCE SPECIFICATIONS

S-521 Site Preparation.
S-502 Roads and Paving.
Q-503 Plain and Reinforced Concrete.

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2	10-21-81	ATTACHED SPECIFICATION S-525			
1	11/11/80	ISSUED FOR PHASE ZERO	FB	HS	
0	10/29/80	ISSUED FOR APPROVAL	FB	HS	

ASFI THE BRECKINRIDGE PROJECT
U.S.DOE COOPERATIVE AGREEMENT NO. DE-FC05-800R20717
PROJECT SPECIFICATIONS
DESIGN OF RAILROADS

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

SHEET 1 OF 8

1.0 SCOPE

This specification establishes the design requirements for railroads. Supplementary or modifying requirements to this specification will be as shown on project drawings. All work shall meet the minimum requirements of the serving railroad.

2.0 EARTHWORK

2 Earthwork criteria established for the jobsite shall be used as applicable for trackage roadbed construction.

3.0 LAYOUT

3.1 Maximum permissible grade under normal conditions is 1.5% with 1.0% maximum grade wherever possible. Maximum permissible grade for switching or storage tracks where brakes are not to be set on the railcars is 0.15%. Maximum grade at loading dock stations shall be 0.0.%.

3.2 Maximum permissible degree of curvature is 12°-00'.

3.3 Minimum vertical clearance shall be 22' and side clearance 8' as shown on A.R.E.A. Clearance Diagram for Tangent Track and new Construction. Minimum distance between centerline of parallel spur tracks is 14 ft. on tangents with additional 1" per each degree of curvature on curves.

3.4 A minimum tangent of 100 ft. shall be provided between reverse curves. Minimum lenth of vertical curve shall be 100 ft.

3.5 No. 8 turnouts as shown on the AREA Trackwork Plans shall be used on loading or storage yard tracks. Mainline turnout shall be No. 10.

3.6 Super-elevation or spiral transitions shall not be used on loading or storage yard tracks.

3.7 Horizontal and vertical curves may occur on same stretch of track.

4.0 MATERIALS

2 Track materials and sub-ballast shall be as specified in Specification S-525.

5.0 DRAINAGE

5.1 Culverts and Subdrains

5.1.1 Material and design shall be as specified in Specifications 14222-S-1 and S-522 (attached to 14222-S-1).

FORM 283

5.1.2 Subdrains may be used to lower a potentially harmful water table in pervious soils.

5.1.3 The minimum clearance from the base of ties to flexible steel pipe culverts up to 48 inches diameter shall be 18 inches. The minimum clearance from base of ties to rigid pipe culverts shall be 2 feet. In normal conditions culverts and subdrains shall be placed so no part of the pipe shall extend above subgrade into ballast or sub-ballast. All culverts shall be checked for structural adequacy.

5.2 DITCHES

5.2.1 Side ditches shall be at least 2 ft. wide and 2.0 ft. below subballast.

5.2.2 Intercepting ditches shall be used along the upper side in cut sections if the natural ground slopes toward the cut for a substantial distance.

6.0 REFERENCES

Specifications 14222-S-1: Design Specification, Sewers and Drainage.

2 Specification S-522 : Construction Specification, Sewers and Drainage.

Specification S-525 : Construction Specification, Railroad.

Area Manual for Railway Engineering, Vol. 1 and 11 1976.

Area Track Work Plans, 1976.

1. SCOPE

This specification covers the general requirements for materials and methods of constructing a standard-gage railroad. Work, including materials, shall be guaranteed to meet the approval of the serving railroad.

2. NEW MATERIALS

New materials shall be used for the following items, except that re-layer material may be used for those items specified in Section 3.

2.1 Ballast

2.11 Crushed stone, crushed air-cooled blast furnace slag, or crushed gravel composed of hard, strong, and durable particles, free from injurious amounts of deleterious substances, and conforming to the requirements given on Pages 1-2-1 through 1-2-4 of the AREA Manual, Vol. I, shall be used.

2.12 Crushed stone or crushed slag shall conform to the grading requirements for AREA sizes 3, 4, or 5.

2.13 Crushed gravel shall conform to the grading requirements for AREA sizes G-1, G-2, or G-3, and shall contain 75% crushed pieces.

2.2 Sub-Ballast

2.21 Cinders, bank-run gravel or coarse sand shall be used.

2.22 Cinders shall be from hard coal, and free of brick bats, rubbish and deleterious materials.

2.23 Bank-run gravel shall consist of a natural gravel or an artificial mixture of hard durable pebbles, rock fragments or sand, and a maximum of 6 per cent of binder material (material passing 200 sieve).

2.24 Coarse sand shall have a maximum of 8 per cent of binder material.

2.3 Ties

Ties shall be Class T, conforming to the requirements given on Page 3-1-4 of the AREA Manual.

NO.	DATE	REVISIONS	BY	CH'K	APPR
	7/73	Updated			

ORIGIN			JOB No.	
R&C ENG. S.F. STRUCT.		STANDARD SPECIFICATION CONSTRUCTION OF RAILROADS	SPEC/ No.	REV.
			S-525	1

FORM NO. A-1

2.31 Size 3 cross ties (6 inches thick by 8 inches wide on top, by 8 feet long), conforming to the requirements given on Pages 3-1-1 through 3-1-16 of the AREA Manual shall be used.

2.32 Switch ties (7 inches thick by 9 inches wide on top, by the required length) conforming to the requirements given on Pages 3-2-1 through 3-2-4 of the AREA Manual shall be used.

2.33 Ties shall be treated in accordance with the requirements of the Standard Specifications of the AWPA: C-6, Standard for Preservative Treatment of Cross Ties and Switch Ties by Pressure Treatment; and P-2, Standard for Creosote-Coal Tar Solutions, Grade D.

2.34 Concrete ties may be used with the approval of the serving railroad.

2.4 Rail

Open-hearth steel rails of No. 1 classification shall be used. Rail shall weigh not less than 90 pounds per linear yard and shall conform to the requirements on Page 4-1-1, and 4-2-1 through 4-2-6 of the AREA Manual. The standard length of new rail shall be 39 feet at a temperature of 60°F. See Section 3.

2.5 Turnouts

2.51 Turnouts shall be furnished as a complete unit consisting of new materials throughout. Materials shall be as specified in the AREA trackwork plans for the turnout number specified on the construction drawings.

2.52 A switch shall consist of a pair of switch rails with double reinforced switch points, one or more rods to hold points in correct relation, gage and switch plates, heel blocks, jaw or transit clips and metal guards for foot protection, all in accordance with AREA Standards.

2.53 Switches shall be equipped with ground-throw switch stands, complete with targets. Switch stands shall be American Brake Shoe Company, No. 36D, or approved equal.

2.6 Miscellaneous

2.61 Track bolts shall be made from heat-treated corbon steel, and nuts from carbon steel. Bolts and nuts shall conform to the requirements given on Pages 4-2-15 through 4-2-18 of the AREA Manual.

2.62 Joint bars shall be made from high-carbon steel, and shall conform to the requirements given on Pages 4-1-6.2 and 4-2-9 through 4-2-11 of the AREA Manual.

2.63 Spring washers shall be made from steel by electric-furnace, open-hearth, or crucible process, and shall conform to the requirements given on Pages 4-2-19 through 4-2-21 of the AREA Manual.

2.64 Tie plates shall be made from low-carbon steel by electric furnace, open-hearth, or Bessemer process, and shall conform to the requirements given on Pages 5-1-1 through 5-1-3, 5-1-7, and 5-1-8 of the AREA Manual.

2.65 Track spikes shall be cut spikes, 9/16" x 5-1/2", made from soft steel by the Bessemer or open-hearth process, and shall conform to the requirements given on Pages 5-2-1, 5-2-2, and 5-2-6 of the AREA Manual.

2.66 Gage rods shall be non-insulated, adjustable type 1-1/4" steel rods threaded on one end and forged into a hook on the other. A steel clip with lock washer on the threaded end shall be used.

2.67 Bumping posts shall be made from carbon steel throughout, and shall be Hayes type WD or Buda Model No. 30.

2.68 Wheel stops shall be made from carbon steel, furnished in pairs with 2 anchor bars, and shall be Hayes Type SF or Buda Type A.

2.69 Derails shall be made from cast carbon steel and shall be Hayes Model Q and C, No. 2, or approved equal.

3. RELAYER MATERIAL

The following re-layer type material may be substituted for new material, but shall be clearly indicated as such on a quotation or subcontract.

3.1 Rail

3.11 Rail shall have a minimum of physical defects and shall pass the requirements for rails as given in 2.4 above, except for wear allowances, and shall be acceptable to the serving railroad.

3.12 Relayer rail shall be rail that weighed not less than 90 pounds per yard when new. Rail shall be full length 30-, 33-, or 39-foot rail. Twenty percent may be in shorter lengths, varying by one foot from 38 feet to 15 feet.

3.13 Re-layer rail with the following wear and defects shall be acceptable.

3.131 Head abrasive wear, not exceeding 12 per cent on one-half of the head width of the original, the abrasive wear being uniform along the entire length of rail.

3.132 Rail with end batter, provided the batter has been sawed back from this defect.

3.14 Rail with the following physical defects will not be acceptable: compound fissure, detail fracture, engine burn fracture, horizontal split head, vertical split head, crushed head, flowed head, piped rail, split web, weeping cracks, broken base, or rail which has been rejected as defective by detector.

3.2 Used joint bars and tie plates which have been in use with re-layer will be acceptable, provided they too have a minimum of physical defects.

4. CONSTRUCTION

4.1 Tracks shall be layed to the line, grades and cross-sections shown on Bechtel drawings. Construction shall be as specified herein and in the AREA Manual, Pages 5-4-1 through 5-4-4, except that subcontractor shall furnish ballast.

4.2 20 ties shall be used for 39-foot rails; 18 ties for 33-foot rails; and 16 ties for 30-foot rails.

4.3 Joints shall be staggered so that the joint on one side will not be more than 4 feet from center of the opposite rail. No joint shall be less than 3 feet from switch joints. Do not have joints in street and road crossings, unless absolutely necessary.

4.4 Tangent rails shall be spiked to ties with a minimum of two spikes per rail per tie, one inside and one outside of rail. On curves and turnouts, three spikes shall be used per rail per tie, with the additional spike on the inside of the rail.

4.5 Track shall be layed to the standard gage of 4' 8-1/2" on curves up to 8 degrees, and gage shall be widened 1/8 inch for each increment of 2 degrees, up to a maximum of 4'-9".

4.6 No super-elevation of outer rail is required, unless specifically indicated on the plans.

4.7 Gage rods shall be installed on all curves and turnouts; rods shall be spaced at 8 feet on center.

4.8 Turnouts and switches shall be installed in accordance with AREA Specifications.

5. CLEARANCES

Clearances shall conform to all local and State laws and regulations, and to the applicable rules, regulations and standards of the serving railroad.

6. MEASUREMENT

Method of measurement for pay quantities under unit prices shall be on the following basis:

6.1 Track

Lineal feet of trackage complete in place, based on centerline measurement, exclusive of turnouts. Track measurement shall end at point of switch and start at heel of frog.

6.2 Turnouts

Each complete in place, Turnout shall include both straight and turnout tracks from point of switch to heel of frog.

6.3 Bumping Posts and Derails

Each complete in place.

6.4 Wheel Stops

Pair complete in place.

7. REFERENCES

Standard Specification S-521 - Site Preparation and Earthwork

AREA Manual for Railway Engineering, Latest Edition

AREA Trackwork Plans, Latest Edition

FORM 203

Welding—W

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3					
2	10-21	ADDED P & IPT WELDING CRITERIA			
1	7/21/80	ISSUE FOR PHASE ZERO	AP	HS	
0	4/80	ISSUED FOR APPROVAL	BS	HS	

ASFI THE BRECKINRIDGE PROJECT AECI

U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717

STANDARD SPECIFICATION

GENERAL WELDING REQUIREMENTS FOR VESSELS

JOB NO. 14222

SPECIFICATION 14222-W-1 REV 2

1.0 SCOPE

This specification covers welding and nondestructive examination requirements for shop purchased or field subcontracted heat exchangers, pressure vessels, fired-heater tubes, and their attachments.

2.0 CODES

To the extent specified, welding and other criteria covered by this specification shall be in accordance with the following Codes and/or Standards. (The Codes or Standards specified in the purchase order shall be the current issue including revisions and addenda, mandatory on the date of the purchase order.)

2.1 ASME Boiler and Pressure Vessel Code; Section I, VIII, Division 1 and 2, and IX.

3.0 WELDING PROCESSES

3.1 The following welding processes are permitted, provided satisfactory evidence is submitted that the procedure is qualified in accordance with all applicable Codes, Standards and job specifications:

3.1.1 Shielded Metal-Arc (SMAW)

3.1.2 Gas Tungsten-Arc (GTAW); manual, machine and automatic.

3.1.3 Automatic Submerged Arc (SAW); with the following limitations:

3.1.3.1 The maximum individual layer thickness for submerged-arc welds shall not exceed 1/2 inch for materials 1-1/4 inch thick or greater and 3/8 inch for materials less than 1-1/4 inch thick.

3.1.3.2 Alloy steel shall only be welded with an alloy wire and a neutral flux unless the Buyer's written permission to proceed is given for individual applications.

3.1.3.3 Removable starting and stopping tabs shall be used for longitudinal welds.

3.1.4 Oxyacetylene (FGW); This process is limited to hard facing and repairs to cast iron. (Hardfacing of austenitic stainless steels with FGW is not allowed.)

3.1.5 Plasma Arc (PAW)

3.1.6 Flux Core Arc (FCAW); With or without a shielding gas, may be used to weld carbon steels and low alloy steels which contain up to 2-1/4 Cr-1 Mo. Steels containing more than 2-1/4 Cr-1 Mo. and corrosion-resisting chromium and chromium-nickel steels must be welded with a shielding gas.

3.1.6.1 FCAW is not permitted in the overhead position or the vertical position with downward progression.

3.1.7 Gas Metal Arc (GMAW); Shall be used only in the spray transfer range. Pulse arc is considered spray transfer. The short arc transfer mode may be used for materials up to and including 3/16 inch thick, and for the root pass in material of any thickness.

3.2 Other welding processes will be considered by the Buyer on a case by case basis.

4.0 RESTRICTIONS

4.1 All welding processes shall be protected from wind, rain and other harmful weather conditions which may affect weld quality.

4.2 Welding techniques shall be selected to assure specified tolerances for straightness and out-of-roundness are not exceeded. Whether or not tolerances are stated in the Buyer drawings, standards or specifications, the tolerance requirements of the relevant code always apply.

4.3 Permanently installed backing rings or strips shall not be used without prior written permission. Where a backing ring or support bar is used in a weld, this material shall be of the same composition as the base material and shall be completely removed by back-chipping or gouging. Proposals to use backing or support bars of compositions different from that of the base material must have all details reviewed by the Buyer and permission received in writing prior to use.

4.4 Peening shall not be used without prior written permission to proceed. The use of pneumatic tools for slag removal is not considered peening and is permitted.

4.5 An argon, helium or nitrogen internal purge shall be used for the Gas Tungsten-Arc root pass on single sided welds on 2-1/4 Cr-1 Mo. and higher alloys. P-1, P-3 and P-4 steels may be welded with or without an internal argon purge.

4.6 For Aluminum or Titanium butt joints welded from one side only, the root pass shall be made by the Gas Tungsten-Arc or Gas Metal-Arc process.

4.7 When welding Titanium, the gas shielding system shall include a glove box, envelope or other supplemental equipment that is specifically indicated in welding procedures. Each weld bead and adjacent base metal shall be cleaned to remove all surface discoloration prior to depositing the next bead. The final weld surface may have intermittent, iridescent straw-colored or light blue oxides.

4.8 For joining clad steels, the following limitations apply:

4.8.1 The cladding shall be stripped back a minimum of 1/4 inch from the edge of base material weld bevels by machining, chipping or grinding, not by flame or arc-gouging.

4.8.2 Removal of the cladding shall not reduce the base materials thickness below the design thickness.

4.8.3 A minimum radius of 1/16 inch shall be used at the limit of cladding removal unless the clad material is beveled at least 30 degrees.

4.8.4 Preparation of local repair cavities in overlay welds that penetrate into the base material more than 10 percent of its thickness shall have the base material re-welded with the proper welding procedure consistent with the base material before completing the overlay repair.

4.9 Weld deposits for alloy welds shall fall within the limits of chemical composition specified for the materials to be joined, unless otherwise permitted by the Buyer.

4.10 Production weld filler materials shall have mechanical properties within the limits specified for the base materials to be joined unless written permission to deviate is received from the Buyer.

4.10.1 In addition, completed welds and heat affected zones specified to be in severe service shall not exceed Brinell Hardness (BHN) as follows:

4.10.1.1 200 BHN in carbon steel welds and heat affected zones.

4.10.1.2 215 BHN in C-1/2 Mo. steel welds and heat affected zones.

4.10.1.3 241 BHN in low alloy Cr-Mo. steel welds and heat affected zones.

4.10.2 If a weld is postweld heat treated, the hardness test shall be conducted after the heat treatment.

4.10.3 Macro-hardness tests shall be taken approximately every ten feet of the weld seam with a minimum of one location per vessel. Whenever possible, readings shall be taken on the I.D. of the vessel weld or as determined by the Buyer's representative. If a test reveals hardness exceeding the specified limit by more than 5%, two more tests at locations six inches on either side of the original tests may be taken. If both of these two tests indicate that hardness is below the specified value, then the weld is considered acceptable.

4.10.4 Hardnesses exceeding the specified value by 5 percent or more, or subsequent adjacent tests showing higher than specified hardnesses are not acceptable. The welds showing excessive hardness shall be repaired. The repair procedure shall be reviewed by the Buyer and written permission from the Buyer must be granted to proceed.

4.11 Weld bevel preparations for P-5 and higher alloys shall be machined or ground back to bright and sound metal if they have been flame or arc cut.

4.12 All surfaces to be welded shall be free of scale, oil, grease, dirt and other contaminants.

4.13 Welded joints shall be made by completing each weld layer before succeeding layers are deposited. Block welding is prohibited unless the Buyer's prior written permission is obtained.

4.14 Vertical welding shall be done vertical up.

5.0 WELDING ELECTRODES

5.1 All Shielded Metal-Arc Welding shall be done using low-hydrogen type electrodes when any of the following conditions apply:

5.1.1 In service with design temperatures below minus $0^{\circ}F$.

5.1.2 With steels having a maximum specified or actual carbon content above 0.30 percent.

5.1.3 For steels having a specified minimum tensile strength of 70,000 psi and greater and the thickness exceeds one inch.

5.1.4 For SMA weld repair of steel castings.

5.2 Electrode classifications E6012, E6013, E7014, E7024 shall not be used for welding of pressure-retaining parts of vessels. These electrodes, however, may be used for non-pressure-retaining fillet welds of P-1 materials.

5.3 For Gas Metal-Arc Welding and Gas Tungsten-Arc Welding of P-1 steels, solid wire electrodes shall conform to ASME SFA-5.18, Classification E70S-2, E70S-3 or E70S-6.

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5.4 For Flux Cored-Arc Welding of P-1 steels, the electrodes shall conform to ASME SFA-5.20, Classification E60T-8, E70T-1, E70T-4, E70T-5, E70T-6 or E70T-G.

5.5 Carbon steels shall not be welded with C-1/2 Mo weld metal.

5.6 Filler metals and consumable inserts for austenitic stainless steel welds shall be selected and controlled to produce weld deposits that fall within the following ferrite ranges and numbers as determined by Figure 1, WRC Delta Ferrite Diagram, and the certified chemical analysis, unless other Buyer specifications have more restrictive limitations.

Weld Material	PWHT or Service Temperature	Ferrite %	Ferrite No.
	Less than 800 F	5-25	5.5 Min.
308, 308L	800 F and over	5- 9	5-9.8
316, 316L	Less than 800F	5-15	5-17
309, 309L	800 F and over	5- 9	5-9.8

5.7 Type 309 or 309L austenitic stainless steel welding materials shall be used for welding carbon or low alloy steels to austenitic stainless steels, including the first layer of austenitic stainless steel corrosion-resistant overlays.

5.7.1 When postweld heat treatment of a dissimilar joint is required, the carbon or low alloy steel member shall be "buttered" with Type 309L and postweld heat treated prior to welding to the austenitic stainless steel member.

5.7.2 For corrosion-resistant austenitic stainless steel overlays, where the carbon or low alloy steel base metal requires postweld heat treatment, the first weld layer shall be made with Type 309L. All other layers shall be made with low carbon grade welding materials.

5.8 The receipt, use, disbursal and retrieval of all welding filler metals shall be maintained under strict control with the storage, baking and drying as recommended by the manufacturer.

6.0 PREHEAT AND INTERPASS TEMPERATURE (P&IPT)

6.1 P&IPT shall be in accordance with the applicable codes and the latest addenda except that recommended minimum preheat temperatures shall be considered mandatory under this specification.

6.2 Welding may be performed only when the metal temperature is above 32°F.

6.3 In addition to governing code requirements, P-1 steels shall have a P&IPT of 200°F minimum when the thickness exceeds 1-1/2 inch.

6.4 The maximum preheat and interpass temperature for austenitic stainless steels shall be 350°F.

6.5 P&IPT shall be determined by temperature-indicating crayons, contact pyrometers or other equally suitable means. Temperature-indicating crayons used on austenitic stainless steels and nickel-base alloys shall not cause corrosive or other harmful effects and shall not contain more than 1 percent by weight of total halogens, or sulfur or 200 ppm by weight of inorganic halogens. It is the manufacturer's responsibility to determine suitable brands and melting temperatures that may be used. This information shall be made available to the Buyer's representative on request.

6.6 The P&IPT requirements listed above shall also apply to tack welding and to the welding of temporary attachments. Except for P-1 steels, the preheat requirements above shall also apply to all thermal gouging and cutting.

7.0 POSTWELD HEAT TREATMENT (PWHT)

7.1 PWHT for pressure vessels shall be in accordance with the applicable code and contract requirements with the following exceptions:

7.1.1 A minimum of 1250°F on P-4 materials is required.

7.1.2 For P-6 materials, the PWHT temperature used shall be the lowest possible to avoid overheating and hardening on cooling and the material shall be checked after PWHT to ensure that the Brinell Hardness does not exceed 241.

7.2 When the Code specifies only a minimum PWHT temperature, the maximum PWHT temperature shall not exceed the minimum by more than 150°F with the following exceptions.

7.2.1 For materials which have been previously hardened by normalizing and tempering or quenching and tempering the PWHT temperature shall be the lowest possible to avoid degradation of base metal properties.

7.3 For vessels and heat exchangers, a minimum of two positively attached thermocouples is required. When there are varying thicknesses, one shall be on the thickest and one on the thinnest section. (Other Buyer job specifications may require additional thermocouples.)

7.4 Direct impingement by torch or furnace burner heating is not permitted for PWHT.

7.5 Exothermic heat treatment is prohibited.

8.0 WORKMANSHIP, VISUAL QUALITY EXAMINATION AND INSPECTION

8.1 Each layer of welding shall be essentially smooth and free of slag, inclusions, cracks, porosity, lack of fusion and undercut; except to the extent permitted in the referenced Codes. In addition, the cover pass shall be essentially free of coarse ripples, irregular surface, non-uniform bead patterns, high crown and deep ridges or valleys between beads.

8.2 Butt welds shall be slightly convex and have full penetration, unless otherwise specified and permitted in the applicable Code.

8.3 Removal of weld defects shall be verified by NDE before repair is started. Repair welding shall be done only by qualified welders using qualified procedures.

8.4 Overlay welds on vessels, heat exchangers and tubesheets shall be liquid-penetrant examined. This shall be done after final machining and postweld heat treatment when machining and/or postweld heat treatment is required.

8.5 During fabrication, a portion of the clad surface may be removed such as to weld in internal attachments or as the result of cutting a hole and welding in a nozzle. After the attachment or nozzle is welded in, exposed base material shall be weld overlayed (back clad). Prior to back cladding, the Buyer shall have reviewed the welding procedure and given the Seller permission to proceed. After the back cladding operation is completed, the finished surface shall be examined to be sure that all base material has been covered by the back cladding. The examination procedure (such as swabbing with 10% ammonium persulfate) shall be developed by the Seller for use on the specific materials involved. The procedure shall be submitted to the Buyer for review and the Seller shall not use the procedure until receiving permission to proceed. The examination procedure shall be capable of differentiating between back cladding and base material. The examination procedure shall contain a description of the examination method, a step by step sequence, the criteria for when the procedure is to be used, the acceptance criteria, repair sequence, and post-examination cleaning. At the option of the Buyer's representative, the back cladding of circumferential and longitudinal welds may be required to receive the above examination.

8.6 All aluminum, titanium or stainless steel butt joints shall have the root side inspected by PT when possible.

8.7 All arc strikes, starts, and stops shall be confined to the welding groove.

8.8 All partial penetration weld joints shall be identified on Form 114, attached.

8.9 The use of temporary welded attachments shall be avoided as much as possible. After fabrication is complete, they shall be removed flush with the base metal without undercutting. Attachments shall not be "knocked off". These attachment areas shall be included in the areas given any PWHT. All attachment areas shall be examined. Magnetic materials shall be MT examined and nonmagnetic materials shall be PT examined except that 5% and 9% nickel steels shall only be PT examined.

9.0 PROCEDURES

9.1 Only welding procedure specifications (with welding procedure qualification records) that have been given written permission to proceed by the Buyer shall be used for welding. Separate or inclusive procedures shall be submitted for repair welding. Applicable welding procedures that have not been previously granted permission to proceed by the Buyer for the project shall be submitted as soon as possible after award of work and sufficiently ahead of any actual welding to allow for adequate review and permission to proceed from the Buyer. The Buyer's representative will review performance qualification records for individual welders.

9.1.1 For all equipment, the attached form 114 (Welding Procedure Control Sheet) shall be completed by the Seller for all items to be fabricated. All procedures to be used shall be listed and identified. Forms shall be submitted as soon as possible after award of the work.

