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Section 9

PIPING SPECIFICATIONS AND MATERIALS

9.1 GENERAL

Primarily, piping specifications include all of the information necessary to properly select and install the component materials of a complete piping system.

The materials selected must provide a durable, efficient system at minimum expense. If we are to create such a system, some degree of compromise must generally be anticipated in any type of material selection. We should attempt to reduce initial material costs and installation costs as much as possible without impairing system performance or reducing desired life-expectancy.

To obtain efficient service and durability, we must consider:

- The nature of the fluid (corrosive or inert)
- The pressure and temperature of the fluid
- The quantity of fluid
- The effects of surrounding atmosphere and soil.

Although it is important that the product be carried without deleterious effect, proper base materials can be costly.

These expenses can be reduced by:

- Adopting cheaper materials which are lined or plated to achieve the desired purpose
- Consolidating stock by up-grading certain materials, thus minimizing purchasing and warehousing costs.

9.2 PIPING MATERIAL SPECIFICATIONS

Piping requirements for process or utility plants are described on the Piping Material Specifications. This document is comprised of a series of material service classifications, or service classes, each one individually tailored to handle specific fluids or commodities within limitations described in the service classes.

The material service classification outlines suitable piping components for the intended service: pipe, fittings, flanges, valves, etc. It also outlines the limitations in design operating conditions (temperature, pressure, corrosion allowance, etc.) within which the components may be used for safety of operation.

Service classes are developed in accordance with regulatory codes, material specifications, standards, and piping criteria based on metallurgical and historical data.

9.2.1 Code For Pressure Piping - ANSI B31

The code for pressure piping sets forth engineering requirements deemed necessary for safe design and construction of piping systems.

The code includes:

- Requirements for the design of component parts and assembled units including necessary pipe and supporting elements
- Requirements for the evaluation and limitation of stresses, reactions and movements associated with pressure, temperature, and external forces
- Material specifications and components standards which have been accepted for code usage
- Requirements for the fabrication, assembly, and erection of piping systems
- Requirements for the testing and inspection of elements before assembly and of the completed systems after erection.

The Code for Pressure Piping is divided into several sections, each dealing with specific engineering installation:

- B31.1 Power Piping
- B31.2 Industrial Fuel Gas Piping
- B31.3 Petroleum Refinery Piping
- B31.4 Oil Transportation Piping
- B31.5 Refrigeration Piping
- B31.6 Chemical Industry Process Piping
- B31.7 Nuclear Power Piping
- B31.8 Gas Transmission and Distribution Piping

Of the above, Refinery & Chemical Division's primary engineering efforts are regulated by the B31.3 section.

9.2.2 Piping Standards

The components of piping systems should, as far as practicable, comply with standards and specifications listed in the Code.

Piping standards contain dimensional requirements and limitations on the usage of piping components such as pipe, flanges, fittings, valves, bolting, gaskets, etc. Dimensional standards for B31.3 are listed in Table 9-1 (see pages 9-5 and 9-6).

Table 9-1

DIMENSIONAL STANDARDS

Standard	Designation
BOLTING	
Square and Hex Bolts and Screws, Including Hex Cap Screws and Lag Screws . . .	ANSI B18.2.1
Square and Hex Nuts	ANSI B18.2.2
FITTINGS, VALVES, FLANGES, AND GASKETS	
Cast Iron Fittings, 2 inch through 48 inch for Water and Other Liquids	ANSI A21.10
Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings	ANSI A21.11
Gray Iron and Ductile Iron Fittings, 3 inch through 24 inch for Gas	ANSI A21.14
Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, 250, and 800 lb	ANSI B16.1
Malleable-Iron Screwed Fittings, 150 and 300 lb	ANSI B16.3
Cast Iron Screwed Fittings, 125 and 250 lb	ANSI B16.4
Steel Pipe Flanges and Flanged Fittings	ANSI B16.5
Wrought Steel Buttwelding Fittings	ANSI B16.9
Face-to-Face and End-to-End Dimensions of Ferrous Valves	ANSI B16.10
Forged Steel Fittings, Socket-Welding and Threaded	ANSI B16.11
Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads	ANSI B16.14
Cast Bronze Screwed Fittings, 125 and 250 lb	ANSI B16.15
Cast Bronze Solder-Joint Pressure Fittings	ANSI B16.18
Ring-Joint Gaskets and Grooves for Steel Pipe Flanges	ANSI B16.20
Nonmetallic Gaskets for Pipe Flanges	ANSI B16.21
Wrought Copper and Bronze Solder-Joint Pressure Fittings	ANSI B16.22
Bronze Flanges and Flanged Fittings, 150 and 300 lb	ANSI B16.24
Buttwelding Ends for Pipe, Valves, Flanges and Fittings	ANSI B16.25
Cast Bronze Fittings for Flared Copper Tubes	ANSI B16.26
Wrought Steel Buttwelding Short Radius Elbows and Returns	ANSI B16.28
Refrigeration Flare-Type Fittings	ANSI B70.1
Specifications for Threads in Valves, Fittings, and Flanges	API 6A
Flanged Steel Safety Relief Valves	API 526
Steel Venturi Gate Valves, Flanged or Buttwelding End	API 597
Steel Plug Valves	API 599
Steel Gate Valves, Flanged or Buttwelding Ends	API 600
Metallic Gaskets for Refinery Piping, Double-Jacketed Corrugated and Spiral Wound	API 601
Compact Design Carbon Steel Gate Valves	API 602
150 lb. Light-Wall, Corrosion-Resistant Gate Valve for Refinery Use (½ inch to 12 inch inclusive)	API 603
Flanged Nodular Iron Gate and Plug Valves for Refinery Use	API 604
Large-Diameter Carbon Steel Flanges (Size: 26 inch to 60 inch inclusive; Nominal Pressure Rating: 75, 150, and 300 lb.	API 605
Unions and Pipe Fittings 300 lb. Pressure	AAR M-404
Gate Valves for Ordinary Water Works Service	AWWA C500
Steel Pipe Flanges	AWWA C207
Steel Water Pipe Fittings	AWWA C208
Standard Finishes for Contact Faces of Pipe Flanges and Connecting	
End Flanges of Valves and Fittings	MSS SP-6
Spot Facing for Bronze, Iron and Steel Flanges	MSS SP-9
Standard Marking System for Valves, Fittings, Flanges and Unions	MSS SP-25
125 lb. Bronze Gate Valves	MSS SP-37
150 lb. Corrosion Resistant Cast Flanged Valves	MSS SP-42
Wrought Stainless Steel Buttwelding Fittings	MSS SP-43
By-Pass and Drain Connection Standard	MSS SP-45
Steel Buttwelding Fittings (26 inches and larger)	MSS SP-48
150 lb. Corrosion Resistant Cast Flanges and Flanged Fittings	MSS SP-51
Pipe Hangers & Supports—Materials and Design	MSS SP-58
Butterfly Valves	MSS SP-67
Cast Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
General Purpose Ball Valves	MSS SP-72
Silver Brazing Joints for Wrought and Cast Solder Joint Fittings	MSS SP-73