9.1.2 Pressure retaining butt, groove, "T", or corner welds in metal less than 1/16 inch thickness shall be qualified in accordance with ASME Section IX and by submittal of two sample cross-sections for examination with the weld procedure. These joints shall be inspected by PT of the face and root and a 10X visual examination of cross-sections. There shall be no cracks, lack of fusion, lack of penetration or porosity. The weld thickness shall be at least equal to the thickness of the thinner member joined.

9.2 The Seller's welding procedures require the Buyer's written permission to proceed only once for each Buyer project or job.

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9.3 Procedures shall be submitted by any of the following methods:

9.3.1 Forms QW-482 and QW-483 as shown in the ASME Code, Section IX, or similar forms showing the same information.

9.3.2 A Seller's procedures which have been previously reviewed by the Buyer for the project or job, using processes listed in Paragraphs 3.1.1 through 3.1.8 need not be resubmitted provided the Seller submits a listing of the following information on a transparency of Form 114:

9.3.2.1 Description of equipment the Seller intends to weld using previously approved procedures.

9.3.2.2 The Buyer's specification number (or equivalent identification).

9.3.2.3 Revision number and date.

9.3.2.4 Date of previous Buyer permission to proceed (and vendor print number, if available).

10.0 NONDESTRUCTIVE EXAMINATION

The information below contains requirements for nondestructive examination. These are minimum requirements and may be supplemented by other requirements contained in additional Buyer specifications and drawings that are part of the purchase documents.

NONDESTRUCTIVE EXAMINATION (NDE)

	Nondestructive Examination (Applicable Notes)			
Equipment	RT(1)	MT(1)	PT(1)	UT(1)
Vessels	2,3,4,5	5,6,9	5,7,9	8
Heat Exchangers	2,3,4,5	5,6,9	5,7,9	8

When nondestructive examination is required by Code or Buyer specification, the following notes are applicable to extent listed on the table.

NOTES:

1. RT (Radiographic Examination), MT (Magnetic-Particle Examination), PT (Liquid Penetrant Examination) and UT (Ultrasonic Examination). All indications shall be considered relevant until proven otherwise.

2. The extent of radiographic examination and applicable Codes shall be as required in the Buyer's drawings and specifications. Unless otherwise specified, radiographic examination and evaluation shall be in accordance with ASME Section VIII, Division 1, Paragraph UW 51 or UW 52 as applicable; or Division 2, as applicable.

3. Radiographic film shall be either Type I or II per ASTM E94 (Kodak Type M, AA or Buyer approved equivalent) and lead screens shall be used.

4. Single-film viewing shall be used and the film density shall be in the range of 1.8-3.4. For those instances where the variable thickness makes single-film impracticable and, with the Buyer Representative's concurrence, double-film viewing may be used. For the double-film technique, the film density shall be in the range of 1.8 to 3.4 for the double-film combination and each individual film shall not be less than 1.3.

5. Welds of a size or type preventing conclusive radiographic images, such as some types of branch connections and fillet welds, shall be given a magnetic-particle examination. For non-magnetic materials, a liquid-penetrant examination shall be used. Internal surfaces shall be examined where accessible.

6. Unless otherwise specified, magnetic-particle examination and evaluation shall be in accordance with Appendix VI of ASME Section VIII, Divison 1, or Appendix 9, Division 2, as applicable, using the D.C. Prod Method. After any final PWHT, the A.C. Yoke Method shall be used. Permanent magnet yokes shall not be used.

7. Unless otherwise specified, liquid-penetrant examination and evaluation shall be in accordance with Appendix VIII of ASME Section VIII, Division 1, or Appendix 9, Division 2, as applicable. In addition, cleaner and developer solutions having a combined total residual sulphur and halogen content of 1% or greater by weight shall not be used.

8. Unless otherwise specified, ultrasonic-examination and evaluation shall be in accordance with Appendix XII of ASME Section VIII, Division 1, or Appendix 9, Division 2, as applicable.

9. For single welded groove joints, where accessible, both surfaces (root I.D. and face O.D.) shall be examined. If the I.D. root cannot be examined, the face of the root pass shall be. If both surfaces are not accessible and preheat or interpass temperature requirements prevent examination of the root pass, the Seller shall propose other means, subject to Buyer permission to proceed, for assuring sound metal in the root of the joint.

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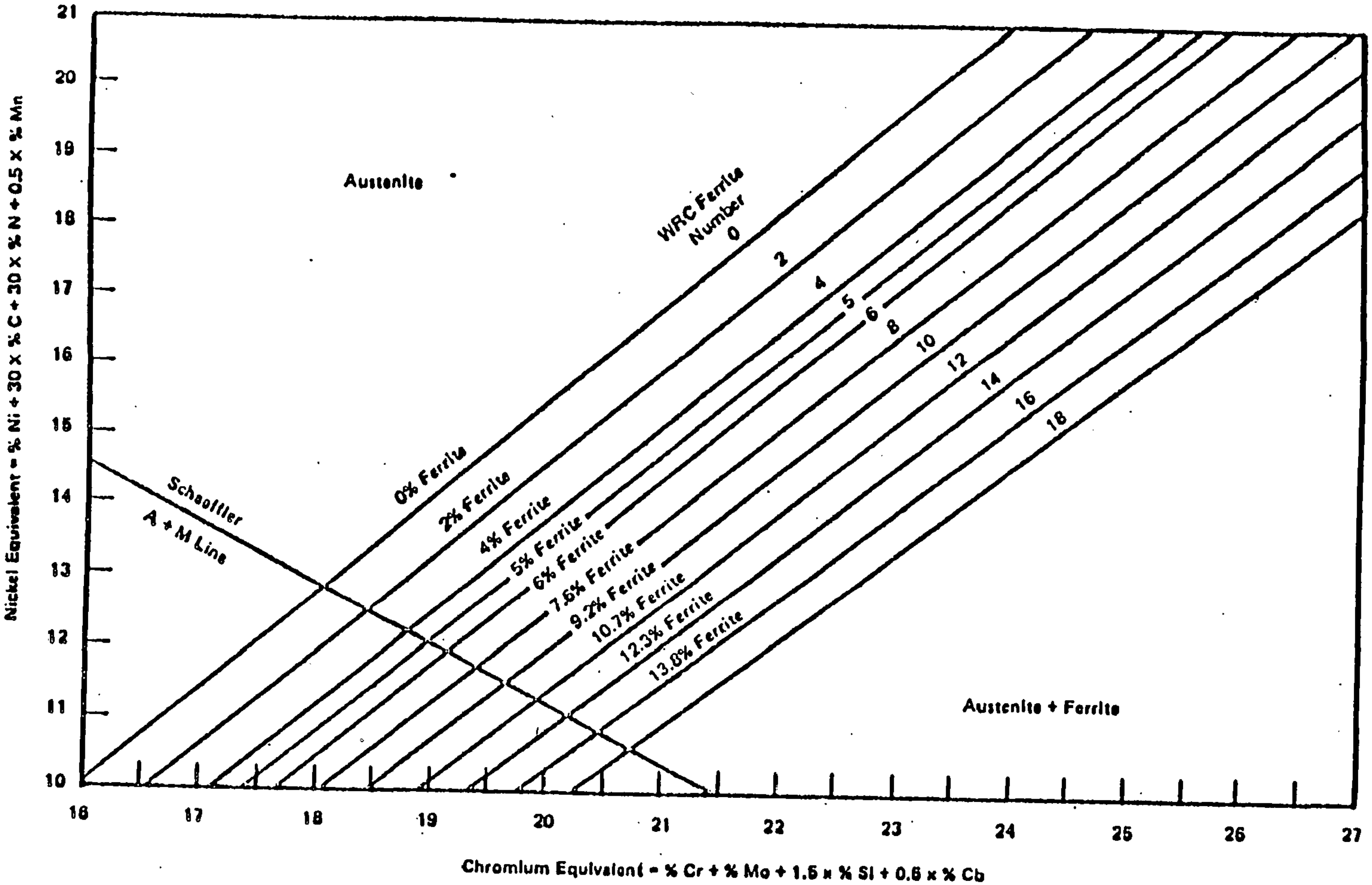
Spec. 14222-W-1

FIGURE 1

WRC

DELTA FERRITE DIAGRAM

Rev. 2



NOTE: The actual nitrogen content is preferred. If this is not available, the following applicable nitrogen value shall be used: GMAW welds—0.08% (except self-shielding flux cored electrode GMAW welds—0.12%); welds of other processes—0.06%.

THIS SECTION SHALL BE COMPLETED BY MANUFACTURER.
LIST ALL PROCEDURES TO BE USED ON THIS EQUIPMENT.

MFR. ______________________ LOCATION ______________________

EQUIP. NO. ______________________ BECHTEL P.O. ______________

DESCRIP./SERVICE ______________________ MFR. S. O. ______________

PWHT: YES (FOR CODE) ☐ YES (FOR PROCESS) ☐ NO ☐

WELDING PROCEDURE IDENTIFICATION					BECHTEL USE ONLY			
MFRS. NO. AND DESCRIP.	REV. DATE	DETAIL FOR THIS EQUIP. PARTS JOINED	"P" No.	MaxThk	BECHTEL V.P. NO.	REV.	DATE	WELDG. & MET. COMMENTS

THIS SECTION FOR BECHTEL USE ONLY.

SPECIFS. ______________________

ADDITIONAL COMMENTS:

SPECIAL REQUIREMENTS

PROCEDURE	PROD. WELDS
☐ ELEV. TEMP. TESTS	☐ PRODUCTION TEST ℞
☐ MAX. TENSILE AT ROOM TEMP.	☐ RADIOGRAPHY
☐ MAX. YIELD AT ROOM TEMP.	☐ ULTRASONIC EXAMN.
☐ BRINNEL HARDNESS	☐ MAGN. PARTICLE EXAMN.
☐ CHARPY IMPACTS	☐ LIQUID PENETRANT EXAMN.
☐ ALL-WELD-METAL TENSILES	☐ BRINNEL HARDNESS
☐ SIMULATED HT. TREATMENT	☐ WELD SAMPLING
☐ SPECIAL CHEMISTRY	

☐ (1) WORK MAY PROCEED.
☐ (2) REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.
☐ (3) REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
☐ (4) REVIEW NOT REQUIRED. WORK MAY PROCEED.

IMPORTANT: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

V. P. –

R&C ENG. FORM 114 4/79

SIGNED ____________ DATE ________

EQUIP. NO.

WELDING PROCEDURE CONTROL SHEET

JOB NO.

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3					
2					
1	7/21/80	ISSUE FOR PHASE ZERO	AD	HS	
0	4/80	ISSUED FOR APPROVAL	PJ	HS	

BECHTEL

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
STANDARD SPECIFICATION
GENERAL WELDING REQUIREMENTS FOR SUPPLIER PIPING

JOB NO. 14222
SPECIFICATION 14222-W-2 REV 1

1.0 SCOPE

This specification covers welding and nondestructive examination requirements for shop purchased or field subcontracted piping, valves and their attachments.

2.0 CODES

To the extent specified, welding and other criteria covered by this specification shall be in accordance with one or more of the following Codes and/or Standards.

2.1 ASME Boiler and Pressure Vessel Code; Section I and IX.

2.2 ANSI Code for Power Piping; B31.1.

2.3 ANSI Code for Pressure Piping; B31.3.

3.0 WELDING PROCESSES

3.1 The following welding processes are permitted, provided satisfactory evidence is submitted that the procedure is qualified in accordance with all applicable Codes, Standards, and job specifications:

3.1.1 Shielded Metal-Arc (SMAW)

3.1.2 Gas Tungsten-Arc (GTAW): manual, machine, and automatic.

3.1.3 Automatic Submerged Arc (SAW); with the following limitations:

3.1.3.1 The maximum individual layer thickness shall not exceed 1/2-inch for materials 1-1/4-inch thick or greater and 3/8-inch for materials less than 1-1/4-inch thick.

3.1.3.2 Alloy steel shall only be welded with an alloy wire and a neutral flux unless the Buyer's permission to use an alloy flux is given for individual applications.

3.1.4 Oxyacetylene (FGW); this process is limited to 2-inch nominal diameter and smaller P-1 piping, repairs to cast iron, and hard facing. (Hardfacing of austenitic stainless steel with FGW is not allowed.).

3.1.5 Plasma Arc (PAW)

3.1.6 Flux Core Arc (FCAW) with or without a shielding gas may be used to weld carbon steel and low alloy steel which contain up to 2-1/4 Cr.-1 Mo. Steel containing more than 2-1/4 Cr-1 Mo and corrosion-resisting chromium and chromium-nickel steel must be welded with a shielding gas.

3.1.6.1 FCAW is not permitted with overhead or the vertical position with downward progression.

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3.1.7 Gas Metal Arc (GMAW) shall be used only in the spray transfer mode. Pulse arc is considered spray transfer. The Shat arc transfer mode may be used for material up to and including 3/16-inch thick, and for the root pass in material of any thickness.

3.2 Other welding processes may be considered providing that satisfactory evidence of the Seller's ability to use the process is submitted to the Buyer.

4.0 RESTRICTIONS

4.1 Permanently installed backing rings or strips shall not be used without prior permission. Where a backing ring or support bar is used in a weld, this material shall be of the same composition as the base material and shall be completely removed by back-chipping or goughing. Proposals to use backing or support bars of compositions different from that of the base material must receive permission from the Buyer prior to use.

4.2 Double welding is permitted on all joints accessible from both sides. Where double groove welding is employed, the first root pass shall be backchipped to sound metal before welding the second side.

4.3 Peening shall not be used without prior permission to proceed. The use of pneumatic tools for slag removal is not considered peening and is permitted.

4.4 The root pass of all circumferential butt welds of compressor suction and lube oil piping, accessible from one side only, shall be welded with the GTAW process. Also, for P-5 and higher ferrous alloy, aluminum, or titanium butt joints welded from one side only, the root pass shall be made by the GTAW process.

4.5 An argon, nitrogen, or helium internal purge shall be used for the Gas Tungsten-Arc root pass of 2-1/4 Cr-1 Mo and higher alloys. P-1, P-3, and P-4 steel may be welded with or without an internal purge.

4.6 When welding titanium, the gas shielding system shall include a glove box, envelope, or other supplemental equipment that is specifically indicated in welding procedures. Each weld bead and adjacent base shall be cleaned to remove all surface discoloration prior to depositing the next bead. The final weld surface may have an intermittent, iridescent straw colored or light blue oxide.

4.7 For clad pipe, the following limitations apply:

4.7.1 The cladding shall be stripped back a minimum of 1/4-inch from the edge of base material bevels by machining or grinding, not by flame or arc-goughing.

4.7.2 Removal of the cladding shall not reduce the base material thickness below the design thickness.

4.7.3 A minimum radius of 1/16-inch shall be used at the limit of cladding removal unless the clad material is beveled at least 30 degrees.

4.7.4 Preparation of local repair cavities in overlay welds that penetrate into the base material more than 10 percent of its thickness shall have the base material rewelded with the proper welding procedure consistent with the base material before completing the overlay repair.

4.8 Weld deposits for alloy welds shall fall within the limits of chemical composition specified for the materials to be joined, unless otherwise specified.

4.9 Production weld filler materials shall have mechanical properties within the limits specified for the base materials to be joined unless permission to deviate is received from the Buyer.

4.9.1 In addition, completed ANSI B31.3 welds specified in Form 167 to be in severe service shall not exceed Brinell Hardness (BHN) as follows:

4.9.1.1 Except for shielded metal arc welds 200 BHN in carbon steel welds.

4.9.2 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 percent or more, or subsequent adjacent tests showing higher than specified hardnesses are not permitted and the welds showing the excessive hardness shall be rejected and subject to re-heat treatment or repair.

4.10 Weld bevel preparations for P-5 and higher alloys shall be machined or ground back to bright and sound metal if they have been flame or arc cut.

4.11 Welded joints shall be made by completing each weld layer before succeeding layers are deposited. Block welding is prohibited unless the Buyer's prior permission is obtained.

4.12 Vertical welding shall be done vertical up. Proposals to use vertical down welding shall be subject to permission from the Buyer.

5.0 WELDING ELECTRODES

5.1 Unless specifically waived, all Shielded Metal-Arc welding shall be done using low hydrogen-type electrodes when any of the following conditions apply:

5.1.1 In service with design temperatures below minus 20°F, or a primary flange rating of Class 900 or greater.

5.1.2 With steels having a maximum specified or actual carbon content above 0.30 percent.

5.1.3 For steels having a specified minimum tensile strength of 70,000 psi and greater and the thickness exceeds one inch.

5.1.4 For SMA weld repair of steel castings.

5.2 For P-1 and P-3 steel piping materials requires the use of low-hydrogen electrodes, the root pass only may be welded with E6010 and E7010-Al electrodes, respectively.

5.3 Electrode classifications E6012, E6013, E7014, and E7024, shall not be used for welding of pressure-retaining parts of piping. These electrodes, however, may be used for non-pressure-retaining fillet welds of P-1 materials.

5.4 For Gas Metal-Arc Welding and Gas Tungsten-Arc Welding of P-1 steel, solid wire electrodes shall conform to AWS A-5.18, Classification E70S-2, E70S-3, E70S-4, or E70S-6.

5.5 For Flux Cored Arc Welding of P-1 steel, the electrodes shall conform to AWS A-5.20, Classification E60T-8, E70T-1, E70T-4, E-70T-5, E70T-6 or E70-TG.

5.6 Carbon steel shall not be welded with C-1/2 Mo weld metal unless the Buyer's permission is obtained.

5.7 Filler metals and consumable inserts for A-8 (Table QW-440, ASME Section IX) austenitic stainless steel welds shall be selected and controlled to produce weld deposits that fall within the following ferrite ranges and numbers as shown in Table 1 below and as determined by Figure 1, WRC Delta Ferrite Diagram, unless other Buyer specifications have more restrictive limitations.

TABLE 1

Weld Material	PWHT or Service Temp.	Ferrite Percent	Ferrite No.
308, 308L	Less than 800°F 800°F and over	5-25 5-9	5 Min. 5-9.8
All Others	Less than 800°F 800°F and over	5-15 5-9	5-17 5-9.8

5.8 Type 309 or 309L austenitic stainless steel welding materials shall be used for welding carbon or low-alloy steel to austenitic stainless steel, including the first layer of corrosion-resistant overlays. Type 309L is preferred but Type 309 can be used with the exceptions of Paragraphs 5.8.1 and 5.8.2 below.

5.8.1 When postweld heat treatment of a dissimilar joint is required, the carbon or low-alloy steel member shall be "buttered" with Type 309L and postweld heat treated prior to welding to the austenitic stainless steel member.

5.8.2 For corrosion-resistant austenitic stainless steel overlays, where the carbon or low-alloy steel base metal requires postweld heat treatment, the first weld layer shall be made with Type 309L. All other layers shall be made with low carbon grade welding materials.

5.9 The requirements listed below shall be mandatory in all filler material procurement wherein austenitic stainless steel may be subjected to cryogenic service at temperatures of minus 150°F or below.

5.9.1 The delta ferrite content of the bare electrodes shall be determined by a certified chemical analysis using the WRC Delta Ferrite Diagram as shown in Figure 1, with nitrogen determined by actual analysis, and shall be within the range of 3 to 8 percent (3 to 8.5 FN).

5.9.2 Weld metal Charpy V-Notch impact tests shall be made on each heat and lot of covered electrodes. The test shall be conducted at the lowest design temperature to which the materials may be exposed. The certified test results shall include the test temperature, absorbed energy in foot pounds, percent shear, and mils lateral expansion. The acceptance criterion is 15 mils minimum lateral expansion on each set of three full-size specimens (see ASTM A-370). Absorbed energy and percent shear is reported for information only.

5.10 The receipt, use, disbursal, and retrieval of all welding filler metals shall be maintained under strict control with the storage, baking, and drying as recommended by the manufacturer.

6.0 PREHEAT AND INTERPASS TEMPERATURE (P&IPT)

6.1 P&IPT shall be in accordance with the applicable codes and the latest addenda except that recommended minimum preheat temperatures shall be considered mandatory under this specification.

6.2 In addition to governing code requirements, P-1 steel shall have a P&IPT of 200°F minimum when the thickness exceeds 1-1/2-inches unless the governing code has more restrictive preheat requirements.

6.3 The maximum preheat and interpass temperature for austenitic stainless steel shall be 350°F except that for the hard facing of low carbon austenitic stainless steel base materials, the maximum preheat and interpass temperature shall be 800°F.

6.4 P&IPT shall be determined by temperature-indicating crayons, contact pyrometers or other equally suitable means permitted by the Buyer. Temperature-indicating crayons used on austenitic stainless steel and nickel-base alloys shall not cause corrosive effects or other harmful effects and shall not contain more than 1 percent by weight of the total halogens, or sulfur or 200 ppm by weight of inorganic halogens. It is the manufacturer's responsibility to determine suitable brands and melting temperatures that may be used. This information shall be made available to the Buyer's representative on request.

6.5 The P&IPT requirements listed above shall also apply to tack welding and to the welding of temporary attachments. The preheat requirements above shall also apply to all thermal gouging and cutting except for P-1 materials.

7.0 POSTWELD HEAT TREATMENT (PWHT)

7.1 PWHT of pressure piping shall be in accordance with Paragraph 331.3 of ANSI B31.3 with the following exceptions:

7.1.1 For P-6 materials, the PWHT temperature used shall be the lowest possible to avoid overheating and hardening on cooling and the material shall be checked to ensure that the Brinell Hardness does not exceed 241.

7.2 PWHT of power piping shall be in accordance with the applicable codes with the following additional requirements:

7.2.1 For P-6 materials, the PWHT temperature used shall be the lowest possible to avoid overheating and subsequent hardening on cooling.

7.3 When the referenced Code or technical specification specifies only a minimum PWHT temperature, the maximum PWHT temperature shall not exceed the specified minimum by more than 150°F with the following exception:

7.3.1 For materials which have been previously heat treated by normalizing and tempering or quenching and tempering the PWHT temperature shall be the lowest possible to avoid degradation of base metal properties.

7.4 One thermocouple shall be positively attached in each furnace charge. Welds given a local PWHT shall have one positively attached thermocouple for nominal diameters up through 12 inches. For nominal diameters over 12 inches; at least two thermocouples are required - located 180° apart, with one on top for welds in a vertical plane.

7.5 Direct impingement by torch or furnace burner flames is not permitted for PWHT.

7.6 Exothermic heat treatment is prohibited.

8.0 WORKMANSHIP, VISUAL QUALITY EXAMINATION, AND INSPECTION

8.1 Butt welds shall be slightly convex and have full penetration, unless otherwise specified and permitted in the applicable Codes. For piping, limitations on weld reinforcement shall apply to the interal surface as well as the external.

8.2 Removal of defects shall be verified by NDE before repair is started. Repair welding shall be done only by qualified welders using qualified procedures.

8.3 Overlay welds shall be liquid-penetrant examined. For overlay welds, this shall be done after final machining and postweld heat treatment when machining and/or postweld heat treatment is required.

8.4 Socket welds shall have a gap of approximately 1/16-inch minimum to 1/8-inch maximum between the bottom of the socket and the end of the pipe prior to welding.

8.5 All arc strikes, starts, and stops shall be confined to the welding groove.

8.6 The use of temporary welded attachments shall be avoided as much as possible. After fabrication is complete, they shall be removed flush with the base metal without undercutting. Attachments shall not be "knocked off". These attachment areas shall be included in the areas given any PWHT. All attachment areas shall be examined. Magnetic materials shall be MT examined and non-magnetic materials shall be PT examined except that 5 percent and 9 percent nickel steel shall only be PT examined.

9.0 WELDING PROCEDURES

9.1 Only welding procedure specifications (with welding procedure qualification records) shall be used for welding which have been given the Buyer's permission to proceed prior to use. Separate or inclusive procedures shall be submitted for repair welding. Applicable welding procedures that have not been previously granted permission to proceed by the Buyer for the project shall be submitted as soon as possible after award of work and sufficiently ahead of any actual welding to allow for permission to proceed from the Buyer. Performance qualification records for individual welders shall be made available to the Buyer's representative.

9.1.1 For piping, Form 167 and 167A (Welding, Heat Treatment, and Nondestructive Examination of Piping) shall be completed by the Seller for all items to be fabricated. All Procedures to be used shall be listed and identified. Forms shall be submitted as soon as possible after award of the work. Form 167 and 167A are attached to 14222-L-5, Project Specification, Piping Fabrication.

9.2 The Seller's welding procedures require the Buyer's permission to proceed only once for each Buyer project or job.

9.3 Procedures shall be submitted by any of the following methods:

9.3.1 Forms QW-483 as shown in the ASME Code, Section IX, or similar forms showing the same information.

9.3.2 A Seller's procedure which has been previously granted permission to proceed by the Buyer for the project or job, using processes listed in Paragraphs 3.1.1 through 3.1.8 need not be resubmitted provided the Seller submits a listing of the following information on Form 167:

9.3.2.1 Description of piping the seller intends to weld using previously permitted procedures.

9.3.2.2 The Buyer's specification number (or equivalent identification).

9.3.2.3 Revision number and date.

9.3.2.4 Date of previous Buyer permission to proceed (and vendor print number, if available).

10.0 NONDESTRUCTIVE EXAMINATION

The information below contains requirements for nondestructive examination. These are minimum requirements and may be supplemented by other requirements contained in additional Buyer specifications and drawings that are part of the purchase documents.

NONDESTRUCTIVE EXAMINATION (NDE)

EQUIPMENT	NONDESTRUCTIVE EXAMINATION (Applicable Notes)			
	RT(1)	MT(1)	PT(1)	UT(1)
PIPING	2,3,4,5, 6,7	3,8	3,9	3,10

When nondestructive examination is specified, the following notes are applicable when indicated above:

NOTES:

1. RT (radiographic examination), MT (magnetic-particle examination), PT (liquid penetrant examination), and UT (ultrasonic examination). All indications shall be considered relevant until proven otherwise.

2. The extent of radiographic examination and applicable Codes shall be as required on Form 167 and 167A (Welding, Heat Treatment, and Nondestructive Examination of Piping).

3. Where random nondestructive examination is specified (i.e, a percentage of each welder's welds or a percentage of the total welding) and shows a weld failing to meet Code or specification requirements, examination shall be made of two or more welds made by the same welder. If either of the additional welds are unsatisfactory, the Buyer's representative may reject all work by that welder. Examinations and repairs to defective or rejected work shall be done at the Seller's expense.

4. Radiographic film shall be either Type I or Type II per ASTM E94 and lead screens shall be used.

5. Single-film viewing shall be used and the film density shall be in the range of 1.8-3.4. For those instances where the variable thickness makes single-film impracticable and, with the Buyer Inspector's permission, double-film viewing may be used. For the double-film technique, the film density shall be in the range of 1.8 to 3.4 for the double-film combination and each individual film shall not be less than 1.3.

6. Radiography or welds in pipe having a nominal diameter of three inches or less may be performed by the elliptical projection technique. At least two separate exposures are required at locations 90° apart.

7. Where there is no internal access, radiography of welds in pipe having a nominal diameter of three inches or greater shall be such that at least three separate radiographs are taken 120° apart. only that portion of the weld on the film side of the pipe (opposite radiation-source side) shall be interpreted. Because of the variation in pipe diameter, wall thickness and source-to-film distance, it may be necessary to take more than the minimum number of radiographs to properly examine the entire circumference of a weld.

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8. Unless otherwise specified, magnetic-particle examination procedures shall be in accordance with ASME Section V, using the D.C. Prod Method. After any final PWHT, the A.C. Yoke Method shall be used. Permanent magnetic yokes shall not be used.

9. Unless otherwise specified, liquid-penetrant examination procedures shall be in accordance with ASME Section V.

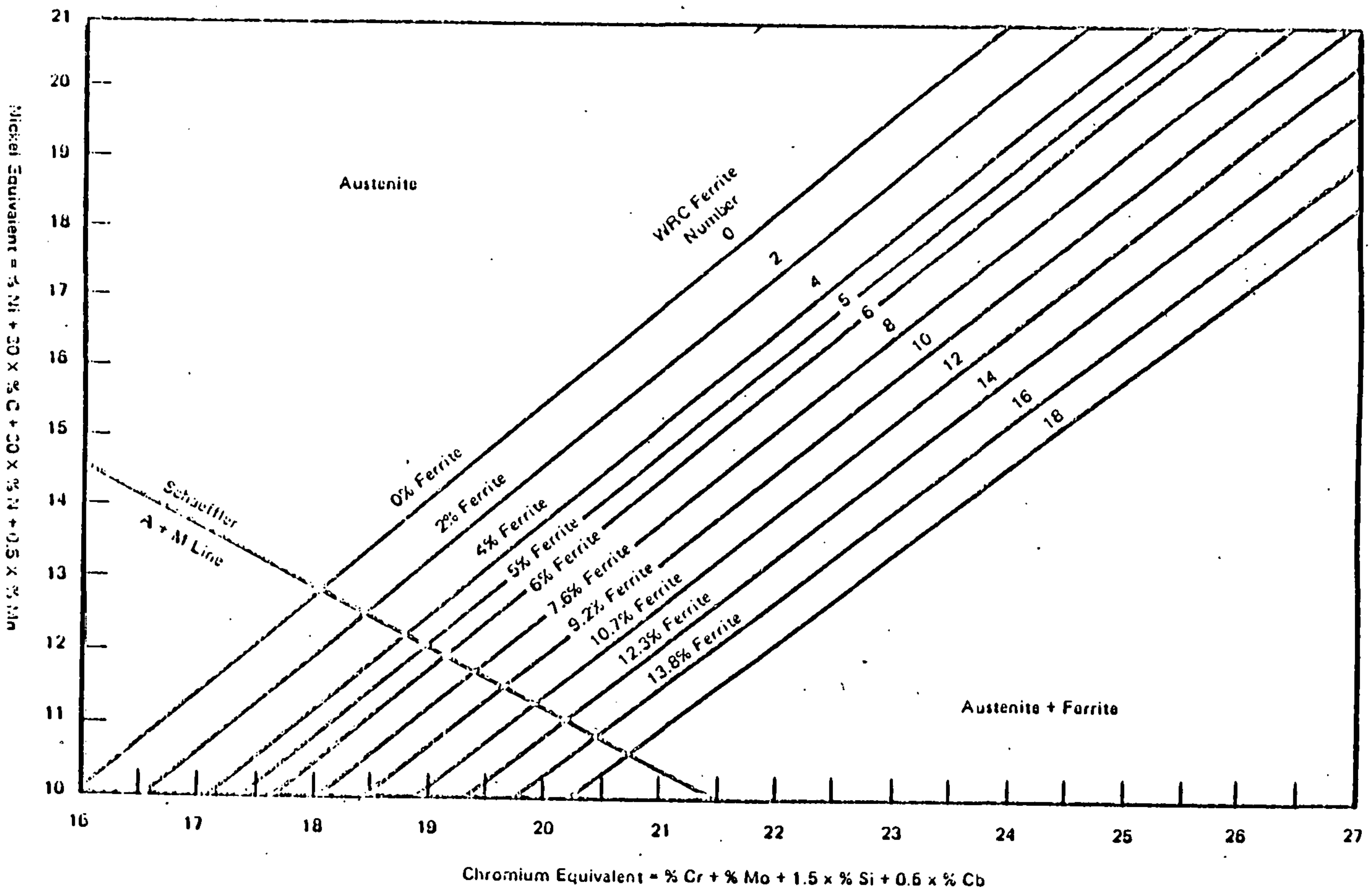
10. Unless otherwise specified, ultrasonic-examination procedures shall be in accordance with ASME Section V.

REFERENCE SPECIFICATIONS AND FORMS

Specification 14222-L-5
Forms 167 and 167A

Attachment: Figure 1.

FIGURE L: WRC DELTA FERRITE DIAGRAM



NOTE: The actual nitrogen content is preferred. If this is not available, the following applicable nitrogen value shall be used: GMAW welds—0.08% (except self-shielding flux cored electrode GMAW welds—0.12%); welds of other processes—0.06%.

1.0 SCOPE

The requirements of this specification cover welded tube-to-tubesheet joints where leak-tightness integrity is of utmost importance.

2.0 SEQUENCE OF CONSTRUCTION

The following general construction sequence only shall be used in welding tube-to-tubesheet joints:

2.1 Prepare tubes and tubesheet.

2.2 Position tubes.

2.3 Weld.

2.4 Visually inspect and repair.

2.5 Preliminary leak test.

2.6 Repair leaks and retest (2.4 and 2.5 above).

2.7 Postweld heat treat when required by the job specification.

2.8 Preliminary leak tests.

2.9 Repair leaks and retest.

2.10 Expand completed joint if required by job specification.

2.11 Final Helium leak test.

2.12 Hydrostatic tests.

2.13 Repair leaks and retest (2.7, 2.9, and 2.11 above).

3.0 PREPARATION OF TUBES AND TUBESHEETS

3.1 Tubes shall be cleaned and solvent degreased on both the OD and ID for a minimum distance equal to the tubesheet thickness plus one inch.

3.2 After all machining operations have been completed, the tubesheet shall be cleaned free of grit, scale, moisture, and other foreign matter, and thoroughly solvent degreased with a suitable solvent. Degreasing shall include tube holes, any machined weld preparations and the area around the weld preparation.

Solvents for stainless steel or nickel alloys shall not contain halogen or sulphur compounds which are deleterious.

3.3 Suitable degreasing solvents are acetone and alcohol.

3.4 Tubes may be positioned prior to welding by light expansion of the tube end sufficient to hold the tube in place for welding. Lubricant shall not be used during this operation. Tubes shall be fitted clean and dry into tube sheets. Care shall be exercised to avoid touching tube ends with oily hands or gloves.

3.5 Care shall be taken to control heat and avoid burn through. Methods to avoid burn through such as inserting clean dry copper plugs into the tube ends prior to weldings shall be employed wherever practical.

4.0 WELDING

4.1 Welding Processes

Gas Tungsten-Arc (TIG) welding shall be used for making tube-to-tubesheet welds except as permitted below. Manual metal arc welding using coated electrodes may be permitted provided the following conditions are met:

4.1.1 Written approval is obtained from the Purchaser.

4.1.2 The tube wall thickness exceeds one-eighth inch.

4.1.3 The tube diameter exceeds on inch.

4.1.4 The vendor supplies a list of successful applications of more than three years duration, where he used the manual metal arc method with coated electrodes.

4.1.5 At least two passes are employed.

4.1.6 Peening is prohibited.

4.2 Filler Metal

4.2.1 For carbon steel and low-alloy steel welded with the gas tungsten-arc process, filler metal shall be of the multiple deoxidized type (e.g, AWS-A5.18 Classification E70S-2 for carbon steel), except as noted in Paragraph 4.2.3.

4.2.2 Manual metal arc welding electrodes shall be the low-hydrogen type only.

4.2.3 For carbon steel and low-alloy steel (less than 12 percent Cr) where the pressure differential between sheet and tube exceeds 500 psi and a liquid phase is present on the higher pressure side, the filler metal shall be AWS-A5.14 Classification ERNiCr-3 (Inconel Filler Metal 82) for gas tungsten-arc welding and AWS A5.11 Classification ENiCrFe-3 (Inconel welding electrode 182) for manual metal arc welding.

4.2.4 Filler metal for alloy construction shall match the base metal, except as otherwise approved by the Buyer.

4.3 Preheat

Preheat shall be that specified in Appendix R of ASME Section VIII for the tubesheet material except that P-1 materials shall be preheated to 200°F minimum, when the specified maximum allowable carbon-content exceeds 0.30 percent. For clad tubesheets, the requirement for preheat shall be governed by the cladding material, providing the tube-to-tubesheet weld is no deeper than one-half of the cladding thickness. For welds deeper than one-half of the cladding thickness, the preheat requirement shall be the more stringent of the tubesheet material or the cladding material.

4.4 Fabricator's Welding Procedure

4.4.1 Immediately upon receipt of the purchase order, the Fabricator shall submit a detailed and properly qualified (see Paragraph 4.5) welding procedure for the Purchaser's approval of welding procedure and qualification tests.

4.4.2 Procedures shall be submitted by any of the following methods:

4.4.2.1 Per Bechtel Standard Form 81.

Note: Form 81 is attached to this specification and and the vendor is invited to request a sufficient number of transparencies for his use.

4 .3 Procedures previously approved by the Purchaser on current or past projects need not be requalified, providing:

4.4.3.1 The Fabricator so requests, and lists the procedure specification number, revision number, and date, and Purchaser's vendor print number.

NOTE: Waiver of procedure requalification does not imply that a particular procedure will be approved for use on all work. Procedures will be re-evaluated for each particular item of equipment.

4.4.3.2 There is no change in the following procedure variables:

a) A change in ASME P-number of the tube or tubesheet material (or cladding, where applicable).

b) A change in tube OD by 25 percent or wall thickness by 10 percent.

c) The addition or omission of filler material.

d) A change in the composition or an increase in the diameter of filler metal, including the addition

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or omission of preplaced consumable inserts and/or a change in their size and shape.

e) A change in the number of weld passes.

f) A change in the tube-to-tubesheet joint detail or a change in the ligament dimension such that the adjacent welds overlap, or vice versa.

g) The addition of other welding positions than those previously qualified.

h) A change in one shielding gas to another or changes in the composition of mixed gases.

i) A change from manual to automatic welding, or vice versa.

j) 1. A decrease in the specific preheat temperature by more than 100°F.

2. Maximum preheat or interpass temperature of tubesheet before starting.

k) A change of ±15 percent of the specified mean voltage or amperage for each size electrode used.

l) Direction or progression of welding.

m) Addition or omission of copper chill.

n) Omission of high frequency arc stabilizing or starting.

4.4.4 A change in the procedure variables noted above shall require a new written procedure specification which shall be requalified as specified under Paragraph 4.5.

4.5 Welding Procedure Specification Test Sample

4.5.1 Test Sample

The Fabricator shall submit a test sample of tube-to-tubesheet welds made using the procedure specification submitted. This test sample shall be made on an assembly that accurately simulates production conditions with respect to the tube hole patterns and dimensions, and the "essential variables" listed in Paragraph 4.4.3.2. Additionally, the thickness of the tubesheet shall be that used in production or two inches, whichever is less.

The minimum number of weld joints in the test assembly and the number of test pieces shall be as shown in Figure 1. Do not expand tubes after welding. The test samples shown in Figure 1 shall be submitted to the Purchaser for evaluation. The Fabricator is requested to evaluate the unused pieces of the test assembly to assure himself that it is capable of meeting the following acceptance criteria. These test samples shall be submitted sufficiently in advance of fabrication in order that they may be properly evaluated by both Purchaser and Fabricator and any required modifications completed before the start of fabrication.

4.5.2 Acceptance Criteria

4.5.2.1 As-Welded Examination

a) The surface of all welds in the test sample shall be examined at 10X magnification and shown to be free of cracks, porosity, weld spatter, weld metal "overhang" or "burn through", and excessive weld reinforcement. Dressing of welds to remove "overhang", "burn through" is not permitted.

b) Welds in the test assembly shall be liquid penetrant inspected in accordance with Procedure B-2 or B-3 of ASTM E165 and shown to be free of cracks and surface porosity.

4.5.2.2 Cross Section Examination

a) Upon macroscopic examination at 10X, the weld cross sections shall be shown to be free from cracks, tears, lack of fusion, inclusions, and porosity.

b) The minimum leak path (Weld throat) shown shall be at least two-thirds of the tube wall thickness; design calculations shall consider the necessity of a larger weld.

c) When maximum hardness limitations are specified, a micro-hardness survey of the weld metal and heat-affected zone (HAZ) shall be required. The proposed welding procedure shall be shown to be capable of producing a weld and HAZ hardness below the maximum specified. Tube-to-tubesheet weldments subject to hydrogen (H_2 partial pressure greater than 100 psi) shall be subject to maximum BHN of 200 for carbon steel and 215 for low-alloy steel. In this case, the tubesheet sample shall be representative of the production steel and six hardness measurements shall be made on the sample weld HAZs.

4.6 Production Welds

If there is evidence that production welds are not being made in accordance with the procedure specification, the inspector may require that test welds be made using the test assembly to determine if the required acceptance criteria are being met.

4.7 Hardness Examination

Hardness measurements shall be made on production tubesheets if the specified service H_2 partial pressure exceeds 100 psi. The acceptance criteria shall be 200 BHN maximum for carbon steel and 215 BHN maximum for low-alloy steel weld metal and HAZ. Ten measurements shall be made on each tubesheet.

5.0 LEAK TESTING

5.1 Preliminary leak testing shall consist of flooding the tubesheet with water and applying pneumatic pressure from the shell side at 50 psi for two hours minimum. The tube-to-tubesheet welds shall be continuously examined for leaks under strong illumination. Leaks are indicated by the formation and growth of bubbles. If stoppers are used to keep the tubes free of water, they shall be recessed at least 1/4" below the weld. All leaks shall be repaired in accordance with Paragraph 6.0 of this specification and the vessel re-leak tested. Alternate procedures are provided in 5.2.

5.2 As an alternate to Paragraph 5.1 above, either a halogen leak test (except for austenitic stainless steel) a helium leak test or a soap bubble test may be performed.

5.2.1 Halogen Leak Test

Halogen leak tests shall be performed with the shell at 50 psi. Each tube-to-tubesheet weld shall be probed with a leak detector.

5.2.2 Helium Leak Test

For the helium leak test, the shell side shall be pressurized to 30 psi with helium. While the shell is under pressure, the tube-to-tubesheet welds shall be leak tested from the channel side with equipment capable of detecting leaks with a leak rate of 1×10^{-7} standard cc/second.

5.2.3 Soap Bubble Test

The shell side shall be pressurized to 50 psig minimum. The channel side of each tube-to-tubesheet weld shall be coated with or covered by a thick concentrated soap solution. Each weld shall be individually inspected under strong illumination.

5.3 Final Leak Test

After completion of preliminary leak testing, and any repairs followed by retesting and rolling; a final leak test shall be performed by any one of the methods described in 5.2 except that the helium leak test shall be performed if the partial pressure of H_2 exceeds 100 psi. If the soap bubble test is performed, the shell side air shall be at 50 psig minimum. If the pressure differential across the tubesheet in service exceeds 50 psi, the test air pressure shall equal the service pressure differential, up to the shell design pressure. If the service differential exceeds the shell design pressure, then the Helium or Halogen test shall be done.

6.0 REPAIRS

6.1 The cost of all repairs shall be at the expense of the Fabricator.

6.2 Welding defects found during inspection shall be removed to sound metal and re-welded with filler metal added in accordance with an approved welding procedure, except that:

6.2.1 Welds found to contain cracks shall be completely removed and the weld re-prepared and re-welded in accordance with the approved welding procedure.

6.2.2 Crater cracks may be removed by grinding if their length is less than "t" the tube wall thickness. The defect crater shall be repaired with the addition of filler metal using a qualified procedure.

6.2.3 If the original tube-to-tubesheet weld procedure did not utilize filler metal, a new repair procedure shall be qualified.

7.0 HYDROSTATIC TESTS

The tube side and shell side shall be hydrostatically tested in accordance with TEMA (Paragraph B1.31, C1.31, or R1.31, as applicable) except that the test pressure shall be held for a minimum of five hours.

8.0 WELDER OR WELDING OPERATOR QUALIFICATION

Each welder or welding operator shall be qualified in the same way as the welding procedure qualification. The welder or operator shall have been qualified or have done acceptable work within three months.

ATTACHMENTS

Form 81 — Fabricator's Tube-to-Tubesheet Welding Procedure, Specification and Qualification Record.

Drawing W-501 — Tube-to-Tubesheet Welding, Welding Procedure Test Sample.

Form 81

FABRICATOR'S TUBE-TO-TUBESHEET

WELDING PROCEDURE SPECIFICATION AND QUALIFICATION RECORD

NAME OF FABRICATOR ______________________________

LOCATION ______________________________

FABRICATOR'S PROCEDURE SPECIFICATION ______________ DATE ________

Bechtel Specification 50W-2 requires a welding procedure specification and qualification record to be submitted for tube-to-tubesheet welding. The information to be furnished shall be recorded in the forms outlined below as Part I and II, or in an equivalent form which covers all of the information required below.

References to Paragraphs and Tables refer to those in Section IX of the ASME Boiler and Pressure Vessel Code.

FOR BECHTEL USE ONLY - DO NOT FILL IN

(1) APPROVED

(1A) APPROVED FOR FABRICATION AS MARKED. REVISED DRAWING NOT REQUIRED

(2) APPROVED AS MARKED. REVISED DRAWING REQUIRED

(3) NOT APPROVED. REVISED DRAWING REQUIRED

COMMENTS

This approval of general compliance with our requirements does not relieve Supplier of responsibility to furnish material or equipment meeting all service and dimensional conditions stipulated or implied by the purchase order.

BECHTEL INCORPORATED

Date ______________ By ______________

____

VP

____

Equip. No.

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PART I

FABRICATOR'S PROCEDURE SPECIFICATION ______________________

1. BASE MATERIAL: The base materials shall conform to the specifications for:

Tube Sheet ______________________ P-Number ______________

Tubes ______________________ P-Number ______________

Cladding (if used) ______________________ P-Number ______________

(Insert reference to ASME, ASTM, or other Code or standard designation.)
(See Table QW-422 for P-Number grouping.)

2. FILLER METAL: The filler metal shall conform to SFA Filler Metal

Number ______________________ for ______________________
(A5.1, 5.9, 5.18, etc.) (ferrous, nonferrous, state which)

filler metal in Group Number F- ______________________
(See Table QW-432)

AWS Classification Number ______________________
(E70S-2, ER-308, ERNiCr-3, etc.)

For Ferrous Filler Metal include the following date:

The chemical composition of the weld deposit shall fall within the limits of weld metal Analysis No. A- ________ (See Table QW-442), or shall be within the following composition limits: ______________

____

Filler Rod Diameter ______________________ inch ______________

3. GAS FOR TUNGSTEN ARC WELDING: The shielding gas shall conform to the following nominal composition: ______________________
(insert here the single gas, the propor-

____
tional parts of mixed gases, or the trade designation of the gas used.)

4. POSITION: The welding shall be done in the ______________________ position. (Give position or positions in which the welding will be done and direction of welding progression, e.g. vertically upward. (See Paragraphs QW-120 and QW-130)

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4.1 Cleaning - The tube OD and ID shall be thoroughly cleaned for a distance of 3 inches from the welding end; and, the tube sheet holes shall be thoroughly cleaned of all foreign contaminants, using solutions or solvents described here.

5. PREHEAT ______________________________

(This paragraph should describe any preheating and control of interpass temperature that will be done during welding.)

6. HEAT TREATMENT ______________________________

(This paragraph should describe any heat treatment or stress relieving that is given the welded parts before or after welding. State rate of heating, holding time at temperature, and rates of cooling.)

7. WELDING PROCEDURE Welded joints shall be made by ______________________________
(Multiple passes of single pass - state which)

8. WELDING PROCESS The welding shall be done using ______________________________
(Automatic or manual equipment - state which)

9. TUBE O.D. AND WALL THICKNESS. This procedure is proposed to allow tube-to-tubesheet welds with tubes having a wall thickness between ________ inch and ________ inch, and an outside diameter between ________ inch(es) and ________ inch(es).

10. ELECTRICAL CHARACTERISTICS Electrical Characteristic ________
AC, DCSP, DCRP

High frequency ________ be used. Amperage ________ $\pm 15\%$
shall/shall not Voltage ________ $\pm 15\%$

11. CHILLS Copper Chills ________ be used.
shall/shall not

COMPANY NAME ______________________________

BY ______________________________

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PART II

TUBE-TO-TUBESHEET WELDING PROCEDURE
QUALIFICATION RECORD

NAME OF FABRICATOR ______________________________

WELDING PROCEDURE SPECIFICATION ______________ DATE ____________

____

____

BASE MATERIAL: (ASME, ASTM - Specification and Grade)

Tube Sheet __________ P-Number __________ Thickness __________ inches

Cladding __________ P-Number __________ Thickness __________ inches

Tubes ______________________ P-Number ______________

O.D. ______________ inch(es) Wall Thickness __________ inch

FILLER MATERIAL: AWS SPEC. ______________ Classification ____________
(E70S-2, ER-308, ERNiCr-3, etc.)

F-Number ______________________ A-Number ______________
(From Table QW-432) (From Table QW-442)

Diameter ________ inch. Manufacturer & Trade Name ______________

Inert Gas Composition ______________ Flow Rate __________ Cu.Ft./Hr
(Argon, Helium or combination)

HEAT TREATMENT: Preheat ______________ Post Heat ______________
(None or °F) (None or °F)

Stress Relief Temperature ______________ Time __________ hours
(None or °F)

WELD PASSES: ______________________ Manual or Automatic ______________

WELD POSITION: ______________________________________
(Flat, Vertical, etc.)

ELECTRICAL CHARACTERISTICS: AMPS ______________; VOLTS ______________;
POLARITY ______________; HI FREQUENCY ______________

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TUBE-TO-TUBESHEET WELDING PROCEDURE
QUALIFICATION RECORD

JOINT DETAIL

---

1. Sketch of joint prepared for welding to be shown above.

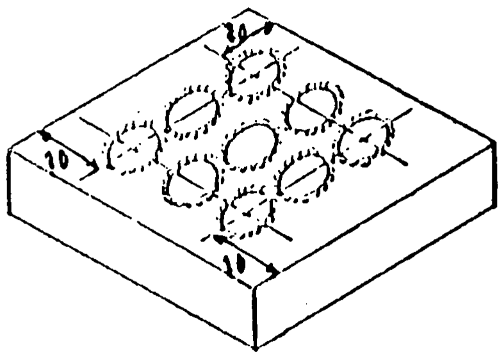
2. The following joint details shall be shown where applicable:

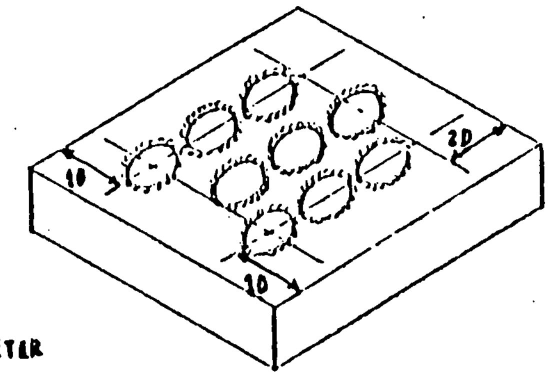
   a. Cladding thickness
   b. Tube projection and/or flaring
   c. Bevel angle
   d. Minimum ligament thickness
   e. Preplaced consumable inserts
   f. Use of copper (chills)

Our examination of the sample shows that it meets all requirements of Bechtel Specification 50W-2.

Date ____________________ COMPANY NAME ____________________

BY ____________________

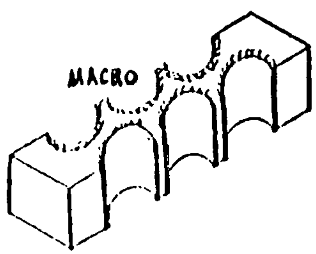




D = TUBE DIAMETER

FIG.1 TEST ASSEMBLY FOR SQUARE PITCH

FIG.2 TEST ASSEMBLY FOR-TRIANGULAR PITCH



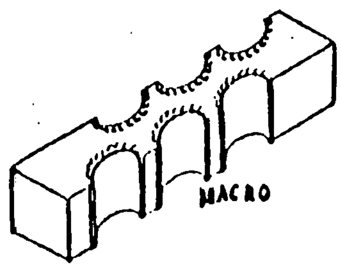


FIG.3 TEST SAMPLE FOR SQUARE PITCH

FIG.4 TEST SAMPLE FOR TRIANGULAR PITCH

NOTE: FABRICATOR SHALL IDENTIFY PLANE OF TUBESHEET DURING WELDING

Figure 1

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8.0 WELDING PROCEDURES

9.0 NONDESTRUCTIVE EXAMINATION

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△					
△					
1	7/21/80	ISSUE FOR PHASE ZERO	AD	HS	ZBG
0	4/30	ISSUED FOR APPROVAL	RS	HS	

1.0 SCOPE

This specification covers welding and nondestructive examination requirements for shop purchased or field subcontracted, fabricated carbon steel, stainless steel, and aluminum low-pressure and atmospheric tanks and their attachments.

2.0 CODES

To the extent specified, welding and other criteria covered by this specification shall be in accordance with one or more of the following Codes and/or Standards.

2.1 ASME Boiler and Pressure Vessel Code; Section IX.

2.2 API 650; Welded Steel Tanks for Oil Storage.

2.3 API 620; Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks.

2.4 AWWA D100; Standard for Steel Tanks - Standpipes, Reservoirs, and Elevated Tanks for Water Storage.

3.0 WELDING PROCESSES

3.1 The following welding processes are permitted, provided satisfactory evidence is submitted that the procedure is qualified in accordance with all applicable Codes, Standards, and job specifications.

3.1.1 Shielded Metal-Arc (SMAW).

3.1.2 Gas Tungsten-Arc (GTAW); manual, machine, and automatic.

3.1.3 Submerged Arc (SAW); with the following limitations:

3.1.3.1 The maximum individual layer thickness shall not exceed 1/2-inch for materials 1-1/4-inch thick or greater and 3/8-inch for materials less than 1-1/4-inch thick.

3.1.3.2 Austenitic stainless steel shall only be welded with an alloy wire and a neutral flux unless the Buyer's permission to use an alloy flux is given for individual applications.

3.1.4 Flux Cored Arc (FCAW) with or without shielding gas; for steel up to and including 2-1/4 Cr-1 Mo. Steel containing more than 2-1/4 Cr-1 Mo and corrosion resisting chromium and chromium-nickel steel must be welded with a shielding gas.

3.1.4.1 FCAW is not permitted in the overhead position or the vertical down position.

3.1.5 Gas Metal-Arc (GMAW) in the spray-transfer range. Pulse arc is considered spray transfer.

3.1.6 The Gas Metal-Arc process using solid-wire electrodes in the short-circuiting transfer range may be used for material up to and including 3/16-inch and for the root pass in material of any thickness.

3.2 Other welding processes may be considered providing that satisfactory evidence of the Seller's ability to use the process is submitted to the Buyer.

4.0 RESTRICTIONS

4.1 Permanently installed backing rings or strips shall not be used without prior permission. Where a backing ring or support bar is used in a weld, this material shall be of the same composition as the base material and shall be completely removed by back-chipping or gouging. Proposals to use backing or support bars of compositions different from that of the base material must receive permission from the Buyer prior to use.

4.2 Peening shall not be used without prior permission to proceed. The use of pneumatic tools for slag removal is not considered peening and is permitted.

4.3 For aluminum and stainless steel butt joints welded from one side only, the root pass shall be made by the Gas Tungsten-Arc process. An internal purge (argon, helium, or nitrogen) shall be used for Gas Tungsten-Arc root pass welding of austenitic stainless steel. P-1 steel may be welded with or without an internal purge.

4.4 Welded joints shall be made by completing each weld layer before succeeding layers are deposited. Block welding is prohibited unless the Buyer's prior permission is obtained. Stripper passes are not considered block welding.

5.0 WELDING ELECTRODES

5.1 Unless specifically waived, all Shielded Metal-Arc welding shall be done using low-hydrogen type electrodes when any of the following conditions apply:

5.1.1 In Service with design temperatures below $0^{\circ}F$.

5.1.2 With steel having a specified allowable carbon content above 0.30 percent.

5.1.3 For steel having a specified minimum tensile strenght of 70,000 psi and greater and the thickness exceeds one inch.

5.1.4 For SMA weld repair of steel castings.

5.2 For Gas Metal-Arc Welding and Gas Tungsten-Arc Welding of P-1 steel, solid wire electrodes shall conform to AWS A.5.18, Classification E70S-2, E70S-3, E70S-4, or E70S-6.

5.3 For Flux Cored Arc Welding of P-1 steel, the wire electrodes shall conform to AWS A.5.20, Classification E70T-1, E70T-4, E70T-5, E70T-6, or E70T-G.

5.3.1 For welding in positions other than flat, the elctrode diameter shall not exceed 0.078 inches.

5.4 Carbon steel shall not be welded with C-1/2 Mo weld metal unless the Buyer's permission is obtained.

5.5 Filler metals and consumable inserts for A-8 (Table QW440, ASME Section IX) austenitic stainless steel welds shall be selected and controlled to produce weld deposits that fall within the following ferrite ranges and numbers as shown in Table 1 below and as determined by Figure 1, WRC Delta Ferrite Diagram, unless other Buyer specifications have more restrictive limitations.

Table 1

Weld Material	PWHT or Service Temp.	Ferrite Percent	Ferrite No.
308, 308L	Less than 800°F	5-25	5 Min.
All Others	Less than 800°F	5-15	5-17

5.6 Type 309 or 309L austenitic stainless steel welding materials shall be used for welding carbon or low-alloy steel to austenitic stainless steel, including the first layer of corrosion-resistant overlays. Type 309L is preferred but Type 309 can be used with the exception of Paragraph 5.6.1 below.

5.6.1 When postweld heat treatment of a dissimilar joint is required, the carbon or low-alloy steel member shall be "buttered" with Type 309L and postweld heat treated prior to welding to the austenitic stainless steel member.

5.7 The requirements listed below shall be mandatory in filler material procurement wherein austenitic stainless steel may be subjected to cryogenic service at temperatures of minus 150°F or below:

5.7.1 The delta ferrite content of the bare electrodes shall be determined by a certified chemical analysis using the WRC Delta Ferrite Diagram as shown in Figure 1, with nitrogen determined by actual analysis, and shall be within the range of 3 to 8 percent (3 to 8.5 FN).

5.8 The receipt, use, disbursal, and retrieval of all welding filler metals shall be maintained under strict control with the storage, baking, and drying as recommended by the manufacturer.

6.0 PREHEAT AND INTERPASS TEMPERATURE (P&IPT)

6.1 P&IPT shall be in accordance with the applicable codes and the latest addenda except that recommended minimum preheat temperatures shall be considered mandatory under this specification.

6.2 In addition to governing code requirements, P-1 steel shall have a P&IPT of 200°F minimum for thicknesses exceeding 1-1/2 inches unless the governing code has more restrictive requirements.

6.3 Welding may be performed only when the metal temperature is above 32°F.

6.4 The maximum preheat and interpass temperature for austenitic stainless steel shall be 350°F.

6.5 P&IPT shall be determined by temperature-indicating crayons, contact pyrometers or other equally suitable means permitted by the Buyer. Temperature-indicating crayons used on austenitic stainless steel and nickel-base alloys shall not cause corrosive effects or other harmful effects and shall not contain more than one percent by weight of total halogens, or sulfur or 200 ppm by weight of inorganic halogens. It is the manufacturer's responsibility to determine suitable brands and melting temperatures that may be used. This information shall be made available to the Buyer's representative on request.

6.6 The P&IPT requirements listed above shall also apply to tack welding and to the welding of temporary attachments.

7.0 WORKMANSHIP, VISUAL QUALITY EXAMINATION, AND INSPECTION

7.1 Each layer of welding shall be smooth and essentially free of slag, inclusions, cracks, porosity, lack of fusion, and undercut; except to the extent permitted in the referenced Codes. In addition, the cover pass shall be sufficiently free of coarse ripples, irregular surfaces, non-uniform heat patterns, high crown, and deep ridges or valleys between heads to permit performance of any required NDE.

7.2 Butt welds shall be slightly convex.

7.3 Repair of welds by chipping, grinding, or gouging shall be done in such a manner as not to gouge, groove, or reduce the adjacent base material below the minimum wall thickness. Removal of defects shall be verified by NDE before repair is started. Repair welding shall be done only by qualified welders using qualified procedures.

7.4 All arc strikes, starts, and stops shall be confined to the welding groove.

7.5 All partial penetration weld joints shall be identified on Form 114, attached.

7.6 After fabrication is complete, temporary welded attachments shall be removed flush with the base metal without undercutting. Attachments shall not be "knocked off". All attachment areas shall be given a visual examination.

8.0 WELDING PROCEDURES

8.1 Only welding procedure specifications (with welding procedure qualification records) which have been given the Buyer's permission to proceed prior to use shall be used for welding. Separate or inclusive procedures shall be submitted for repair welding. Applicable welding procedures that have not been previously granted permission to proceed by the Buyer for the project shall be submitted as soon as possible after award of work and sufficiently ahead of any actual welding to allow permission to proceed from the Buyer. Performance qualification records for individual welders shall be made available to the Buyer's representative.

8.1.1 The attached Form 114 (Welding Procedure Control Sheet) shall be completed by the Seller for all items to be fabricated. All procedures to be used shall be listed and identified. Forms shall be submitted as soon as possible after award of work.

8.2 The Seller's welding procedures require the Buyer's permission to proceed only once for each Buyer project or job.

8.3 Procedures shall be submitted by any one of the following methods:

8.3.1 Forms QW-482 and QW-483 as shown in the ASME Code, Section IX, or similar forms showing the same information,

8.3.2 A Seller's procedures which have been previously granted permission to proceed by the Buyer for the project or job, using processes listed in Paragraphs 3.1.1 through 3.1.6 need not be resubmitted provided the Seller submits a listing of the following information on Form 114:

8.3.2.1 Description of equipment the Seller intends to weld using previously permitted procedures.

8.3.2.2 The Buyer's Specification Number (or equivalent identification).

8.3.2.3 Revision number and date.

8.3.2.4 Date of previous Buyer permission to proceed (and vendor print number, if available).

9.0 NONDESTRUCTIVE EXAMINATION

The information below contains requirements for nondestructive examination. These are minimum requirements and may be supplemented by other requirements contained in additional Buyer specifications and drawings that are part of the purchase documents.

NONDESTRUCTIVE EXAMINATION (NDE)

EQUIPMENT	NONDESTRUCTIVE EXAMINATION (Applicable Notes)			
	RT(1)	MT(1)	PT(1)	UT(1)
TANKS	2, 3, 4	3, 5	3, 6	3, 7

When nondestructive examination is specified, the following notes are applicable when indicated above.

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NOTES:

1. RT (radiographic examination), MT (magnetic-particle examination), PT (liquid penetrant examination), and UT (ultrasonic examination). All indications shall be considered relevant until proven otherwise.

2. The extent of radiographic examination and applicable Codes shall be as required in the Buyer's drawings and specifications.

3. Where random nondestructive examination is specified (i.e, a percentage of each welder's welds or a percentage of the total welding) and shows a weld failing to meet Code or specification requirements, examination shall be made of two or more welds made by the same welder. If either of the additional welds are unsatisfactory, the Buyer's representative may reject all work by that welder. Examinations and repairs to defective or rejected work shall be done at the Seller's expense.

4. Radiographic film shall be either Type I or II per ASTM E94 and lead screens shall be used.

5. Unless otherwise specified, magnetic-particle examination procedures shall be in accordance with ASME Section V, using the D.C. Prod Method. After any final PWHT, the A.C. Yoke Method shall be used. Permanent magnet yokes shall not be used.

6. Unless otherwise specified, liquid-penetrant examination procedures shall be in accordance with ASME Section V.

7. Unless otherwise specified, ultrasonic-examination procedures shall be in accordance with ASME Section V.

Reference Specifications and Forms

Form 114

Attachment: Form 114, Figure 1.

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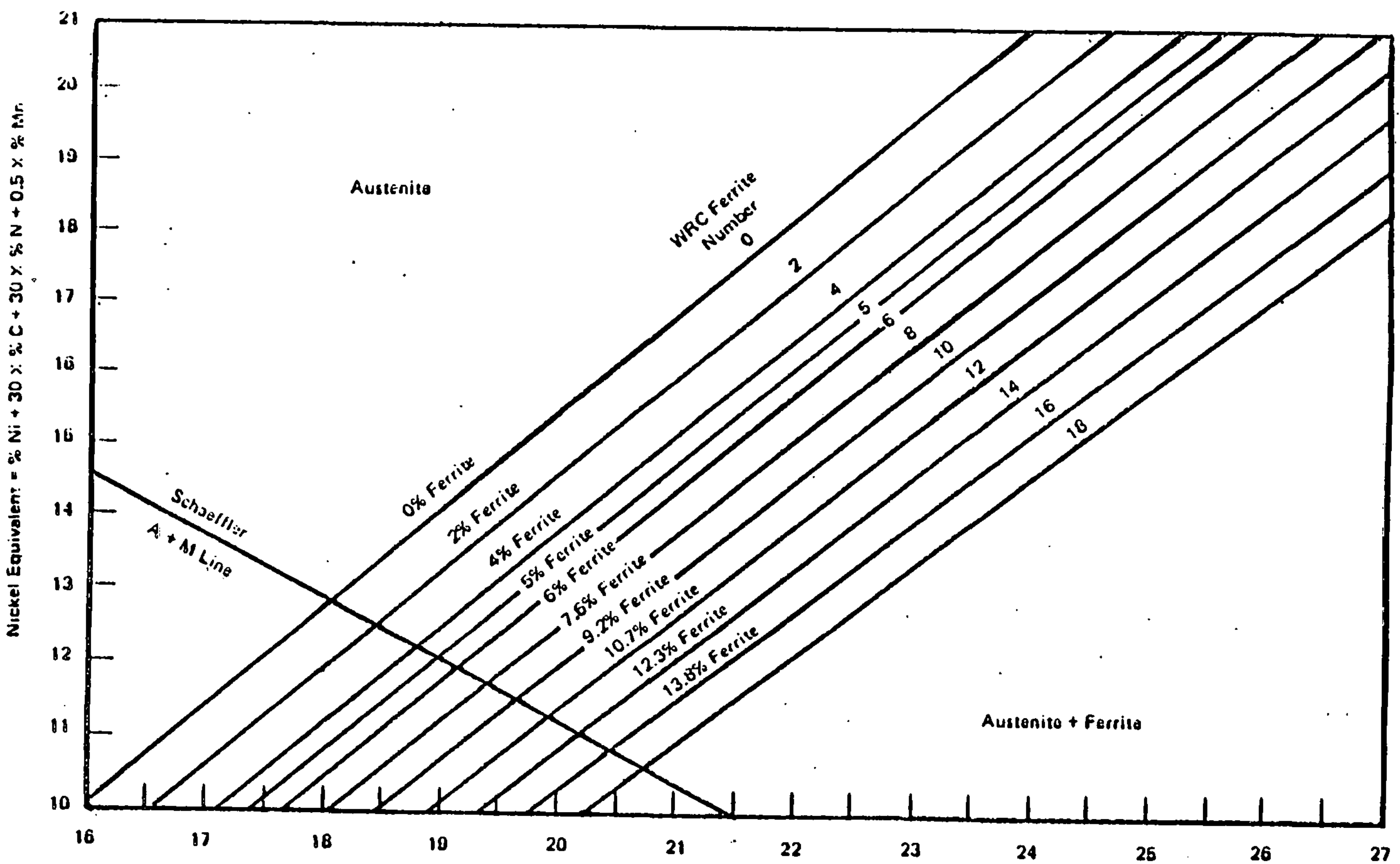
FIGURE 1 WRC DELTA FERRITE DIAGRAM



NOTE: The actual nitrogen content is preferred. If this is not available, the following applicable nitrogen value shall be used: GMAW welds–0.08% (except self-shielding flux cored electrode GMAW welds–0.12%); welds of other processes–0.06%.

THIS SECTION SHALL BE COMPLETED BY MANUFACTURER.
LIST ALL PROCEDURES TO BE USED ON THIS EQUIPMENT.

MFR. ____________ LOCATION ____________

EQUIP. NO. ____________ BECHTEL P. O. ____________

DESCRIP./SERVICE ____________ MFR. S. O. ____________

PWHT: YES (FOR CODE) ☐ YES (FOR PROCESS) ☐ NO ☐

WELDING PROCEDURE IDENTIFICATION					BECHTEL USE ONLY			
MFRS. NO. AND DESCRIP.	REV. DATE	DETAIL FOR THIS EQUIP.			BECHTEL V.P. NO.	REV.	DATE	WELDG. & MET. COMMENTS
		PARTS JOINED	"P" No.	MaxThk				

THIS SECTION FOR BECHTEL USE ONLY.

SPECIFS. ____________

ADDITIONAL COMMENTS:

SPECIAL REQUIREMENTS	
PROCEDURE	PROD. WELDS
☐ ELEV. TEMP. TESTS	☐ PRODUCTION TEST ℞
☐ MAX. TENSILE AT ROOM TEMP.	☐ RADIOGRAPHY
☐ MAX. YIELD AT ROOM TEMP.	☐ ULTRASONIC EXAMN.
☐ BRINNEL HARDNESS	☐ MAGN. PARTICLE EXAMN.
☐ CHARPY IMPACTS	☐ LIQUID PENETRANT EXAMN.
☐ ALL-WELD-METAL TENSILES	☐ BRINNEL HARDNESS
☐ SIMULATED HT. TREATMENT	☐ WELD SAMPLING
☐ SPECIAL CHEMISTRY	

☐ (1) WORK MAY PROCEED.
☐ (2) REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.
☐ (3) REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
☐ (4) REVIEW NOT REQUIRED. WORK MAY PROCEED.

IMPORTANT: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

V. P. –

SIGNED ____________ DATE ____________

EQUIP. NO.

R&C ENG. FORM 114 4/79

BECHTEL

WELDING PROCEDURE CONTROL SHEET

JOB NO.

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1	7/21/80	ISSUE FOR PHASE ZERO	AD	HS	
0	4/80	ISSUED FOR APPROVAL		HS	

1.0 SCOPE

This specification covers welding and nondestructive examination requirements for engineered shop purchased and field subcontracted critical structural components, sheet metal ductwork and structures, and miscellaneous processing equipment.

2.0 CODES

To the extent specified, welding and other criteria covered by this specification shall be in accordance with one or more of the following Codes and/or Standards:

2.1 ASME Boiler and Pressure Vessel Code; Section IX for welding procedure and welder qualification requirements for miscellaneous processing equipment.

2.2 AWS D1.1, Structural Welding Code, for structural steel components. As an option, ASME Section IX may be used for qualification of welders or operators.

2.3 AWS D9.1, Specification for Welding Sheet Steel for sheet metal ductwork and structures.

3.0 WELDING PROCESSES

3.1 The following welding processes are permitted, provided satisfactory evidence is submitted that the procedure is qualified in accordance with all applicable Codes, Standards, and job specifications:

3.1.1 Shielded Metal-Arc (SMAW).

3.1.2 Gas Tungsten-Arc (GTAW): manual, machine, and automatic.

3.1.3 Submerged Arc (SAW); with the following limitations:

3.1.3.1 The maximum individual layer thickness shall not exceed 1/2-inch for materials 1-1/4-inch thick or greater and 3/8-inch for materials less than 1-1/4-inch thick.

3.1.3.2 Alloy steel shall only be welded with an alloy wire and a neutral flux unless the Buyer's permission to use an alloy flux is given for individual applications.

3.1.3.3 Removable starting and stopping tabs shall be used for longitudinal welds.

3.1.4 Oxyacetylene (FGW); this process is limited to two-inch nominal diameter and smaller carbon steel piping, hard facing, and repairs to cast iron. (Hardfacing of austenitic stainless steel with FGW is not allowed.).

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3.1.5 Flux Cored Arc (FCAW), with or without a shielding gas, may be used to weld P-1, P-3, P-4, and 2-1/4 Cr-1 Mo steel. Steel containing more than 2-1/4 Cr-1 Mo and corrosion-resisting chromium and chromium-nickel steel must be welded with a shielding gas.

3.1.5.1 FCAW is not permitted in the overhead position or the vertical down position.

3.1.6 Stud Welding.

3.1.7 Gas Metal-Arc (GMAW) in the spray-transfer range. Pulse arc is considered spray transfer.

3.1.8 The Gas Metal-Arc process using the solid-wire electrodes in the short-circuiting transfer range may be used for materials up to and including 3/16-inch, and for the root pass in material of any thickness.

3.1.9 Plasma Arc (PAW).

3.2 Other welding processes may be considered providing that satisfactory evidence of the Seller's ability to use the process is submitted to the Buyer.

4.0 RESTRICTIONS

4.1 All welding processes shall be protected from wind, rain, and other harmful weather conditions which may affect weld quality.

4.2 Welding techniques shall be selected to assure specified tolerances for straightness and out-of-roundness are not exceeded.

4.3 Where a backing ring or support bar is used in a weld, this material shall be compatible with the base material.

4.4 Peening of the root and cover passes is not permitted. The use of pneumatic tools for slag removal is not considered peening and is permitted.

4.5 An argon, nitrogen, or helium internal purge shall be used for Gas Tungsten-Arc root pass welding of 2-1/4 Cr-1 Mo and higher filler metal.

4.6 When welding titanium, each weld bead and the adjacent base metal shall be cleaned to remove all surface discoloration prior to depositing the next bead. The final weld surface may have an intermittent, irridescent straw-colored or light-blue oxide film.

4.7 For joining clad steel, the following limitations apply:

4.7.1 The cladding shall be stripped back a minimum of 1/4-inch from the edge of base material weld bevels by machining or grinding, not by flame or arc-gouging.

4.7.2 Removal of the cladding shall not reduce the base materials thickness below the design thickness.

4.7.3 A minimum radius of 1/16-inch shall be used at the limit of cladding removal unless the clad material is beveled at least 30 degrees.

4.7.4 Preparation of local repair cavities in overlay welds that penetrate into the base material more than 10 percent of its thickness shall have the base material rewelded with the proper welding procedure consistent with the base material before completing the overlay repair.

4.8 Weld deposits for alloy welds shall fall within the limits of chemical composition specified for the materials to be joined, unless otherwise permitted by the Buyer.

4.9 Production weld filler materials shall have mechanical properties within the limits specified for the base materials to be joined unless permission to deviate is received from the Buyer.

4.9.1 In addition, completed welds specified in drawings, specifications or data sheets to be in severe service shall not exceed Brinell Hardness (BHN) listed below.

4.9.1.1 200 BHN in carbon steel welds and heat affected zones. The shielded metal arc process is exempt from this requirement.

4.9.1.2 215 BHN in Cr-1/2 Mo steel welds and heat affected zones.

4.9.1.3 241 BHN in low-alloy Cr-Mo steel welds and heat affected zones.

4.9.2 Macro-hardness tests shall be taken approximately every 50 feet of the weld seam with a minimum of one location per component. Whenever possible, readings shall be taken on the I.D. of the component weld or as determined by the Buyer's representative. If a test reveals hardness exceeding the specified limit by more than 5 percent, two more tests at locations six inches on either side of the original tests may be taken. If both of these two tests indicate that hardness is below the specified value, then the weld is considered acceptable.

4.9.3 Hardness exceeding the specified value by 5 percent or more, or subsequent adjacent tests showing higher than specified hardnesses are not permitted and the welds showing the excessive hardness shall be rejected and subject to re-heat treatment or repair.

4.10 Weld bevel preparations for P-5 and higher alloys shall be machined or ground back to bright and sound metal if they have been flame or arc cut.

4.11 All surfaces to be welded shall be free of loose scale, oil, grease, dirt and other contaminants.

4.12 Welded joints shall be made by completing each weld layer before succeeding layers are deposited. Block welding is prohibited unless the Buyer's prior permission is obtained. Stripper passes are not considered block welding.

4.13 Vertical welding shall be done vertical up. Proposals to use the vertical down position shall be subject to permission from the Buyer.

5.0 WELDING ELECTRODES

5.1 All Shielded Metal-Arc welding shall be done using low-hydrogen type electrodes when any of the following conditions apply:

5.1.1 In Service with design temperatures below 0°F.

5.1.2 With steel having a specified allowable carbon content above 0.30 percent.

5.1.3 For steel having a specified minimum tensile strength of 70,000 psi and greater and the thickness exceeds one inch.

5.1.4 For SMA weld repair of steel castings.

5.2 For Gas Metal-Arc Welding and Gas Tungsten-Arc Welding of P-1 steel, solid wire electrodes shall conform to AWS A.5.18, Classification E70S-2, E70S-3, E70S-4, or E70S-6.

5.3 For FCAW of carbon steel, the wire electrodes shall conform to AWS A.5.20, Classifications E70T-1, E70T-4, E70T-5, E70T-6, or E70T-G.

5.3.1 For welding in positions other than flat, the electrode diameter shall not exceed 0.078 inches.

5.4 Filler metals and consumable inserts for A-8 (Table QW-440, ASME Section IX) austenitic stainless steel welds shall be selected and controlled to produce weld deposits that fall within the following ferrite ranges and numbers as shown in Table 1 below and as determined by Figure 1, WRC Delta Ferrite Diagram and the certified chemical analysis, unless other Buyer specifications have more restrictive limitations.

Table 1

Weld Material	PWHT or Service Temp.	Ferrite Percent	Ferrite No.
308, 308L	Less than 800°F	5-25	5 Min.
	800°F and over	5-9	5-9.8
All Others	Less than 800°F	5-15	5-17
	800°F and over	5-9	5-9.8

5.5 Type 309 or 309L austenitic stainless steel welding materials shall be used for welding carbon or low-alloy steel to austenitic stainless steel including the first layer of austenitic stainless steel corrosion-resistant overlays. Type 309L is preferred but Type 309 can be used with the exception of Paragraphs 5.5.1 and 5.5.2 below.

5.5.1 When postweld heat treatment of a dissimilar joint is required, the carbon or low-alloy steel member shall be

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"buttered" with Type 309L and postweld heat treated prior to welding to the austenitic stainless steel member.

5.52 For corrosion-resistant overlays, where the carbon or low-alloy steel base metal requires postweld heat treatment, the first weld layer shall be made with Type 309L. All other layers shall be made with low-carbon grade welding materials.

5.6 The receipt, use, disbursal, and retrieval of all welding filler metals shall be maintained under strict control with the storage, baking, and drying as recommended.

6.0 PREHEAT AND INTERPASS TEMPERATURE (P&IPT)

6.1 The preheat and interpass temperature for the welding of carbon steel listed in AWS D1.1 shall be as specified in that code except that no welding may proceed if the metal temperature is below 32°F.

6.2 The preheat and interpass temperature for the welding of carbon steel not listed in AWS D1.1 and for the welding of all P-1 carbon steel for miscellaneous processing equipment shall be 200°F when the thickness at the joint exceeds 1-1/2 inches.

6.2.1 For the repair of pumps and valves, carbon steel which have both a specified maximum (or actual) carbon content in excess of 0.30 percent and a repair cavity in excess of one inch shall have a preheat and interpass temperature of 175°F.

6.2.2 All other P-1 carbon steel shall have a minimum preheat temperature of 50°F.

6.3 All P-3, P-4, P-5, and P-6 steel shall have a P&IPT in accordance with ASME Section VIII, Appendix R except that the recommended Code minimum preheat temperatures shall be considered mandatory under this specification.

6.4 The maximum preheat and interpass temperature for austenitic stainless shall be 350°F.

6.5 P&IPT shall be determined by temperature-indicating crayons, contact pyrometers or other equally suitable means permitted by the Buyer. Temperature-indicating crayons used on austenitic stainless steel and nickel-base alloys shall not cause corrosive effects or other harmful effects and shall not contain more than one percent by weight of total halogens, or sulfur, or 200 ppm by weight of inorganic halogens. It is the manufacturer's responsibility to determine suitable brands and melting temperatures that may be used. This information shall be made available to the Buyer's representative upon request.

6.6 The P&IPT requirements listed above shall also apply to tack welding and to the welding of temporary attachments. The preheat requirements above shall also apply to all thermal gouging and cutting except for P-1 steel.

7.0 POSTWELD HEAT TREATMENT (PWHT)

7.1 Postweld heat treatment for structural steel components, when required by the technical specification or design drawings, shall be in accordance with AWS D1.1.

7.2 Postweld heat treatment for miscellaneous processing equipment, when required by the technical specification or design drawings, shall be in accordance with the ASME Code (Paragraphs UCS-56, UHA-32, and UW-40 of Section VIII, Division 1) with the following exceptions:

7.2.1 A minimum of 1250°F on P-4 materials is required.

7.2.2 For P-6 materials, the PWHT temperature used shall be the lowest possible to avoid overheating and hardening or cooling.

7.3 When the referenced Code or technical specification specifies only a minimum PWHT temperature, the maximum PWHT temperature shall not exceed the specified minimum by more than 150°F with the following exception:

7.3.1 For materials which have been previously heat treated by normalizing and tempering or quenching and tempering, the PWHT temperature shall be the lowest possible to avoid degradation of the base material properties.

7.4 A minimum of two positively attached thermocouples is required. When there are varying thicknesses, one shall be on the thickest and one on the thinnest section. (Other Buyer job specifications may require additional thermocouples.).

7.5 Direct impingement by torch or furnace burner flames is not permitted for PWHT.

7.6 Exothermic heat treatment is prohibited.

8.0 WORKMANSHIP, VISUAL QUALITY EXAMINATION, AND INSPECTION

8.1 Each layer of welding shall be smooth and essentially free of slag, inclusions, cracks, porosity, lack of fusion, and undercut. In addition, the cover pass shall be sufficiently free of coarse ripples, irregular surfaces, non-uniform bead patterns, high crown and deep ridges or valleys between beads to permit performance of any required NDE.

8.2 Butt welds shall be slightly convex.

8.3 Repair of welds by chipping, grinding, or gouging shall be done in such a manner as not to gouge, groove, or reduce the adjacent base-material thickness below the minimum wall thickness. Removal of defects shall be verified by NDE before repair is started. Repair welding shall be done only by qualified welders using qualified procedures.

8.4 Overlay welds (except for hardfacing) on miscellaneous processing equipment shall be liquid-penetrant examined. This shall be done after final machining and postweld heat treatment when machining and/or postweld heat treatment is required.

8.5 All arc strikes, starts, and stops shall be confined to the welding groove.

8.6 All partial penetration weld joints shall be identified on Form 114, attached.

8.7 After fabrication is complete, temporary welded attachments shall be removed flush with the base metal without undercutting. Attachments shall not be "knocked off". All attachment areas shall be examined. Magnetic materials shall be MT or PT examined and nonmagnetic materials shall be PT examined.

9.0 WELDING PROCEDURES

9.1 Only welding procedure specifications (with welding procedure qualification records) which have been given the Buyer's permission to proceed prior to use shall be used for welding. Separate or inclusive procedures shall be submitted for repair welding. Applicable welding procedures that have not been previously granted permission to proceed by the Buyer for the project shall be submitted as soon as possible after award of work and sufficiently ahead of any actual welding to allow for adequate review and permission to proceed from the Buyer. Performance qualification records for individual welders shall be made available to the Buyer's representative.

9.1.1 For all equipment, the attached Form 114 (Welding Procedure Control Sheet) shall be completed by the Seller for all items to be fabricated. All procedures to be used shall be listed and identified. Forms shall be submitted as soon as possible after award of work.

9.1.2 The welding procedures for all self-shielded FCAW to AWS D1.1 shall be qualified by testing; i.e, prequalified procedures are not permitted.

9.2 The Seller's welding procedures require the Buyer's written permission to proceed only once for each Buyer project or job.

9.3 Procedures shall be submitted by any one of the following methods:

9.3.1 Forms as shown in the applicable codes, or similar forms showing the same information.

9.3.2 A Seller's procedures which have been previously granted permission to proceed by the Buyer for the project or job, using processes listed in Paragraphs 3.1.1 through 3.1.9 need not be resubmitted provided the Seller submits a listing of the following information on Form 114.

9.3.2.1 Description of equipment the Seller intends to weld using previously permitted procedures.

9.3.2.2 The Buyer's specification number (or equivalent identification).

9.3.2.3 Revision number and date.

9.3.2.4 Date of previous Buyer permission to proceed (and vendor print number, if available).

10.0 NONDESTRUCTIVE EXAMINATION

The information below contains requirements for nondestructive examination. These are minimum requirements and may be supplemented by other requirements contained in additional Buyer specifications and drawings that are part of the purchase documents.

NONDESTRUCTIVE EXAMINATION (NDE)

NONDESTRUCTIVE EXAMINATION (Applicable Notes)				
EQUIPMENT	RT(1)	MT(1)	PT(1)	UT(1)
VESSELS	2,3,4	5	6	7

When nondestructive examination is required by Code or Buyer specification, the following notes are applicable to the extent listed on the table.

NOTES:

1. RT (radiographic examination), MT (magnetic-particle examination), PT (liquid-penetration examination), and UT (ultrasonic examination). All indications shall be considered relevant until proven otherwise.

2. The extent of radiographic examination and applicable Codes shall be as required in the Buyer's drawings and specifications. Unless otherwise specified, radiographic examination procedures shall be in accordance with the referenced Code or technical specifications.

3. Radiographic film shall be either Type I or II per ASTM E94 and lead screens shall be used.

4. Single-film viewing shall be used and the film density shall be in the range of 1.8-3.4. For those instances where the variable thickness makes single-film impracticable and, with the Buyer Representative's concurrence, double-film viewing may be used. For the double-film technique, the film density shall be in the range of 1.8-3.4 for the double-film combination and each individual film shall not be less than 1.3.

5. Unless otherwise specified, magnetic-particle examination procedures shall be in accordance with the referenced Code or technical specifications using the D.C. Prod Method. After any final PWHT, the A.C. Yoke Method shall be used. Permanent magnet yokes shall not be used.

6. Unless otherwise specified, liquid-penetrant examination procedures shall be in accordance with the referenced Code or technical specifications.

7. Unless otherwise specified, ultrasonic-examination procedures shall be in accordance with the referenced Code or technical specifications.

Reference Specifications and Forms

ATTACHMENT: Form 114
Figure 1

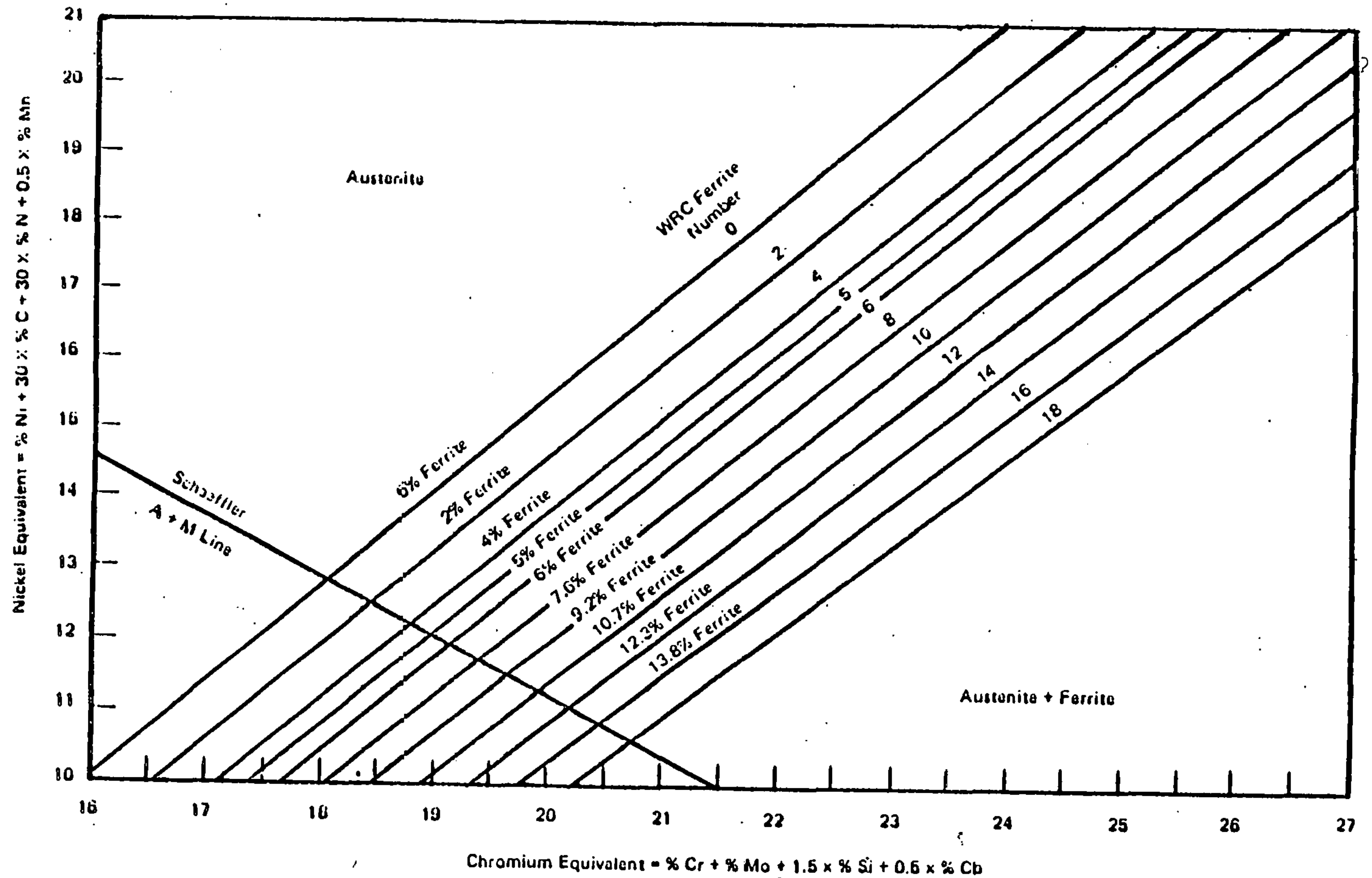

FIGURE 1 WRC DELTA FERRITE DIAGRAM

NOTE: The actual nitrogen content is preferred. If this is not available, the following applicable nitrogen value shall be used: GMAW welds—0.08% (except self-shielding flux cored electrode GMAW welds—0.12%); welds of other processes—0.08%.

THIS SECTION SHALL BE COMPLETED BY MANUFACTURER.
LIST ALL PROCEDURES TO BE USED ON THIS EQUIPMENT.

MFR. ______________________ LOCATION ______________________

EQUIP. NO. ______________________ BECHTEL P. O. ______________________

DESCRIP./SERVICE ______________________ MFR. S. O. ______________________

PWHT: YES (FOR CODE) ☐ YES (FOR PROCESS) ☐ NO ☐

WELDING PROCEDURE IDENTIFICATION					BECHTEL USE ONLY			
MFRS. NO. AND DESCRIP.	REV. DATE	DETAIL FOR THIS EQUIP.			BECHTEL V.P. NO.	REV.	DATE	WELDG. & MET. COMMENTS
		PARTS JOINED	"P" No.	MaxThk				

THIS SECTION FOR BECHTEL USE ONLY.

SPECIFS. ______________________

ADDITIONAL COMMENTS:

SPECIAL REQUIREMENTS

PROCEDURE	PROD. WELDS
☐ ELEV. TEMP. TESTS	☐ PRODUCTION TEST ℞
☐ MAX. TENSILE AT ROOM TEMP.	☐ RADIOGRAPHY
☐ MAX. YIELD AT ROOM TEMP.	☐ ULTRASONIC EXAMN.
☐ BRINNEL HARDNESS	☐ MAGN. PARTICLE EXAMN.
☐ CHARPY IMPACTS	☐ LIQUID PENETRANT EXAMN.
☐ ALL-WELD-METAL TENSILES	☐ BRINNEL HARDNESS
☐ SIMULATED HT. TREATMENT	☐ WELD SAMPLING
☐ SPECIAL CHEMISTRY	

☐ (1) WORK MAY PROCEED.
☐ (2) REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.
☐ (3) REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
☐ (4) REVIEW NOT REQUIRED. WORK MAY PROCEED.

IMPORTANT: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

V. P. –

SIGNED ____________ DATE ____________

EQUIP. NO.

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BECHTEL

WELDING PROCEDURE CONTROL SHEET

JOB NO.

Painting—X

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3					
2	10-21-81	ADDED CODE REFERENCE SH.3			
1	8/80	ISSUE FOR PHASE ZERO		HS	
0	6/80	ISSUED FOR APPROVAL	RW	HS	

BECHTEL	ASFI THE BRECKINRIDGE PROJECT AECI U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717 GENERAL SPECIFICATION FIELD PAINTING-NON ARCHITECTURAL	JOB NO. 14222 SPECIFICATION 14222-X-1 REV 2

1.0 SCOPE

1.1 This specification covers the surface preparation, method of application and material to be used for all field painting of equipment, tanks, structures and piping, including touch-up, repairs and inspection.

1.2 In general, small shop fabricated equipment and off-shelf type items will be delivered to the jobsite coated with a shop applied primer or the manufacturer's standard finish.

1.3 Items Included

1.3.1 Preparation of the surfaces, furnishing and the application of all field applied protective coatings.

1.3.2 Documentation of materials and procedures.

1.3.3 Inspection and tests.

1.3.4 Protection of coated surfaces.

1.3.5 Touch-up and repair of defective or damaged coated surfaces arriving in the field.

1.3.6 Upgrading of manufacturer's standard coating system, where required.

1.3.7 Application of final top coat on structural steel.

1.3.8 Appendix "A" - Coating Systems.

1.3.9 Appendix "B" - Coating Schedule.

1.3.10 Appendix "C" - Safety Color Coding.

1.4 Related Items Not Included

1.4.1 The following surfaces shall not be coated:

1.4.1.1 Nonferrous or stainless steel parts, unless otherwise specified.

1.4.1.2 Buildings.

1.4.1.3 Name and instruction plates, etc.

1.4.1.4 Rubber or similar nonmetallic parts.

1.4.1.5 Surfaces to be completely embedded in concrete, unless otherwise specified.

1.4.1.6 Machined surfaces and fittings.

1.4.1.7 Prefinished metal with an approved finish and color acceptable to the Buyer.

2.0 QUALITY STANDARDS

2.1 General

2.1.1 The Seller shall control the quality of items and services to meet the requirements of this Specification, applicable codes and standards, and other procurement documents.

2.2 Referenced Codes and Standards

Sponsor	Number	Subject
ASTM	E337	Test for Relative Humidity by Wet-and-Dry-Bulb-Psychrometer
SSPC	SP-1	Solvent Cleaning
SSPC	SP-3	Power Tool Cleaning
SSPC	SP-5	White Metal Cleaning
SSPC	SP-6	Commercial Blast Cleaning
SSPC	SP-10	Near-White Blast Cleaning
SSPC	Vis-1-67-T	Pictorial Surface Preparation Standards for Painting Steel Surfaces
SSPC	PA-2	Measurement of Dry Paint Thickness with Magnetic Gages
ANSI	A13.1	Scheme for the Identification of Piping Systems
2 NACE	TM-01-70	Visual Standards of Surfaces of New Steel Airblast Cleaned with Sand Abrasive

The revision to the above standards shall be that current at the date of purchase.

2.3 Quality Requirements

2.3.1 The Seller's Quality Control/Inspection Program shall include the necessary measures for control to ensure that the completed coating work conforms to the requirements of the technical specification and the applicable codes and standards. This plan shall provide for assurance that only accepted coating materials are used, that inspection of the surface preparation and the coating application is implemented for all phases of coating work performed, and that records and documentation are prepared and maintained to furnish evidence of compliance with procedures.

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2.3.2 The Seller, including any lower-tier organizations engaged by him, shall be subject to surveillance inspection and audit by the Buyer for compliance with the requirements of the procurement documents until the completion or termination of the procurements. This surveillance inspection and audit does not relieve the Seller from the responsibility for conformance to the requirements set forth in the procurement documents.

2.3.3 The Buyer's inspection personnel shall be provided with a detailed schedule and shall be notified of all required hold and witness points requiring inspection by the Buyer prior to the scheduled date for coating activities. Failure to provide the required notification may result in the requirement for reinspection or rework.

2.3.4 The Seller shall identify and document uncorrected deviations from the technical specification, codes and standards and shall transmit these deviations to the Buyer for review and disposition. Deviations detected during the performance of work shall be reported. The Seller shall submit his recommended disposition based on an appropriate analysis.

3.0 SUBMITTALS

3.1 Engineering Documents

3.1.1 The Seller shall submit a listing of all coating materials to be used in this work which shall identify the specific products by manufacturer and catalog number in each coating system as scheduled.

3.1.2 The Seller's written procedures for storage, handling, surface preparation, environmental control, application, touch-up and repair, curing and inspection of the coating system shall be submitted for review and acceptance prior to use. Conflicts, if any, between the coating manufacturer's recommendations and this specification shall be noted.

3.1.3 The Seller's proposed cleaning and coating verification forms for daily inspection records shall be submitted for review.

3.2 Quality Verification Documents

3.2.1 Deviations detected during the performance of work shall be reported and submitted as specified in Quality Requirements, Subparagraph 2.3.4.

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3.2.2 A detailed cleaning and coating verification report in accepted form shall be completed each day during the work and shall be submitted for record. The final verification report shall include a statement of completion conformance verifying that required material was used and that the accepted application procedures and specifications were followed.

4.0 MATERIALS

4.1 Material Manufacturers

4.1.1 Unless otherwise specified, all coating materials used on any one surface or piece of equipment shall be products accepted by the Buyer. Materials from different manufacturers shall not be used over each other without prior written acceptance.

4.1.2 The Seller shall notify the coating manufacturer on the purchase order for the coating material that the coating is to be applied to equipment to be furnished to the Buyer.

4.1.3 The coating materials shall be in pre-measured units.

4.1.4 The coating materials for each system shall be as shown in Appendix "A". Only the materials approved shall be used unless authorized in writing by the Buyer.

4.2 Machined-Surface Coatings

4.2.1 The acceptable materials shall be those which meet the requirements of MIL-C-16173, Grade 1:

Material	Manufacturer
Nox Rust 201B	Danbert Chemical Co.
Nokorode	Lion Oil Co.
Rust Veto	E.F. Houghton & Co.

4.3 Abrasive Materials

4.3.1 Abrasives for blast cleaning shall be clean and dry, furnished either in bulk or packaged, and shall be free of oil or contaminants. The particle size shall be capable of producing the specified surface profile. Cast iron or malleable iron shot shall not be used. Chilled iron shot may be used.

4.4 Touch-Up Materials

4.4.1 Materials for touch-up of damaged areas of surfaces shall be the same as that originally applied, thinned according to recommendations of the manufacturer.

4.4.2 Touch-up materials shall be provided in premeasured units, unless otherwise specified by the Buyer.

4.5 Thinners, Solvents, and Cleaners

4.5.1 Thinners, solvents, and cleaners shall be as recommended by the coating material manufacturer and shall be identified by the product number or generic formulation.

5.0 DELIVERY, RECEIPT AND STORAGE

5.1 Delivery and Storage

5.1.1 Coating materials shall be delivered to the jobsite in the manufacturer's unopened, original containers bearing a legible product designation, batch number, and date of manufacture. Containers which are damaged to the point of jeopardizing the contents shall not be used. A record shall be kept of all items received and used.

5.1.2 The materials shall be received and stored in accordance with the manufacturer's latest published instructions, and shall be protected from damage, moisture, direct sunlight, and temperatures below 40F or above 100F. In the event the temperature is elevated to ranges exceeding this specified limit, the Seller shall re-confirm the manufacturer's acceptance of a representative sample from the storage area.

5.2 Date of Materials

5.2.1 The coating materials shall be used within twelve months of their manufacture. The date of use shall in no case exceed the manufacturer's recommended shelf life. If the manufacturer's recommended shelf life is exceeded, the Seller must gain the manufacturer's and the Buyer's acceptance of the materials prior to their use, based on a representative sample from the storage area.

5.2.2 Containers of coatings or components shall not be issued or opened unless for immediate use.

6.0 EQUIPMENT

6.1 General Requirements

6.1.1 The Seller shall provide equipment capable of regulating and controlling conditions within the work area to the extent that the temperature of the substrate is always a minimum of 5F above the dew point. The substrate temperature during coating application and curing shall be maintained between a minimum of 50F and a maximum of 120F.

6.1.2 The equipment shall include the necessary blowers, filters, and humidity control equipment to provide clean air to the work area in sufficient quantity to maintain an atmosphere for performing the specified operations at no more than 30% relative humidity.

6.1.3 The equipment shall be capable of producing the specified environment for performance of the work according to the schedule accepted by the Buyer.

6.1.4 The spray equipment shall be a type as recommended by the coatings manufacturer and shall be suitable to apply the coatings as specified.

6.1.5 Spray equipment air supply lines shall be equipped with traps to remove moisture and oil as close to the point of use as possible.

7.0 SURFACE PREPARATION

7.1 General Requirements

7.1.1 Prior to the start of work, the Seller shall examine all surfaces to be coated to determine their acceptability for the specified work. If the surfaces are found to be unacceptable, the Seller shall immediately work until corrective action has been taken. Commencement of work prior to the taking of corrective action shall preclude any subsequent claim by the Seller. The Buyer may require corrective action at the Seller's expense.

7.1.2 Cleaning and coating shall be coordinated with other work in the area. Prior to starting any cleaning or coating operations, the Seller shall obtain assurance that the surface is ready for cleaning and coating.

7.1.3 Surfaces to be coated shall be cleaned in accordance with the schedule.

7.1.4 The surface profile of the steel cleaned by blasting shall be as specified in Appendix "A". A comparison shall be made with a Testex Press-O-Film or another Buyer accepted equivalent which is appropriate to the type of abrasive material being used.

7.1.5 The abrasive mixture and the compressed air shall be clean, dry, and oil-free. Traps, in addition to oil and water extractors mounted on the compressor, shall be used in compressed air lines to remove oil and moisture from the air close to the point of use.

7.1.6 Prior to any surface preparation procedures, contamination shall be removed from the steel surfaces. Oil and grease shall be removed by solvent cleaning in accordance with SSPC-SP-1.

7.1.7 Blast cleaning shall not be performed in the immediate area where coating or curing of coated surfaces is in progress. All surfaces and equipment which is not to be coated shall be suitably protected from blast cleaning.

7.1.8 Burrs, slivers, scabs, and weld spatter which become visible after blasting shall be removed by the Seller. Repaired areas shall have the surface profile suitably restored.

7.1.9 If visible rusting occurs or if the cleaned surfaces become wet or otherwise contaminated, they shall be recleaned to the degree specified above.

7.1.10 After blast cleaning and immediately before coating, dust shall be removed with compressed air, free of oil and moisture. Vacuuming shall be used if the surface is not dust free, as determined by the Buyer's inspector.

8.0 MIXING AND APPLYING COATINGS

8.1 General Requirements

8.1.1 The Seller's application personnel shall be qualified to apply the specified coating material in accordance with the Seller's written qualification procedure, accepted by the Buyer.

8.1.2 Mixing, applying, and curing of the coating material shall be in accordance with the manufacturer's latest published instructions and the requirements specified herein. When multiple component units are mixed, each component shall be mixed separately prior to the mixing of the combined materials. Only complete kits shall be mixed.

8.1.3 Coating materials shall be thoroughly mixed until they are smooth and free from lumps, then strained through a 30 mesh or finer screen. Mixed materials shall be agitated to keep the solids in suspension.

8.1.4 The blast cleaned surface shall be coated before any visible rust forms on the surface.

8.1.5 The coating materials shall not be applied when there is moisture on the surface, dust is present which can contaminate the freshly-coated surface, dirt or other detrimental materials have recontaminated the surface, or when the surface temperature of the steel is below 50F or above 120F.

8.1.6 In particular, ample drying time shall be allowed between coats or primers and finish paints. Thickness of the paint shall be in accordance with Painting Schedule or manufacturer's recommendations, whichever is greater.

8.1.7 The spray equipment shall be conventional or airless and in acceptable operating condition as determined by the Seller through inspection and testing. The air supply lines shall be equipped with traps to remove moisture and oil.

8.1.8 Runs, sags, voids, drips. overspray, loss of adhesion, blistering, peeling, mudcracking, inadequate cure, or rusting of the substrate shall not be permitted.

8.1.9 Enclosures to permit coating of surfaces during inclement weather may be used, provided the environmental restrictions specified are maintained throughout the coating and curing periods. The enclosures and methods of environmental control are subject to acceptance by the Buyer.

8.1.10 Where shop paint has been damaged in transit, or where damage has occurred to field coats, all damaged and loosely adhering paint shall be removed and the surface thoroughly cleaned. Edges of the breaks shall be feathered and the designated number of prime and finish coats applied.

8.1.11 All painting shall be done in accordance with Appendix "A", "B", and "C".

8.1.12 Pumps shall be marked with stencil numerals on the concrete base or driver as directed by the Buyer's Field Superintendent.

8.1.13 Exchangers and pressure vessels shall be marked with stencil numerals on the insulation covering if insulated or on the painted surface. Position of marking shall be as directed by the Buyer's Field Superintendent.

△1 8.1.14 Field storage tanks shall be marked with stencil numerals. Tank numbers shall be placed on the roof and on the shell as directed by the Buyer's Field Superintendent.

9.0 INSPECTION AND TESTS

9.1 General Requirements

9.1.1 The surfaces to be coated shall be divided into identifiable areas or units of production as a basis for inspection and/or documentation.

9.1.2 The inspection points identified in item 9.1.1 above shall be established as follows:

9.1.2.1 Prior to the start of work.

9.1.2.2 Immediately following the surface preparation.

9.1.2.3 Immediately prior to the coating application.

9.1.2.4 Following the application and curing of each coat.

9.1.2.5 After final inspection and sign-off, in accordance with the project requirements.

9.1.3 The Seller shall furnish the necessary testing and inspection instruments, properly calibrated and maintained. Such equipment shall be available for use by the Buyer in conducting his surveillance of the work.

9.1.4 Prior to using compressed air, the quality of the air downstream of the separator shall be tested by blowing the air onto a clean white blotter (minimum size 8" x 8") for two minutes to check for any contamination, oil, or moisture. The blotter test shall be performed at the beginning of each shift and at not less than four-hour intervals. The test also shall be made after any interruption of the air compressor operation or as required by the Buyer. The air shall be used only if the blotter test indicates no visible contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the air stream shall be retested. Traps shall be bled continuously. All surfaces shall be tested individually prior to use. Surfaces which are determined to have been blasted with contaminated air must be reblasted with clean air and abrasive.

9.1.5 Any defects disclosed by inspection shall be re-inspected after correction.

9.2 Surface Preparation Inspection

9.2.1 The temperature, dew point, and relative humidity shall be determined with a sling psychrometer or an accepted equal following procedures in ASTM E337. Readings are required at the start of work and every two hours or at time intervals designated by the Buyer. Alternatively, continuous monitoring may be performed using systems established and/or accepted by the Buyer.

9.2.2 Blast cleaned surfaces shall be compared with SSPC-Vis-1-67, Visual Standards, or accepted NACE Standards. The anchor pattern profile depth shall be verified with a Testex Press-O-Film, or an accepted equal appropriate to the abrasive material being used.

9.2.3 A grease-free chalk shall be used to mark local areas which do not meet the specified standards.

9.3 Coating Inspection

9.3.1 Surface temperature and humidity reading shall be taken every two hours. The work shall not proceed if the substrate temperature falls below 5F above the dew point.

9.3.2 The dry film thickness shall be tested with a Mikro-test FIM gage or an accepted equivalent, at five random points for each 100 square feet of surface area or at three random points on each piece less than 100 square feet in area. The testing method shall be in accordance with SSPC PA-2.

9.3.3 The film shall be visually inspected for defects such as overspray, runs, sags, mudcracking, inadequate cure or lack of adhesion. The Seller shall repair all defects according to the touch-up and repair procedures accepted by the Buyer.

9.3.4 Minor, randomly located film imperfections from air bubbles, dust particles, etc., scattered over the surface may be accepted if they are not in excess of 10 per square Foot as determined by the Buyer's inspector.

9.3.5 The total dry film thickness of sags and runs shall not exceed 120 percent of the maximum specified dry film thickness nor shall it be less than 90 percent of the minimum specified dry film thickness.

10.0 REMEDIAL WORK

10.1 Touch-Up

10.1.1 Coated surfaces within the scope of this specification that have been damaged during assembly or handling shall be repaired in accordance with procedures as accepted by the Buyer.

10.1.2 The surface profile shall be restored to meet the specified surface preparation requirements for cleanliness and profile. The periphery of a damaged area shall be feathered in with an acceptable material.

10.1.3 Precautions shall be taken to protect adjacent coated areas from damage caused by touch-up cleaning. The use of vacuum blast type equipment and needle guns will be permitted for abrasive blast cleaning.

11.0 APPENDIX "A" - COATING SYSTEMS

11.1 Coating System No. 1

Generic: High Build Epoxy over Zinc Rich Epoxy Primer

Substrate: Carbon Steel

Operating Temperature Range: Ambient to 200°F

Surface Preparation Required: SSPC-SP-6 Commercial Blast Cleaning

Surface Profile Required: 1.0 to 2.5 mils

Coat	Color	Generic	D.F.T Mils	Manufacturer
Primer	Red/Grey	Zinc Rich Epoxy	2.5 to 3	Note.1
Intermediate	White/Buff	High Build Epoxy	5	Note 1
Finish	ANSI-70	High Build Epoxy	5	Note 1
		TOTAL	12 to 13	

NOTE 1: The following are acceptable manufacturers of primer, intermediate and finish coats. All three coats must be the products of the same manufacturer.

Manufacturer	Primer	Intermediate	Finish
Ameron	68	66	66
Mobil	Mobil Zinc 13-F-4	89-D-7	89 Series
Napko	Hi Zinc 5615	PA 5820	5800 Series
Porter	Zinc Lock 308	MCR 4351	M.C.R. 43 HB

11.0 APPENDIX "A" - COATING SYSTEMS

11.2 Coating System No. 2

Generic: High Build Epoxy over Water Based Epoxy

Substrate: Manufacturer's Standard Coating

Operating Temperature Range: Per equipment specification up to 200°F

Surface Preparation Required: SSPC-SP-1 Solvent Cleaning

Coat	Color	Generic	D.F.T Mils	Manufacturer
Intermediate	Buff/Red/ Orange	Water Based Epoxy	1 to 2	Note 1
Finish	ANSI 70	High Build Epoxy	5	Note 1

NOTE 1: The following are acceptable manufacturers of intermediate and finish coats. Both coats must be the products of the same manufacturer.

Manufacturer	Intermediate	Finish
Ameron	2120	66
Carboline	290 WB	190 HB
Mobil	98-D-7	89 Series
Porter	Aqualock 6600	M.C.R. 43 HB

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11.0 APPENDIX "A" - COATING SYSTEMS

11.3 Coating System No. 3

Generic: High Build Vinyl over High Build Epoxy

Specific Service: Exterior surfaces of sulfuric acid tanks, equipment and piping

Substrate: Carbon Steel

Operating Temperature Range: Ambient

Surface Preparation Required: SSPC-SP-6 Commercial Blast Cleaning

Surface Profile Required: 1.5 to 2.5 mils

Coat	Color	Generic	D.F.T Mils	Manufacturer
Primer	Red/Grey	High Build Epoxy	5 to 7	Note 1
Finish	OSHA Yellow	High Build Vinyl	4 to 5	Note 1
		TOTAL	9 to 12	

NOTE 1: The following are acceptable manufacturers of primer and finish coats. Both coats must be the products of the same manufacturer.

Manufacturer	Primer	Finish
Ameron	83	99 HS
Carboline	190 HB	Polyclad 936-627
Porter	M.C.R. 4335	V.C. 37

NOTE 2: A chlorinated rubber system may be offered as an alternate to system number 3. Seller shall submit written procedures for review by the Buyer in accordance with Paragraph 3.1.2. Identification and complete technical data for the proposed products shall also be submitted for review.

11.0 APPENDIX "A" - COATING SYSTEMS

11.4 Coating System No. 4

Generic: High Build Aliphatic Polyurethane over Epoxy

Specific Service: Exterior surfaces of sulfuric acid tanks, equipment and piping. Alternate to system No. 3.

Substrate: Carbon Steel

Operating Temperature Range: Ambient

Surface Preparation Required: SSPC-SP-6 Commercial Blast Cleaning

Surface Profile Required: 1.5 to 2.0 mils

Coat	Color	Generic	Manufacturer Code	D.F.T. Mils
Primer	Reddish-Grey	Epoxy	Note 1	2.0
Finish	OSHA Yellow	Aliphatic Polyurethane	Note 1	5.0
			TOTAL	7.0

Note 1: The following are acceptable manufacturers of primer and finish coats. Both coats must be the products of the same manufacturer.

Manufacturer	Primer	Finish
Mobil	13-R-56	41 Series
Napko	5616	8-4323 Series

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12.0 APPENDIX "B" - COATING SCHEDULE

(To be Added Later)

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13.0 APPENDIX "C" - SAFETY COLOR CODING

13.1 Identification of Piping

13.1.1 All service piping which is accessible for maintenance operations (except piping in finished spaces) will be identified with semi-rigid plastic (not pressure-sensitive) identification markers.

13.1.2 Direction of flow arrows are to be included on each marker.

13.1.3 In conformance with "Scheme for the Identification of Piping Systems" (ANSI A13.1-1975), each marker must show (1) approved color-coded background, (2) proper color of legend in relation to back color, (3) approved legend letter size, and (4) approved marker length.

13.1.4 For pipes under 3/4" O.D. (too small for color bands and legends), brass identification tags 1-1/2" in diameter with depressed 1/4" high black-filled letters above 1/2" black-filled numbers will be fastened securely at specified locations.

13.1.5 Locations for pipe markers to be as follows:

13.1.5.1 Adjacent to each valve and fitting

13.1.5.2 At each branch and riser take-off

13.1.5.3 At each pipe passage through wall, floor and ceiling construction

13.1.5.4 At each pipe passage to underground

13.1.5.5 On all horizontal pipe runs - marked every 25 feet.

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11.0 APPENDIX "A" HIGH TEMPERATURE COATING SYSTEMS

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8/80	ISSUED FOR PHASE ZERO	BD	HS	ZBS	
6/80	ISSUED FOR APPROVAL	RJ	Hd		

ASFI THE BRECKINRIDGE PROJECT AECI	JOB NO. 14222	
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717	SPECIFICATION	REV
GENERAL SPECIFICATION HIGH TEMPERATURE COATINGS	14222-X-2	1

1.0 SCOPE

1.1 Items Included

1.1.1 The preparation of the surfaces, and the furnishing and application of high temperature coating materials to all exposed ferrous surfaces as scheduled.

1.1.2 Documentation of the materials and procedures.

1.1.3 Inspection and tests.

1.1.4 Protection of coated surfaces.

1.1.5 Environmental control equipment to provide the application and curing conditions required.

1.1.6 Erection marking.

1.1.7 Touch-up and repair of defective or damaged coated surfaces.

1.2 Related Items Not Included

1.2.1 The following surfaces shall not be coated:

1.2.1.1 Nonferrous or stainless steel parts, unless otherwise specified.

1.2.1.2 Surfaces within two inches of field welds, unless otherwise specified.

1.2.1.3 Name and instruction plates, etc.

1.2.1.4 Rubber or similar nonmetallic parts.

1.2.1.5 Surfaces to be completely embedded in concrete, unless otherwise specified.

1.2.1.6 Machined surfaces and fittings.

1.2.2 Correcting of substrate defects as defined herein.

1.2.3 Caulking and sealing.

1.2.4 Shop priming and finishing, unless otherwise specified.

1.2.5 Fireproof coatings.

1.2.6 Prefinished metal.

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2.0 QUALITY CONTROL

2.1 General

2.1.1 The Seller shall control the quality of items and services to meet the requirements of this specification, applicable codes and standards, and other procurement documents.

2.2 Referenced Codes and Standards

Sponsor	Number	Subject
ASTM	E337-62 (1979)	Test for Relative Humidity by Wet-and-Dry-Bulb Psychrometer
SSPC	SP-1 (1971)	Solvent Cleaning
SSPC	SP-5 (1971)	White Metal Blast Cleaning
SSPC	Vis-1 (1967)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
SSPC	PA-2 (1973)	Measurement of Dry Paint Thickness with Magnetic Gages
NACE	TM-01-70	Visual Standards of Surfaces of New Steel Airblast Cleaned with Sand Abrasive.

2.3 Quality Requirements

2.3.1 The Seller's Quality Control/Inspection Program shall include the necessary measure for control to ensure that the completed coating work conforms to the requirements of the technical specification and the applicable codes and standards. This plan shall provide for assurance that only accepted coating materials are used, that inspection of the surface preparation and the coating application is implemented for all phases of coating work performed, and that records and documentation are prepared and maintained to furnish evidence of compliance with procedures.

2.3.2 The Seller, including any lower-tier organizations engaged by him, shall be subject to surveillance inspection and audit by the Buyer for compliance with the requirements of the procurement documents until the completion or termination of the procurements. This surveillance inspection and audit does not relieve the Seller from the responsibility for conformance to the requirements set forth in the procurement documents.

2.3.3 The Buyer's inspection personnel shall be provided with a detailed schedule and shall be notified of all required hold and witness points requiring inspection by the Buyer prior to the scheduled date for coating activities. Failure to provide the required notification may result in the requirement for reinspection or rework.

2.3.4 Deviations from the technical specification, codes and standards detected during the performance of work shall be reported. The Seller shall submit his recommended disposition based on an appropriate analysis.

3.0 SUBMITTALS

3.1 Engineering Documents

3.1.1 A listing of all coating materials to be used in this work which shall identify the specific products by manufacturer and catalog number in each coating system as scheduled.

3.1.2 The Seller's written procedures for storage, handling, surface preparation, environmental control, application, touch-up and repair, curing, and inspection of the coating system shall be submitted for Buyer's review and acceptance prior to use. Conflicts, if any, between the coating manufacturer's recommendations and this specification shall be noted.

3.1.3 The Seller's proposed cleaning and coating verification forms for daily inspection records shall be submitted to the Buyer for review.

3.2 Quality Verification Documents

3.2.1 Deviations detected during the performance of work shall be reported as specified in Quality Requirements, Subparagraph (2.3.4).

3.2.2 A detailed cleaning and coating verification report in the accepted form shall be completed each day during the work and shall be submitted for the record. The final verification report shall include a statement of completion conformance verifying that required material was used and that the accepted application procedures and specifications were followed.

3.3 Samples

3.3.1 The Seller shall submit two prepared steel panels for the Buyer's acceptance, each measuring 6" x 6" x 1/4" minimum, showing the degree of cleanliness and the anchor profile of blast cleaning specified. The panels shall be fully labeled and sealed in air-tight, 3/16" acrylic transparent plastic.

4.0 MATERIALS

4.1 Material Manufacturers

4.1.1 Unless otherwise specified, all coating materials used on any one surface or piece of equipment shall be products accepted by the Buyer. Materials from different manufacturers shall not be used over each other without prior written acceptance.

4.1.2 The Seller shall notify the coating manufacturer on the purchase order for the coating material that the coating is to be applied to equipment to be furnished to the Buyer.

4.1.3 The coating materials shall be in pre-measured units.

4.1.4 The coating materials for each system shall be as shown in Appendix "A". Only the materials approved shall be used unless authorized in writing by the Buyer.

4.2 System Z-1, Inorganic Zinc Coatings, for temperatures to 750F Intermittent temperatures to 800F.

4.2.1 Material shall be an inorganic zinc with an alkyl silicate vehicle and meeting the following requirements:

4.2.1.1 Total solids by volume shall be 43 to 50% based on nonvolatile calculations per ASTM-D 1644 (calculate volume solids from weight solids by calculation.)

4.2.1.2 Percentage of metallic zinc in the dry applied film shall be 80 to 87%.

4.2.1.3 Weight of metallic zinc at 3 mils film thickness shall not be less than 0.83 ozs. per square foot.

4.2.1.4 Minimum temperature resistance to dry heat shall be 600F continuous or 800F intermittent.

4.2.1.5 Coverage shall not be less 700 sq. ft./gallon at 1 mil based on void content application measurements.

4.2.1.6 Zinc dust particle size distribution shall be such that particle size shall be no greater than 8 microns.

4.3 System HT-1, Silicone Acrylic, for temperatures to 400F continuous. Intermittent temperatures to 425F.

4.3.1 This system is a single package material not requiring a heat cure. It is applied over steel surfaces that have been blasted to white metal (SSPC-SP-5). The anchor pattern profile shall be 1 to 1-½ mils. It may be applied by brush or spray to a dry film thickness of 2 mils minimum, and may require two coats.

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4.3.2 This system also may be applied over surfaces previously primed with inorganic zinc, where a color other than the zinc color is desired. If applied over inorganic zinc, it should be applied in one coat of 1 to 2 mils, either brush or spray applied.

4.4 System HT-2. 100% Silicone Resin with Aluminum Pigment, for temperatures up to 550F under weather exposure and up to 1000F on weather protected (interior) surfaces.

4.4.1 This is a two package system that may be applied over an inorganic zinc by either brush or spray.

4.4.1.1 The primer shall be cleaned, if necessary, by Solvent Cleaning (SSPC-SP-1) to remove contamination.

4.4.1.2 Application shall be one coat at a minimum of 0.8 mil dry film thickness.

4.4.1.3 Substrate temperature during application shall be 40F minimum to 160F maximum.

4.4.1.4 This system must be heat cured after drying for 24 hours, it shall be heated to 400F for a minimum of one hour to affect cure.

4.4.2 This system may be applied directly to base metal under the following procedure:

4.4.2.1 The steel surface shall be cleaned to a white metal blast (SSPC-SP-5) with an anchor pattern profile no deeper than 1-1/2 mils.

4.4.2.2 The first coat must be applied, immediately after cleaning, to a dry film thickness of 0.7 to 1.0 mils.

4.4.2.3 For indoor, or protected, exposures, a second coat shall be applied after a minimum of 24 hours drying time has lapsed.

4.4.2.4 For weather exposure, a third coat shall be applied, allowing another 24 hours between coats.

4.4.2.5 This system must be cured at 400F for one hour. Twenty-four hours shall be allowed between the final coat and heat curing to obtain a fully dried system. Total dry film thickness shall be 2 to 3 mils.

4.5 System HT-3 Silicone-Ceramic Coating, a combination of ceramic frits and silicone resins for temperatures up to 1400F. Some colors are available.

4.5.1 This is a single package material that is applied directly to the bare steel in one coat by either brush or conventional spray in the following manner:

4.5.1.1 The surface shall be abrasive blasted to a white metal blast (SSPC-SP-5) with an anchor pattern profile no deeper than 1 mil.

4.5.1.2 Apply one coat not to exceed 2-1/2 mils.

4.5.1.3 This system has no abrasion resistance and must be heat cured after 6 hours or more drying time. The coating is cured at 400F for a minimum of one hour.

4.6 System HTL-1 High-Baked Phenolic Lining, an excellent corrosion resistant lining system for submerged or frequently wetted surfaces as well as dry surfaces at temperatures up to 400F continuous and 500F for short periods of time.

4.6.1 The modified phenolic high bake lining is applied to filter press plates, fans, blowers, machinery parts, tank linings, etc. where corrosion protection is needed at these temperatures. The surface preparation and application of this material is quite critical and where it is required, the manufacturers recommendations shall be followed with the following:

4.6.1.1 The lining material is a modified high baked phenolic.

4.6.1.2 The dry film thickness of the applied phenolics is approximately 2 mils per coat for three coats of primer and 1 mil per coat for the two finish coats.

4.6.1.3 The total dry film thickness shall be a minimum of 8 mils.

4.6.1.4 Each coat shall be allowed to dry and then shall receive an intermediate bake at 250F for 15 minutes with a final bake, after the last coat and repairs have been made, at 400F for 1-1/2 hours.

4.7 System HTL-2, a high temperature resistant organic coating for corrosion protection of wet or submerged hot metal surfaces at 200F to over 750F. It is not recommended for dry surfaces.

4.7.1 This is a unique single package coating material without a known equivalent at this time. It is used in submerged conditions at a minimum of 200F operating temperature. No maximum is given by the manufacturer who claims it has been used at temperatures above 750F. It is used to protect the interior surfaces of boiler tubes, drums and headers, economizers, feed water heaters, evaporators, steam turbines, etc.

4.7.2 The approved material for this purpose is Apexior Number 1 Protective Coating as sold by the Dampney Company in Everett, Massachusetts.

4.7.3 The required surface preparation is as follows:

4.7.3.1 All surfaces must be free of dirt, dust, grease, oil, rust or mill scale. Blast cleaning to SSPC-SP-6 is recommended, if this is not possible, a phosphatizing pretreatment is recommended.

4.7.4 Application shall be as recommended by the manufacturer.

4.7.4.1 Mix thoroughly before use.

4.7.4.2 Apply by brush only. Do not use nylon or plastic bristle brushes.

4.7.4.3 Apply one coat only, at 1-1/2 to 2 mils dry film thickness. Do not try to remove brush marks.

4.7.5 This material is NOT recommended for use in boilers which are held for long periods in cold wet lay-up or standby service, or in hot water tanks where the operation temperature is below 200F.

4.8 Abrasive Materials

4.8.1 Abrasives for blast cleaning shall be clean and dry, furnished either bulk or packaged, and shall be free of oil or contaminants. The particle size shall be capable of producing the specified surface profile. Cast iron or malleable iron shot shall not be used. Chilled iron shot may be used.

4.9 Touch-Up Materials

4.9.1 Materials for touch-up of damaged areas of surfaces shall be the same as those originally applied, thinned according to recommendations of the manufacturer.

4.9.2 Alternate materials for touch-up may be used, subject to acceptance by the Buyer and the coating manufacturer.

4.10 Thinners. Solvents. and Cleaners

4.10.1 Thinners, solvents, and cleaners shall be as recommended by the coating material manufacturer and shall be identified by the product number or generic formulation.

5.0 SHIPPING. HANDLING. AND STORAGE

5.1 Delivery and Storage

5.1.1 Coating materials shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number, and date of manufacture. Containers which are damaged to the point of jeopardizing the contents shall not be used.

5.1.2 The material shall be handled and stored in accordance with the manufacturer's latest published instructions, and shall be protected from damage, moisture, direct sunlight, and temperatures below 40F or above 80F. In the event the temperature is elevated to or falls below these specified limits, the Seller shall reconfirm the manufacturer's acceptance of a representative sample from the storage area.

5.2 Date of Materials

5.2.1 The coating materials shall be used within six months of their manufacture. The date of use shall in no case exceed the manufacturer's recommended shelf life, if such self life is less than six months. If the manufacturer's recommended shelf life is exceeded, the Seller must gain the manufacturer's and the Buyer's acceptance of the materials prior to their use, based on a representative sample from the storage area.

5.2.2 Containers of coatings or components shall not be opened except for immediate use.

5.3 Handling of Coated Items

5.3.1 Coated surfaces shall be protected from damage during lifting or handling. Coated items shall be protected on nonabrasive supports during shipment and storage.

6.0 EQUIPMENT

6.1 General Requirements

6.1.1 The Seller shall provide equipment capable of regulating and controlling the conditions within the work area to the extent that the temperature of the substrate is always a minimum of 5F above the dew point. The substrate temperature during coating application and curing shall be maintained between a minimum of 50F and a maximum of 90F unless otherwise approved by the manufacturer.

6.1.2 The equipment shall include the necessary blowers, filters, humidity control equipment to provide clean air to the work area in sufficient quantity to maintain an atmosphere for performing the specified operations at no more than 80 percent relative humidity.

6.1.3 The equipment shall be capable of producing the specified environment for performance of the work according to the time schedule accepted by the Buyer.

6.1.4 The spray equipment shall be as recommended by the coatings manufacturer and shall be suitably sized to the configuration of the work.

6.1.5 Spray equipment air supply lines shall be equipped with traps to remove moisture and oil.

7.0 SURFACE PREPARATION

7.1 General Requirements

7.1.1 Prior to the start of work, the Seller shall examine all surfaces to be coated to determine their acceptability for the specified work. If the surfaces are found to be unacceptable, the Seller shall immediately notify the Buyer in writing and shall not commence work until corrective action has been taken. Commencement of work prior to the taking of corrective action shall preclude any subsequent claim by the Seller. The Buyer may require corrective action at the Seller's expense.

7.1.2 Cleaning and coating shall be coordinated with other construction operations. Prior to starting any cleaning or coating operations, the Seller shall obtain assurance from the Buyer that all other work on or in the vicinity of the surfaces to be coated has been completed and that the surface is ready for cleaning and coating.

7.1.3 Surfaces to be coated shall be abrasive blast cleaned in accordance with SSPC-SP-5 except as noted below.

7.1.4 The surface profile of the steel cleaned by blasting shall be as specified. A comparison shall be made with a Testex Press-O-Film or other Buyer accepted equivalent which is appropriate to the type of abrasive material being used.

7.1.5 The abrasive mixture and the compressed air shall be clean, dry, and oil-free. Separators, in addition to oil and water extractors mounted on the compressor, shall be used in compressed air lines to remove oil and moisture from the air close to the point of use.

7.1.6 Prior to blast cleaning, contamination shall be removed from the steel surfaces. Oil and grease shall be removed by solvent cleaning in accordance with SSPC-SP-1.

7.1.7 Abrasive blast cleaning shall not be performed in the immediate area where the coating or curing of coated surfaces is in progress. All surfaces and equipment which are not to be coated shall be suitably protected from abrasive blast cleaning.

7.1.8 Burrs, slivers, scabs, and weld spatter which become visible after blasting shall be removed by the Seller. Repaired areas shall have the surface profile suitably restored.

7.1.9 If rusting occurs or if the cleaned surfaces become wet or otherwise contaminated prior to coating, they shall be recleaned to the degree specified above.

7.1.10 After blast cleaning and immediately before coating, dust shall be removed with compressed air, free of oil and moisture. Vacuuming shall be used if the surface is not dust free, as determined by the Buyer's inspector.

7.1.11 Machined surfaces shall be free of all foreign matter and wiped with clean solvent before the application of the machined-surface coating and shall be protected from damage due to cleaning and coating operations.

7.1.12 Floor drains and piping systems in the buildings shall not be used to remove, conduct, or convey any liquids or waste resulting from any surface preparation or coating operations.

8.0 MIXING AND APPLYING COATINGS

8.1 General Requirements

8.1.1 The Seller's application personnel shall be qualified to apply the specified coating material in accordance with the Seller's written qualification procedure, as accepted by the Buyer.

8.1.2 The mixing, applying, and curing of the coating material shall be in accordance with the manufacturer's latest published instructions and the requirements specified herein. When multiple component units are mixed, each component shall be mixed separately prior to the mixing of the combined materials. Only complete, measured units shall be mixed. After mixing, the coating material shall be applied within the manufacturer's latest published pot life time.

8.1.3 Coating materials shall be thoroughly mixed until they are smooth and free from lumps, then strained through a 30 mesh or finer screen. Mixed material shall be agitated to keep the solids in suspension.

8.1.4 The blast cleaned surface shall be coated before any rust forms on the surface.

8.1.5 The application of the coating shall be performed only when the environmental conditions meet the parameters specified in paragraphs 6.1.1 and 6.1.2 of this specification.

8.1.6 The coating materials shall not be applied when there is moisture on the surface, dust is present which can contaminate the freshly-coated surface, dirt or other detrimental materials have recontaminated the surface, or when the surface temperature of the steel is below 50F or above 90F or less than 5F above the dew point.

8.1.7 The spray equipment shall be conventional or airless and in acceptable operating condition as determined by the Seller through inspection and testing. The air supply lines shall be equipped with traps to remove moisture and oil.

8.1.8 Runs, sags, voids, drips, overspray, loss of adhesion, blistering, peeling, mudcracking, inadequate cure, or rusting of the substrate shall not be permitted.

8.1.9 Erection marks as shown on drawings shall be marked on each member with an accepted erection marking material after the application of the coating.

8.1.10 Enclosures to permit the coating of surfaces during inclement weather may be used, provided the environmental restrictions specified are maintained throughout the coating and curing period. The enclosures and methods of environmental control are subject to acceptance by the Buyer.

9.0 INSPECTION AND TESTING

9.1 General Requirements

9.1.1 The surfaces to be coated shall be divided into identifiable areas or units of production as a basis for inspection and/or documentation.

9.1.2 The inspection points identified in paragraph 9.1.1 above shall be established as follows:

9.1.2.1 Prior to the start of work.

9.1.2.2 Immediately following the surface preparation.

9.1.2.3 Immediately prior to the coating application.

9.1.2.4 Following the application and curing of each coat.

9.1.2.5 Final inspection and sign-off, in accordance with the project requirements.

9.1.3 The Seller shall furnish the necessary testing and inspection instruments, properly calibrated and maintained. Such equipment shall be available for use by the Buyer in conducting his surveillance of the work.

9.1.4 Prior to using compressed air, the quality of the air downstream of the separator shall be tested by blowing the air onto a clean white blotter (minimum size 8" x 8") for one minute to check for any contamination, oil, or moisture. The blotter test shall be performed at the beginning of each shift and at not less than four-hour intervals. The test also shall be made after any interruption of the air compressor operation or as required by the Buyer. The air shall be used only if the blotter test indicates no visible contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the air stream shall be retested. Separators shall be bled continuously. All lines shall be tested individually prior to use. Surfaces which are determined to have been blasted with contaminated air must be reblasted with clean air and abrasive.

9.1.5 Any defects disclosed by inspection shall be reinspected after correction.

9.2 Surface Preparation Inspection

9.2.1 The temperature, dew point, and relative humidity shall be determined with a sling psychrometer or an accepted equal following procedures in ASTM E337. Readings are required at the start of work and every four hours or at time intervals designated by the Buyer. Alternatively, continuous monitoring shall be performed using systems established and/or accepted by the Buyer.

9.2.2 Blast cleaned surfaces shall be compared with SSPC-Vis-1, or accepted NACE Standards. The anchor pattern profile depth shall be verified with a Testex Press-O-Film or other Buyer accepted equivalent which is appropriate to the type of abrasive material being used.

9.2.3 Recirculated shot and grit used for abrasive cleaning shall be tested for the presence of oil by immersing them in water and checking for oil flotation. Tests shall be made at the start of blasting, every four hours thereafter, and at the end of blasting. If oil is evident, the contaminated abrasive shall be replaced with clean abrasive and retested before proceeding. All contaminated steel blasted after the previous satisfactory test shall be completely recleaned.

9.2.4 A grease-free chalk shall be used to mark local areas which do not meet the specified standards.

9.3 Coating Inspection

9.3.1 Surface temperature and humidity readings shall be taken every four hours. The work shall not proceed if the substrate temperature falls below 5F above the dew point.

9.3.2 The dry film thickness shall be tested with a Mikro-test FIM gage or an accepted equivalent, at a rate of 10 random points for each 100 square feet of surface area. The testing method shall be in accordance with SSPC-PA-2.

9.3.3 The film shall be visually inspected for defects such as overspray, runs, sags, mudcracking, inadequate cure or lack of adhesion. The Seller shall repair all defects according to the touch-up and repair procedures accepted by the Buyer.

9.3.4 Minor, randomly located film imperfections from air bubbles, dust particles, etc., scattered over the surface, may be accepted if they are not in excess of 10 per square foot as determined by the Buyer's inspector.

9.3.5 The total dry film thickness of sags and runs shall not exceed 120 percent of the maximum specified dry film thickness nor shall it be less than 90 percent of the minimum specified dry film thickness.

10.0 REMEDIAL WORK

10.1 Touch-up

10.1.1 Coated surfaces within the scope of this specification that have been damaged during assembly or handling shall be repaired in accordance with procedures as accepted by the Buyer.

10.1.2 The surface profile shall be restored to meet specific surface preparation requirements for cleanliness and profile. The periphery of a damaged area shall be feathered in with an acceptable material.

10.1.3 Precautions shall be taken to protect adjacent coated areas from damage caused by abrasive blast cleaning. The use of vacuum blast-type equipment and needle guns will be permitted for abrasive blast cleaning.

11.0 APPENDIX "A" HIGH TEMPERATURE COATING SYSTEMS

11.1 High Temper ure System Z-1

Generic: Inorganic Zinc Rich Primer

Substrate: Carbon Steel

Operating Temperature Range: Up to 750F continuous, and 800F intermittent

Surface Preparation Required: SSPC-SP-10, near white blast cleaved (minimum)

Surface Pro e Required: 1.0 to 2.0 mils

Coating	Color	Generic	DFT Mils	Manufacturer
Primer	Metallic	Inorganic Zinc	2.0 to 4.0	Note 1

Note 1: The following are acceptable manufacturers of the Inorganic Zinc Rich Primer.

Manufacturer	Material No.
Ameron	Dimetcote 6
Mobil	Mobilzinc 7 (13-F-12)
Napko	Kwik Kure 5Z (137700)

11.2 High temperature sytem HT-1

Generic: Silicone Acrylic

Substrate: Carbon Steel or Inorganic Zinc Primed

Operating Temeperature Range: 400F continuous and 425F intermittent

Surface Preparation Required: SSPC-SP-5, white metal blast cleaved

Surface Profile Required: 1.0 to 1.5 Mils

Coating	Color	Generic	DFT Mils	Manufacturer
Heat Resistant	As Selected	Silicone Acrylic	2.0(Min.)	Note 1

Note 1: The following are acceptable manufacturers of 400F Heat Resistant Silicone Acrylic.

Manufacturer	Material No.
Dampney	Thurmalox 200 Series
Mobil	Silicone-Acrylic 37-W-1
Napko	5300 Series Silicone-Acrylic
Ameron	Amercoat 891

11.3 High Temperature System HT-2

Generic: 100% Silicone Resin

Substrate: Carbon Steel or Inorganic Zinc Primed

Operating Temperature Range: 550F weather exposure or 1000F interior (protected) exposure

Surface Preparation Required: SSPC-SP-5 white metal blast or Hover Inorganic Zinc SSPC-SP-1

Surface Profile Required: 0.5 to 1.5 mils

Coating	Color	Generic	DFT Mils	Manufacturer
High Temperature	Aluminum	Silicone-Aluminum	0.7-1.0	Note 1
High Temperature	Aluminum	Silicone-Aluminum	0.7-1.0	Same

Note 1: The following are acceptable manufacturers of the 100% Silicone Resin Aluminum.

Manufacturer	Material No.
Ameron	Amercoat 878
Dampney	Thurmalox 280
Mobil	Heat Resistant Aluminum 37-A-10
Napko	Thermoflex Aluminum 6003

11.4 High Temperature System HT-3

Generic: Silicone-Ceramic

Substrate: Carbon Steel

Operating Temperature Range: Up to 1400F

Surface Preparation Required: SSPC-SP-5 white metal blast

Surface Profile Required: Up to 1.0 mil maximum.

Coating	Color	Generic	DFT Mils	Manufacturer
Very High Temperature	As Selected	Silicone-Ceramic	2.5 mils Max.	Dampney

Note: This product is identified as Dampney's Thurmalox #240.

Other manufacturers of an equivalent material suitable for 1400F may be offered for consideration upon submittal of full technical data for review.

11.5 High Temperature Lining, System HTL-1

Generic: High Baked Phenolic Lining

Substrate: Carbon Steel

Operating Temperature Range: 400F continuous and 500F for short intermittent periods

Surface Preparation Required: SSPC-SP-5 white metal blast

Surface Profile Required: 1.5 to 2.0 mils

Coating	Color	Generic	DFT Mils	Manufacturer
High Temperature Lining	Brown-Tan	Phenolic	Total 8 mils	Note 1

Note 1: Lining Material shall be applied in 5 coats, or more, to obtain a minimum of 8.0 mils dry. The following are acceptable manufacturers.

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Manufacturer	Material No.
Heresite	P-403
Plasite	3066

11.6 High Temperature Lining, System HTL-2

Generic: A high Temperature Organic Coating

Substrate: Carbon Steel

Operating Temperature Range: Submerged only, 200F minimum to over 750F. Not for dry surfaces.

Surface Preparation Required: Free of dirt, dust, grease, oil, rust or mill scale. Preferable blast cleaved to SSPC-SP-6, commercial blast; if this is not possible, phosphatizing pretreatment as minimum.

Surface Profi Required: 1.0 mil maximum.

Coating Generic	Color	DFT Mils	Manufacturer
Proprietary organic	Black	1.5 to 2.0	Dampney

At this time, there is no known equivalent to the material specified here. It is known as Apexior No. 1 Protective Coating, sold by Dampney Company in Everett, Massachusetts. Refer to section 4.7 of this specification and follow the manufacturer's recommendations on their data sheet PC-001.

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1	11/20/80	ISSUED FOR PHASE ZERO	HD	HS	[illegible]
0	7/17/80	ISSUED FOR APPROVAL	HD	HS	

1.0 SCOPE

This specification covers the requirements for shop applied coatings on non-submerged steel surfaces of fabricated equipment and components, structural steel, aboveground piping, machinery, electrical equipment and external surfaces of steel vessels.

1.1 Items Included

1.1.1 Preparation of the surfaces, furnishing and the application of protective coatings to all exposed ferrous surfaces (as scheduled)

1.1.2 Documentation of materials and procedures

1.1.3 Inspection and tests

1.1.4 Protection of coated surfaces

1.1.5 Environmental control e uipment to provide the application and curing conditic required.

1.1.6 Erection marking

1.1.7 Touch-up and repair of defective or damaged coated surfaces

1.1.8 Hot Dip Galvanizing, where applicable and specified

1.2 Related Items Not Included

1.2.1 The following surfaces shall not be painted:

1.2.1.1 Nonferrous or st less steel parts, unless otherwise specified

1.2.1.2 Surfaces within one inch of field welds, unless otherwise specified

1.2.1.3 Name and instruction plates, etc.

1.2.1.4 Rubber or similar nonmetallic parts

1.2.1.5 Surfaces to be completely embedded in concrete, unless otherwise specified

1.2.1.6 Machined surfaces and fittings.

1.2.1.7 Coating of galvanized surfaces unless otherwise specified

1.2.2 Correcting of substrate defects as defined herein

1.2.3 Touch-up and Topcoating at jobsite

1.2.4 Caulking and sealing

1.2.5 Fireproof coatings

1.2.6 Prefinished metal

1.2.7 Underground piping and valves

2.0 QUALITY STANDARDS

2.1 General

2.1.1 The Seller shall control the quality of items and services to meet the requirements of this specification, applicable codes and standards, and other procurement documents.

2.2 Referenced Codes and Standards

Sponsor	Number	Subject
ASTM	E337	Test for Relative Humidity by Wet-and-Dry-Bulb Pyschrometer
NACE	TM-01-70	Visual Standard for surfaces of new steel .ir-blast cleaned with sand abrasive
NACE	TM-01-75	Visual Standard for surface of new steel centrifugally blast cleaned with steel grit and shot
SSPC	SP-1	Solvent Cleaning
SSPC	SP-10	Near-White Blast Cleaning
SSPC	Vis-1-67-T	Pictorial Surface Preparation Standards for Painting Steel Surfaces
SSPC	PA-2	Measurement of Dry Paint Thickness with Magnetic Gages
ASTM	A-90	Test for weight of coating on zinc-coated (galvanized) iron or steel articles
ASTM	A120	Specifications for black and hot-dipped zinc-coated (galvanized) welded and seamless steel pipe for ordinary use
ASTM	A123	Specification for zinc (hot-galvanized) coatings on products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip
ASTM	A143	Safeguarding against embrittlement of hot-dipped galvanized structural steel products and procedure for detecting embrittlement
ASTM	A153	Specification for zinc coating (hot-dip) on iron and steel hardware
ASTM	A384	Recommended practice for safeguarding against

		warpage and distortion during hot-dip galvanizing of steel assemblies
ASTM	A385	Recommended practice for providing high quality zinc coatings (hot-dip)
ASTM	A386	Specification for zinc coating (hot-dip) on assembled steel products
ASTM	A446	Specification for steel sheet, zinc-coated (galvanized) by the hot dip process, structural (physical) quality

2.3 Quality Requirements

2.3.1 The Seller's Quality Control/Inspection Program shall include the necessary measures for control to ensure that the completed coating work conforms to the requirements of the technical specification and the applicable codes and standards. The plan shall provide for assurance that only accepted coating materials are used, that inspection of the surface preparation and the coating applicaiton is implemented for all phases of coating work performed, and that records and documentation are prepared and maintained to furnish evidence of compliance with procedures and traceability by item or batch to the area of use.

2.3.2 The Seller, including any lower-tier organizations engaged by him, shall be subject to surveillance inspection and audit by the Buyer for compliance with the requirements of the procurement documents until the completion or termination of the procurements. This surveillance inspection and audit does not relieve the Seller from the responsibility for conformance to the requirements set forth in the procurement documents.

2.3.3 The Buyer's inspection personnel shall be provided with a detailed schedule and shall be notified of all required hold and witness points requiring inspection by the Buyer prior to the scheduled date for coating activities. Failure to provide the required notification may result in the requirement for reinspection or rework.

2.3.4 The Seller shall identify and document deviations from the technical specification, codes and standards and shall transmit these deviations to the Buyer for review and disposition. The Seller shall submit his recommended disposition based on an appropriate analysis.

3.0 SUBMITTALS

3.1 Engineering Documents

3.1.1 A listing of all coating materials to be used in this work which shall identify the specific products by manufacturer and catalog number in each coating system as scheduled.

3.1.2 The Seller's written procedures for storage, handling, surface preparation, environmental control, application, touch-up and repair, curing and inspection of the coating system shall be submitted for review and acceptance prior to start of work. Conflicts if any, between the coating manufacturer's recommendations and this specification shall be noted.

3.1.3 The Seller's proposed cleaning and coating verification forms for daily inspection records shall be submitted for review.

3.2 Quality Verification Documents

3.2.1 Deviations detected during the performance of work shall be reported and submitted as specified in Quality Requirements, Subparagraph (2.3.4).

3.2.2 A detailed cleaning and coating verification report in accepted form shall be completed each day during the work and shall be submitted for record. The final verification report shall include a statement of completion conformance verifying that required material was used and that the accepted application procedures and specifications were followed.

4.0 MATERIALS

4.1 Material Manufacturers

4.1.1 Unless otherwise specified, all coating materials on any one surface or piece of equipemnt shall be a product accepted by the buyer. Materials from different manufacturers shall not be used over each other without Buyer's acceptance.

4.1.2 The Seller shall notify the coating manufacturer on the purchase order for the coating material that the coating is to be applied to equipment to be furnished to the buyer.

4.1.3 See the attached list of acceptable materials manufacturers Appendix B.

4.2 Inorganic Zinc (System 1)

4.2.1 Material shall be an inorganic zinc with an alkyl silicate vehicle and meeting the following requirements:

4.2.1.1 Total solids by volume shall be 43 to 50% based on nonvolatile calculations per ASTM-D 1644 (calculate the volume solids from weight solids by calculation).

4.2.1.2 Percentage of metallic zinc in the dry applied film shall be 80 to 87%.

4.2.1.3 Weight of metallic zinc at 3 mils film thickness shall not be less than 0.83 oz./sq. ft.

4.2.1.4 Minimum temperature resistance to dry heat shall be 600°F continuous or 800°F intermittent.

4.2.1.5 Coverage shall not be less than 700 Sq. ft./gal. at 1 mil thick based on void content application measurements.

4.2.1.6 Zinc dust particle size distribution shall be such that particle size shall be no greater than 8 microns.

4.3 <u>Inorganic Zinc, Preconstruction Primer (System 2)</u>

4.3.1 Material shall be an inorganic zinc with an alkyl silicate vehicle and meet the following:

4.3.1.1 Total Solids by Volume 26% to 35%

4.3.1.2 Percent metallic zinc in the dry film - 75% minimum

4.3.1.3 Shall be a weldable zinc primer

4.4 <u>Hot Dip Galvanizing</u>

4.4.1 Hot dip galvanizing of light weight steel, such as sag bars, handrails, ladders, etc. may be acceptable as an alternate to the inorganic zinc. Special fabrication procedures may be required on some items.

4.4.2 Assemblies accepted to be galvanized shall be properly prepared by welding as covered by Specification for Providing High Quality Zinc Coatings (Hot Dip) ASTM A385, and Specification for Zinc Coating (Hot Dip) ASTM A386.

4.4.3 In addition to required structural welding, all mating surfaces shall be sealed off by welding to prevent entrapment of the pickling fluid used in the galvanizing process. Exception to this requirement is permitted only as outlined in ASTM A385 Par. 2.2 and Note 1.

4.4.4 Vent and drain holes must be provided in pipe handrails to prevent buildup in pressure of entrapped pickling solution of 3/8" diameter and located at natural drainage points such as bottom of handrails, near posts, etc.

4.4.5 Punched or drilled holes to be oversized by 1/16 inch.

4.4.6 Nuts shall be tapped oversize, prior to galvanizing, to insure proper fit on bolt threads.

4.4.7 Materials 3/4 inch or greater in thickness, which have been cold-worked, shall be annealed or stress relieved prior to galvanizing.

4.4.8 All oil, grease, paint, residue, scale, welding slag, foreign matter and rust shall be removed from materials prior to galvanizing. Cleaning shall be done by pickling in a dilute hot sulfuric acid solution. After pickling surfaces shall be thoroughly rinsed with clean water. With the buyer's approval, blast cleaning may be substituted in lieu of pickling. In such cases, surfaces shall be blast cleaned to "Near White" condition per latest revision of Specification SSPC-SP-10.

4.4.9 To prevent warpage and distortion, the provisions of ASTM A394 shall govern.

4.4.10 To prevent material embrittlement, the provisions of ASTM A143 shall govern.

4.4.11 Zinc Coating

4.4.11.1 Products fabricated from rolled, pressed, and foreign steel shapes, plates, bars, strips, and sheets shall be zinc coated in accordance with ASTM Specification A123 or A446, whichever is applicable.

4.4.11.2 Pipe Handrail shall be zinc coated in accordance with ASTM A120.

4.4.11.3 Iron and steel hardware and fasteners shall be zinc coated in accordance with ASTM Specification A153.

4.4.12 Post Galvanizing Treatment

4.4.12.1 Straightening: Structural sections and their major components warped during the galvanizing process shall be straightened to AISC tolerances. Warped plates shall be pressed flat.

4.4.12.2 Re-tapping: All threaded openings shall be retapped after galvanizing; however, male threads shall not be re-cut.

4.4.12.3 Touch-up: Damaged galvanized surfaces shall be repaired by cleaning surfaces and applying Organic Zinc Rich Cold Galvanizing Compound per manufacturer's instructions. The dry mil thickness of this zinc application shall be equal to the thickness required for the original work. The area of surfaces thus repaired shall not exceed 5 percent of the total galvanized area.

4.4.13 <u>Identification</u>

4.4.13.1 The identification mark number of each member shall be stamped in characters at least 1/2 inch high on No. 9 annealed wire. This marking shall be legible after galvanizing.

4.5 Erection Marking Material

The coating system manufacturer's recommendation shall be followed.

4.6 Machined-Surface Coatings

Machined surfaces shall be protected with an asphaltic cutback coating meeting Military Specification MIL-C-16173, Grade 1, or equivalent.

4.7 Abrasive Materials

Abrasives for blast cleaning shall be clean and dry, furnished either in bulk or packaged, and shall be free of oil or contaminants. The particle size shall be capable of producing the specified surface profile. Cast iron or mallable iron shot shall not be used. Chilled iron shot may be used. Type of abrasive shall be submitted for review and shall include size and hardness.

4.8 Touch-up Materials

4.8.1 Materials for touch-up of damaged areas of surfaces shall be the same as that originally applied, thinned according to recommendations of the manufacturer.

4.8.2 Touch-up materials shall be provided in premeasured units, unless otherwise specified by the Buyer.

4.9 Thinners, Solvents, and Cleaners

Thinners, solvents, and cleaners shall be as recommended by the coating material manufacturer and shall be identified by the product number or generic formulation.

4.10 Fasteners (Nuts, Bolts, and Washers)

4.10.1 All fasteners shall be supplied with a flake zinc-chromium coating such as Dacromet* 320, manufactured by Diamond-Shamrock Corporation and applied by Protective Coatings, Inc. of Houston, Texas.

5.0 SHIPPING, HANDLING AND STORAGE

5.1 Delivery and Storage

5.1.1 Coating materials shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number, and date of manufacture. Containers which are damaged to the point of jeopardizing the contents shall not be used.

5.1.2 The material shall be handled and stored in accordance with the manufacturer's latest published instructions, and shall be protected from damage, moisture, direct sunlight, and temperatures below 40F or above 95F. In the event the temperature should exceed these limitations, the Seller shall re-confirm the manufacturer's acceptance of a representative sample from the storage area.

5.2 Date of Materials

5.2.1 The coating materials shall be used within twelve months of their manufacture. The date of use shall in no case exceed the manufacturer's recommended shelf life. If the manufacturer's recommended shelf life is exceeded, the Seller must gain the manufacturer's and the Buyer's acceptance of the materials prior to their use, based on a representative sample from the storage area.

5.2.2 Containers of coatings or components shall not be opened unless for immediate use.

5.3 Handling of Coated Items

Coated items shall be protected on nonabrasive supports during shipment and storage. Coated surfaces shall be protected from damage during lifting or handling.

6.0 EQUIPMENT

6.1 General Requiremnts

6.1.1 The Seller shall provide equipment capable of regulating and controlling conditions within the work area to the extent that the temperature of the substrate is always a minimum of 5F above the dew point. The substrate temperature during coating application and curing shall be maintained between a minimum of 40F and a maximum of 110F unless authorization is given by the Buyer.

6.1.2 The equipment shall include the necessary blowers, filters, and humidity control equipment to provide clean air to the work area in sufficient quantity to maintain an atmosphere for performing the specified operations at no more than 95% relative humidity.

6.1.3 The equipment shall be capable of producing the specified environment for performance of the work according to the schedule accepted by the Buyer.

6.1.4 The spray equipment shall be as recommended by the coatings manufacturer and shall be suitable to apply the coating as specified.

6.1.5 Spray equipment air supply lines shall be equipped with traps to remove moisture and oil as close to the point of use as possible.

7.0 SURFACE PREPARATIONS

7.1 General Requirements

7.1.1 Prior to the start of work, the Seller shall examine all surfaces to be coated to determine their acceptability for the specified work. If the surfaces are found to be unacceptable, the Seller shall immediately notify the Buyer in writing and shall not commence work until corrective action has been taken. Commencement of work prior to the taking of corrective action shall preclude any subsequent claim by the Seller. The Buyer may require corrective action at the Seller's expense.

7.1.2 Cleaning and coating shall be coordinated with other fabrication operations. Prior to starting any cleaning or coating operations, the Seller shall obtain assurance that the surface is ready for cleaning and coating.

7.1.3 Surfaces to be coated shall be abrasive blast cleaned in accordance with SSPC-SP-10 except as noted on the schedule, Appendix A.

7.1.4 The surface profile of the steel cleaned by blasting shall be between 1.0 and 3.0 mils. A comparison shall be made with a Testex Press-O-Film, Keane-Tator Profile Comparator or another Buyer accepted equivalent which is appropriate to the type of abrasive material being used.

7.1.5 The abrasive mixture and the compressed air shall be clean, dry, and oil-free. Traps, in addition to oil and water extractors mounted on the compressor, shall be used in compressed air lines to remove oil and moisture from the air close to the point of use.

7.1.6 Prior to blast cleaning, contamination shall be removed from the steel surfaces. Oil and grease shall be removed by solvent cleaning in accordance with SSPC-SP-1.

7.1.7 Blast cleaning shall not be performed in the immediate area where coating or curing of coated surfaces is in progress. All surfaces and equipment which is not to be coated shall be suitably protected from blast cleaning.

7.1.8 Burrs, slivers, scabs, and weld spatter which become visible after blasting shall be removed by the Seller. Repaired areas shall have the surface profile suitably restored.

7.1.9 When the relative humidity is higher than 80% blasting may be continued, providing the following relationship of time to humidity is maintained.

Humidity	Maximum Time Limit to Prime After Blasting
80% to 85%	3 hours
85% to 90%	2 hours
90% ro 95%	1 hour

7.1.10 If visible rusting occurs or if the cleaned surfaces become wet or otherwise contaminated, they shall be recleaned to the degree specified above.

7.1.11 After blast cleaning and immediately before coating, dust shall be removed with compressed air, free of oil, and moisture. Vacuuming shall be used if the surface is not dust free, as determined by the Buyer's inspector.

7.1.12 Machined surfaces shall be wiped with clean solvent before the application of machined-surface coating and shall be protected from damage due to cleaning and coating operations.

8.0 MIXING AND APPLYING COATINGS

8.1 General Requirements

8.1.1 Mixing, applying and curing of the coating material shall be in accordance with the manufacturer's latest published instructions and the requirements specified herein. When multiple component units are mixed, each component shall be mixed separately prior to the mixing of the combined materials. Only complete kits shall be mixed.

8.1.2 Coating materials shall be thoroughly mixed until they are smooth and free from lumps, then strained through a 30 mesh or finer screen. Mixed materials shall be agitated to keep the solids in suspension.

8.1.3 The blast cleaned surface shall be coated before any visible rust forms on the surface.

8.1.4 The application of the coating shall be performed only when the environmental conditions meet the parameters specified in paragraph 6.11 of this specification.

8.1.5 The coating materials shall not be applied when there is moisture on the surface, dust is present which can contaminate the freshly-coated surface, dirt or other detrimental materials have recontaminated the surface, or when the surface temperature of the steel is below 40F or above 110F.

8.1.6 The spray equipment shall be conventional or airless and in acceptable operating condition as determined by the Seller through inspection and testing. The air supply lines shall be equipped with traps to remove moisture and oil.

8.1.7 Runs, sags, voids, drips, overspray, loss of adhesion, blistering, peeling, mudcracking, inadequate cure, or rusting of the substrate shall not be permitted.

8.1.8 Enclosures to permit coating of surfaces during inclement weather may be used, provided the environmental restrictions specified are maintained throughout the coating and curing periods. The enclosures and methods of environmental control are subject to acceptance by the Buyer.

8.1.9 Items shall be coated in accordance with Appendix A. Appendix B lists acceptable coating materials.

9.0 INSPECTION AND TESTING

9.1 General Requirements

9.1.1 The surfaces to be coated shall be divided into identifiable areas of units of production as a basis for inspection and/or documentation.

9.1.2 The inspection points identified in item 9.1.1 above shall be established as follows:

9.1.2.1 Prior to the start of work

9.1.2.2 Immediately following the surface preparation

9.1.2.3 Immediately prior to the coating application

9.1.2.4 Following the application and curing of each coat

9.1.2.5 After final inspection and sign-off, in accordance with the project requirements.

9.1.3 The Seller shall furnish the necessary testing and inspection instruments, properly calibrated and maintained. Such equipment shall be available for use by the Buyer in conducting his surveillance of the work.

9.1.4 Prior to using compressed air, the quality of the air downstream of the separator shall be tested by blowing the air onto a clean white blotter (minimum size 8" x 8") for two minutes to check for any contamination, oil, or moisture. The blotter test shall be performed at the beginning of each shift and at not less than four-hour intervals. The test also shall be made after any interruption of the air compressor operation or as required by the Buyer. The air shall be used only if the blotter test indicates no visible contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the air stream shall be retested. Seaparators shall be bled continuously. All lines shall be tested individually prior to use. Surfaces which are determined to have been blasted with contaminated air must be reblasted with clean air and abrasive.

9.1.5 Any defects disclosed by inspection shall be re-inspected after correction.

9.2 Surface Preparation Inspection

9.2.1 The temperature, dew point, and relative humidity shall be determined with a sling psychrometer or an accepted equal following procedures in ASTM E337. Readings are required at the start of work and every two hours or at time intervals designated by the Buyer. Alternatively, continuous monitoring shall be performed using systems established and/or accepted by the Buyer.

9.2.2 Blast cleaned surfaces shall be compared with SSPC-Vis-1, Pictorial Standards, or NACE Standard TM-01-70 or TM-01-75. The anchor pattern profile depth shall be verified with a Testex Press-O-Film, Keane-Tator Profile Comparator, or an accepted equal appropriate to the abrasive material being used.

9.2.3 Recirculated shot and grit used for abrasive cleaning shall be tested for presence of oil by immersing in water and checking for oil flotation. Tests shall be made at the start of blasting, every four hours thereafter, and at the end of blasting. If oil is evident, contaminated abrasive shall be replaced with clean abrasive and retested before proceeding. All steel blasted since the last satisfactory test shall be inspected and all contaminated steel shall be reblasted.

9.2.4 A grease-free chalk shall be used to mark local areas which do not meet the specified standards.

9.3 Coating Inspection

9.3.1 Surface temperature and humidity reading shall be taken every two hours. The work shall not proceed if the substrate temperature falls below 5F above the dew point.

9.3.2 The dry film thickness shall be tested with a Mikro-test FIM gage or an accepted equivalent, at five random points for each 50 square feet of surface area or at three random points on each piece less than 50 square feet in area. The testing method shall be in accordance with SSPC PA-2.

9.3.3 The film shall be visually inspected for defects such as overspray, runs, sags, mudcracking, inadequate cure or lack of adhesion. The Seller shall repair all defects according to the touch-up and repair procedures accepted by the Buyer.

9.3.4 Minor randomly located film imperfections from air bubbles, dust particles, etc., scattered over the surface, may be accepted if they are not in excess of 10 per square foot, as determined by the Buyer's inspector.

9.3.5 The total dry film thickness of sags and runs shall not exceed 120 percent of the maximum specified dry film thickness nor shall it be less than 90 percent of the minimum specified dry film thickness.

9.4 Inspection of Galvanized steel

Weight of zinc coating shall be determined by weighing one or more specimens after pickling and drying, and again after coating, or by methods of ASTM Specification A90. Magnetic thickness guage may be used to determine the weight using Table A1 of ASTM A90. Uniformity of coating shall be determined by visual inspection and/or magnetic thickness gage.
Warped, excessively distorted and/or embrittled materials shall be rejected.

10.0 REMEDIAL WORK

10.1 Touch-up

10.1.1 Coated surface within the scope of this specification that have been damaged during assembly or handling shall be repaired in accordance with procedures as accepted by the Buyer.

10.1.2 The surface profile shall be restored to meet the specified surface preparation requirements for cleanliness and profile. The periphery of a damaged area shall be feathered in with an acceptable material.

10.1.3 Precautions shall be taken to protect adjacent coated areas from damage caused by abrasive blast cleaning. The use of vacuum blast type equipment and needle guns will be permitted for abrasive blast cleaning.

APPENDIX A

SHOP COATING SCHEDULE

	Equipment or Material	Surface Preparation	System	Total dry Film Thick	Remarks
1.	Structural Steel, ducts, insulated and uninsulated shop-fabricated tanks and vessels and piping over 2: diameter (under 100F temp.). Stacks and uninsulated piping over 2" diameter (100F to 750F temp.). Major mech. & elect. equipment.	SSPC-SP-10	1 or 2 followed later by 1	2-4 mils (min.)	Insulated items do not receive field coat.
2.	Insulated piping & vessels over 2" diameter (100F to 750F temp.).	None	-	-	Steel protrusions (i.e., nozzles, brackets, etc.) to be coated per System 1.
3.	Small pumps, compressors, motors,	Manufacturer's Standard			-
4.	Pipe, valves and fittings, 2" and under	Manufacturer's Standard			
5.	Light weight and miscellaneous steel	-	-	-	Hot dip galvanize per ASTM A386 or A123.

APPENDIX B

Acceptable Supplier List for Shop

Applied Protective Coatings

Manufacturer	Inorganic Zinc	Preconst. Zinc Primer
Ameron	D-9	D-1-M
Copon	R.Z.-100	R.Z. 90
Devoe/Prufcoat	Zinc Prime 500	Catha Cote 308
Mobil	MZ-13-F-12	MZ-13-F-122
Napko	Kwik Kure 1377	Nap Weld 1380
Porter	ZL.351	ZL 352

Special—Y

1.0 SCOPE

This specification outlines the general requirements for tank mixers. It is used in conjunction with Form 191, Tank Mixer Data Sheet.

2.0 DESIGN AND MATERIALS

2.1 All gears shall be totally enclosed. Belts and sheaves, if required, shall be adequately guarded.

2.2 All drive units shall be designed in such a manner that impeller speed can be changed in the field by the use of tools normally available in a Plant Maintenance Shop.

2.3 Gear change, if later desired, shall be modular.

2.4 In the case of impellers designed to provide a vertical thrust, the impeller thrust shall be downward in the fluid. The shaft thrust shall be upward.

2.5 Unless stated otherwise on the Tank Mixer Data Sheets, the tank mixers shall be of carbon steel construction.

3.0 PAINTING

Shop painting shall be in accordance with Standard Specification 14222-X-3.

4.0 ASSEMBLY AND TESTING

Prior to shipment, all critical dimensions shall be verified and all critical parts shall be tested.

5.0 MARKING AND TAGGING

Each part shall be properly marked to facilitate field erection. Each Tank Mixer shall be tagged with a stainless steel tag bearing the equipment number and purchase order number.

6.0 REFERENCES

Specification 14222-X-3. Shop Painting
Form 191, Tank Mixer Data Sheet

FORM H-292 7-66

Rev	Date	Description			
△					
△					
1	8/80	ISSUE FOR PHASE ZERO	ARP	HS	
0	6/80	ISSUED FOR APPROVAL	ALP	HS	

ASFI THE BRECKINRIDGE PROJECT AECI
U.S. DOE COOPERATIVE AGREEMENT NO. DE-FC05-80OR20717
GENERAL SPECIFICATION
TANK MIXERS

JOB NO. 14222
SPECIFICATION 14222-Y-1 REV 1

TANK MIXER DATA SHEET

TANK MIXERS FOR ______________________ PLANT

______________________ PROJECT LOCATION ______________________

MANUFACTURER ______________________

SPECIFICATION NO. __________ REQ. NO. __________

MIXER NUMBER						
MIXER INSTALLED IN TANK NUMBER						
NUMBER OF MIXERS IN TANK						
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)						
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)						
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						
Motor Horsepower						
Motor Speed 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						
Shipping Weight (Incl. Driver if Factory Mounted) LB						
Manufacturer's Model						
Manufacturer's Serial Number (On Final Data Sheet)						

REV. | DATA SHEET NO. | REV.

1.0 GENERAL

1.1 This specification covers the general requirements for the mechanical equipment for removing separated oil and settled sludge from an API oil-water separator.

1.2 The API oil-water separator will operate out-of-doors in the location and under the meteorological conditions given in Spec. 14222-A-3.

1.3 Specification 14222-P-2 forms a part of this specification.

2.0 WORK INCLUDED

The Seller shall furnish the following:

2.1 Flight type collecting mechanism including motors and drives.

2.2 Cross conveyors without sludge pumps.

2.3 Reaction jets and baffles.

2.4 Oil skimming pipes.

2.5 Anchor bolts.

3.0 WORK NOT INCLUDED

3.1 All concrete structures - forebays, channels, and effluent chambers.

3.2 Electric motor starters and all external wiring and conduit between control panel and devices.

3.3 Control panel and instruments.

3.4 Sludge pumps and electric motor drivers.

4.0 API SEPARATOR

4.1 The Buyer will design and construct an oil-water separator in accordance with the API Manual on Disposal of Refinery Wastes, Volume on Liquid Wastes, 1969, First Edition. Design conditions are as given on Buyer's Data Sheet "A" attached.

4.2 The separator will consist of the number of main separator channels, forebays, and effluent changers given on Buyer's Data Sheet "A".

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Rev	Date	Description	By	Chk	Appr
1	8/80	ISSUE FOR PHASE ZERO	ARP	HS	
0	6/80	ISSUED FOR APPROVAL	ARP	HS	

4.3 Each main channel shall be designed to handle the maximum and normal flow given on Buyer's Data Sheet "A". Inside dimensions shall be as given on Buyer's Data Sheet "A".

4.4 The mechanical equipment covered by this specification shall consist of: a) flight-type collecting mechanisms, b) oil skimming pipes, c) reaction jet nozzles with baffles, and cross conveyors.

5.0 FLIGHT-TYPE COLLECTING MECHANISM

5.1 The flight cleaning mechanisms shall skim oil along the water surface and scrape sludge along the bottom. Flight speed shall be 2 fpm. Each channel shall have a separate collector mechanism capable of operating independently of the other. Each mechanism shall consist of flight scrapers, two sets of chain with four sprocket wheels, tee rails and track angles, drive motor and speed reducers, and anchor bolts.

5.2 Flight scrapers shall be made of Douglas Fir 2" x 6" with replaceable 3/8"-thick steel wearing shoes to run on tee rails, flush mounted in the bottom of the separator, and additional wearing shoes to run on track angles on the return run. Wearing shoes for the rails shall be case hardened steel (R.C. 55 hardness) and shall be attached with the same bolts as for chain attachment. Spring brass wall scrapers shall be mounted on at least two scrapers.

5.3 Flight cleaner chains shall be 720-S Heavy Pintle type and shall have an average ultimate strength of 40,000 pounds and weigh 5.3 pounds per foot with the plan and attachment links assembled with 3/4"-diameter heat-treated high carbon steel pins and s.s. cotter keys. The chain shall consist of 6" pitch links made of a corrosion resisting processed metal, having an average tensile strength of 70,000 psi and an average Brinell hardness of 170. Attachments for scrapers shall be the full depth of the flight and be provided with four 3/8"-diameter attachment bolts each.

5.4 Two industrial 25# tee rails shall be furnished by the Seller for each basin bottom. Tee rails shall be set in accordance with the manufacturer's instructions.

5.5 Track angles for the return run of scrapers shall be furnished by the Seller and shall be made of 3" x 2" x 3/8"-thick steel anges, with 1/4"-thick steel supporting brackets.

5.6 Sprockets for drive and collector chains shall be Flint-Rim and shall have a hardness of not less than 360 Brinell at the tooth bearing surfaces. Depth of chill shall be at least 3/16" at the tooth bearing surfaces. All sprockets shall be stress relieved before machining. Sprocket teeth shall be accurately ground to fit the chain. Driving sprockets shall be keyed firmly to the headshaft and the cornershaft shall have one sprocket set screwed and one to run loose on the shaft. Flight chain sprockets on the head shafts shall be not less than 24.09" pitch diameter with a minimum of 25 teeth. All other flight cleaner chain sprockets shall be not less than 18.46 pitch diameter with a minimum of 19 teeth. Shafts shall be solid cold-rolled steel extending across the full width of the channel and shall be held in alignment with set screwed set collars. Sprockets shall be furnished on all shafts. Substitutions for sprockets will not be accepted.

5.7 All underwater bearings shall be babbitted and of the water lubricated, ball and socket, especially designed to prevent the accumulation of settled solids on their surfaces. These bearings shall be bolted directly to the concrete walls in a manner which will permit their easy adjustment. The flight mechanism shall be provided with takeups on the lower corner shaft at the effluent end of the basin. The takeups shall be designed for operation from the top of the basin through a bronze worm gear arrangement thereby eliminating the necessity for dewatering the basin for adjusting the takeups.

5.8 Motors and drives shall be supplied by Seller; motor controls shall be supplied by Buyer. Each flight mechanism shall be driven by a separate motor. Motors shall be induction-type in accordance with Specification 14222-P-2. Motors and drives should be connected by a flexible coupling and mounted on a common base by the Seller. Each drive unit speed reducer shall be of the helical-gear type, 95 percent efficient, fully housed, running in oil, and of approved make with anti-friction bearings throughout. Each reducer unit and electric motor shall be mounted as a common unit directly on the concrete. Each driving sprocket shall be fitted with bronze bushing and shall be provided with a shear pin device to provide for full protection of the equipment in case of excessive loading. The driving sprockets on reducer shafts shall have not less than 11 teeth and be not less than 9.26" pitch diameter. Each large driven sprocket on the headshafts shall be of the "dished" or offset type to permit mounting the shaft bearing directly on the concrete. This sprocket shall have not less than 40 teeth and be not less than 33.25" pitch diameter. The driving chains shall be #H 78 Mill type made of the same material as the flight cleaner chains, shall consist of 2.609" pitch links, and shall have an average ultimate strength of 20,000 pounds. A chain tightener shall be provided to take up any unnecessary slack in each drive chain. The chain drive above the operating platform shall be covered with a removable metal guard of #14 ga. steel, galvanized after fabrication.

6.0 CROSS CONVEYORS

Cross conveyors shall be supplied by the vendor to scrape sludge in the sludge trough across the width of each channel into a sludge hopper. A separate sludge pump will remove sludge from each hopper. Sludge is a combination of hydrocarbon coke fines and hydrocarbon sludge. The tons of sludge collected per day shall be as given in Buyer's Data Sheet "A".

6.1 Seller shall furnish the type of conveyor he recommends for this service. Either a screw conveyor or flight-type cleaner will be acceptable. If flight type is used, the flights shall be of Douglas Fir 2" x 6", spaced 5 ft. apart. Flights shall be mounted on two strands of chain running over three sets of sprocket wheels at 4 fpm. Collector chains, sprockets, shafts, bearings, drives, and motors shall be as specified in Section 5.3 through 5.8.

6.2 The width of the bottom of sludge through shall be as given in Buyer's Data Sheet "A".

7.0 REACTION JETS AND BAFFLES

The Seller shall supply reaction jet nozzles and baffles to be installed, by the purchaser, in the wall which separates the forebays and the separator channels to give an even distribution of flow in the channels.

7.1 The number, size, design, and location of the nozzles shall be determined by the Seller.

7.2 The baffles shall be dished with size and radius of curvature to be determined by the Seller. Baffles shall be supported by a suitable bracket.

7.3 The nozzles and baffles shall be hot-dip galvanized after fabrication.

8.0 OIL SKIMMING PIPES

Seller shall furnish revolving handwheel worm-operated scum collecting pipes. One shall be installed in each of the forebays, and one in each of the channels.

8.1 Pipes shall be 12" nominal size with 0.330 wall thickness carbon steel pipe hot dipped galvanized after fabrication and cutting. A 60^{o} wide slot shall be cut symmetrical about the vertical axis of the pipe with the edges of the slot serving as a weir over which the scum flows into the pipe when the pipe is rotated. Oil skimmed from the surface shall flow from one pipe to the other and shall discharge on the side of the separator. The edges of the slot shall be parallel to the longitudinal axis of the pipe. At regular intervals of not more than 2'-6", 1" wide bands of the full periphery shall be left in the pipe to act as stiffeners.

8.2 Pipes shall be supported by and revolve in rolled steel or cast iron collars which shall be mounted on adjustable wall plates. The open end support shall have segments attached to the internal periphery of the collar to provide ample bearing surface for the pipe without crushing the seal. Plywood fillers shall be furnished with the open end supports to provide a watertight connection to the tank walls without grouting.

8.3 A suitable watertight seal shall be provided for the open end of the pipe. This seal shall be so constructed that it shall remain effective even with a slight misalignment of the pipe and collar. The seal shall not be affected by grease, mild acids, or alkalies. The

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seal shall be readily renewable without removing the pipe from the supporting brackets and shall not bind or impede the smocth action of the revolving pipe.

8.4 The revolving scum collecting pipe shall be manually operated by means of a 12" diameter cast iron handwheel with handle. The handwheel shall be fitted to a structural steel floorstand of welded construction having a nonrising stem. The stem shall be brass and threaded, having four 1-1/8" Acme threads per inch and shall turn inside a 2" diameter standard pipe lifting stem which raises and lowers the sliding rack assembly. The rack assmebly shall consist of two 2" x 2" x 3/8" angles fastened together by two 3/4" diameter connecting pins and welded to a 3/8" thick plate which is welded to the lifting stem. The rack assembly shall move in a cast iron guide-bracket to assure positive contact of the connecting pins with a 3/4" thick steel pinion segment welded to the scum collecting pipe. The pinion segment shall rotate on the rack connecting pins so as to permit an easy and accurate means of adjusting the scum collecting pipe through a 75^{o} radius in either direction or a total of 150^{o}. Each pipe shall be able to rotate independently of the other.

8.5 Skim pipe end supports and rotation drives shall be constructed of materials suitable for service in oily fresh water.

9.0 <u>ANCHOR BOLTS</u>

All anchor bolts shall be galvanized steel furnished by the Equipment Manufacturer and shall be of ample size and strength for purpose intended. All anchor bolts shall be set by the General Contractor in accordance with the Manufacturer's instructions.

10.0 All appurtenances including electrical controls, wiring of motors or controls, wooden baffles, valves, piping, pipe railing, floor grating, tools, lubricants, and all field work including erection and final painting, shall be furnished by the Buyer.

11.0 <u>Attachments</u>

1.A - Form 38 - Seller's Data Sheet "B".
2.B - Form 39 - Buyer's Data Sheet "A".

Name of Bidder________________

A. API Separator & Cross Collectors

1. Materials

Shafts: Head/Foot/Turn____/____/____

Take up: Frame/Screw____/____

Chain Side Bars________

Chain Pins: Material/BHN____/____

Sprockets: Head/Foot/Turn____/____/____

Bearings: Brackets/Inserts____/____

Flights________

T-Rails (lbs/yard)________

Wear Shoes: Carrying Run________

Return Run________

Return Angles- Size________

Return Angles- Supports________

Anchor Bolts________

2. Drive Assembly

Gear Reducer________

Manufacturer________

Type and Size________

AGMA Service Factor________

Sprocket________

Drive Chain________

Side Bars________

Pins: Material/BHN________

Take Up________

3. Speed Ratio

Gear Reducer/Drive Sprocker____/____

Flight Travel Speed (fpm)________

4. Weight - lbs

Complete Separator________

Drive________

Chains________

5. Dimensions - (Ft.)

Required Width of Channel(s)________

Required Length of Channels________

Length Between Shafts________

Upper________

Lower________

6. If a Cross Screw Collector is Used:

Materials

Flighting________

Pipe________

Shafts: End/Drive/Coupling____/____/____

End Bearings: Brackets/Inserts____/____

Support Bearings: Brackets/Inserts____/____

Bolts________

Drive Assembly

Type of Drive: Chain or Shaft with right angle Gear Box________

-Gear Reducer

Manufacturer________

Type & Size________

AGMA Service Factor________

Sprocket________

-Chain Drive

Side Bars________

Pins: Material/BHN________

-Take Up

Weight - Lbs

Complete Unit________

Drive________

Dimensions

Length of Screw(Ft)________

Diam. of Screw(in)________

Thickness of Flights________

Pitch of Flights________

RPM of Screw________

B. API Oil-Skimmer Pipe

1. Materials

Pipe________

Bearings________

End Plate________

Seal________

Stem________

Stem Support Bracket________

Hand Wheel________

Wormgear Segment________

Collar________

2. Weight of Complete Unit (Lbs)________

3. Dimensions

Required Width of Channel________

Diameter of Pipe________

Thickness of Pipe________

4. Estimate of Manhours to Field Assemble One Scum Trough________

C. Reaction Jet Baffles

1. Materials

Baffles________

Supports(Brackets)________

Bolts________

2. Dimensions

Diameter________

Radius of Curvature________

3. Estimate of Manhours to Assemble and Install One Set of Reaction Jet Baffles________

NO.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR
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MECHANICAL EQUIPMENT
FOR API SEPARATOR
SELLER'S DATA SHEET "B"

JOB No.	DRAWING No.	REV.

R & C SFE Form 38 (8/75)

A. API Separator & Cross Collector

1. Number of channels ______
2. Flow rate per channel,(GPM), Normal/Maximum ______ / ______
3. Maximum Water Velocity(FPS) ______
4. Elevation of Drive Base Support Slab(ft) ______
5. Elevation of Channel Floor(ft) ______
6. Slope of Channel Floor(If any) (in./ft.) ______
7. Maximum Water Level(ft.) ______
8. Minimum Water Level(ft.) ______
9. Elevation of Sludge Hopper(ft.) ______
10. Freeboard(ft.) ______
11. Width of Bottom of Sludge Trough(ft.) ______
12. Sludge Removed per Day(Tons) ______
13. Unusual Conditions ______

B. Oil Skimming Pipes

1. Number of Units per Channel ______
2. Number of Units per Forebay ______

C. Oily Water Analysis

1. Hardness, ppm Ca CO_3 ______
2. Calcium, ppm Ca ______
3. Magnesium, ppm Mg ______
4. Chlorides, ppm Cl ______
5. Sulphates, ppm SO_4 ______
6. Sodium, ppm Na ______
7. Silica, ppm $S_i O_2$ ______
8. ph ______
9. Potassium, ppm k ______
10. Total Dissolved Solids, ppm ______
11. PO_4 ______
12. CO_3 ______
13. HCO_3 ______
14. Alk, Ca CO_3 ______
15. Sulfur, ppm S ______
16. Water Viscosity,(SSU) ______
17. Water Specific Gravity ______
18. Oil Specific Gravity ______
19. Oil Viscosity,(SSU) ______
20. Temperature Average,(^{o}F) ______

NO.	DATE	REVISIONS	BY	CHKD	DES SUPV	ENGR	PROJ ENGR	APPR

SCALE | DESIGNED | DRAWN | CHIEF ENGR

BECHTEL
SAN FRANCISCO

MECHANICAL EQUIPMENT
FOR API SEPARATOR
BUYER'S DATA SHEET "A"

JOB No.	DRAWING No.	REV.
	DS-	

R & C SFE Form 39 (8/75)