Table 9-1 (Cont'd.)

Standard	Designation
PIPE AND TUBES	
Thickness Design of Cast Iron Pipe	ANSI A21.1
Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids	ANSI A21.6
Cast Iron Pipe Centrifugally Cast in Metal Molds, for Gas	ANSI A21.7
Cast Iron Pipe Centrifugally Cast in Sand-Lined Molds, for Water or other Liquids	ANSI A21.8
Cast Iron Pipe Centrifugally Cast in Sand-Lined Molds, for Gas	ANSI A21.9
2 Inch and 2½ Inch Cast Iron Pipe, Centrifugally Cast for Water or other Liquids	ANSI A21.12
Thickness Design of Ductile-Iron Pipe	ANSI A21.50
Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water or Other Liquids	ANSI A21.51
Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Gas	ANSI A21.52
Wrought Steel and Wrought Iron Pipe	ANSI B36.10
Stainless Steel Pipe	ANSI B36.19
Pipe, Cast Iron: Pressure (Gas and Water).	FS WW-P-360
Pipe, Cast Gray and Ductile Iron, Pressure (For Water and Other Liquids)	FS WW-P-421
MISCELLANEOUS	
Unified Screw Threads	ANSI B1.1
Pipe Threads (Except Dryseal).	ANSI B2.1
Dryseal Pipe Threads	ANSI B2.2
Hose Coupling Screw Threads	ANSI B2.4
Fire-Hose Coupling Screw Thread.	ANSI B26
Surface Texture	ANSI B46.1

Many of these dimensional standards have been duplicated on Bechtel standards L-524, 525 and 526 (shown on pages 9-8, 9-9, and 9-10), and are available to the designer.

9.2.3 Material Specifications

Material specifications are established by the American Society of Testing Materials (ASTM). These specifications standardize the manufacture of metallic or non-metallic materials, processes, chemical composition, heat treatment, tests and inspection, and constitute the basis for rejection.

9.2.4 Selection of Materials

In a piping system, every component must be considered for its strength, durability and maintainability, and all these considerations must be weighed against the cost of the system and the service it is to perform.

Materials are selected primarily to provide safe operation during the expected life of the equipment. This means they must have the ability to resist not only the design operating conditions, but onstream and offstream service deterioration as well. This deterioration is usually the result of corrosion, erosion, or abrasion by the fluid being handled. Deterioration may also be in the form of a specific attack by chemicals such as sulfur, chlorides, or hydrogen on the inner structure of the metal.

600 LB.														
NOMINAL PIPE SIZE					PIPE					NOMINAL PIPE SIZE				
GLOBE					PLUG COCK					CHECK				
GATE					RING JOINT					FLANGE				
WELDING FITTINGS					WELDING FITTINGS					WELDING FITTINGS				
RAD O D					RAD O D					RAD O D				
1/2					1/2					1/2				
3/4					3/4					3/4				
1					1					1				
1 1/2					1 1/2					1 1/2				
2					2					2				
2 1/2					2 1/2					2 1/2				
3					3					3				
3 1/2					3 1/2					3 1/2				
4					4					4				
4 1/2					4 1/2					4 1/2				
5					5					5				
6					6					6				
8					8					8				
10					10					10				
12					12					12				
14					14					14				
16					16					16				
18					18					18				
20					20					20				
22					22					22				
24					24					24				

In choosing the suitable material for the intended service either a careful evaluation must be made of the historical behavior of these materials in equal or similar installations, or a careful testing program must be conducted using laboratory simulation procedures.

9.3 BECHTEL STANDARD PIPING MATERIAL SPECIFICATION
L-531

The experience accumulated by Bechtel R&C in the design and construction of piping systems for refineries and chemical plants enables us to standardize piping materials requirements for all services for application to projects. This composite standard is designated Specification L-531.

Knowledge of each of the commodities (or fluid service) encountered in any of the processes utilized in the refining of petroleum crudes and the production of by-products makes possible the development of material service classifications for each of these commodities.

The body of this standard consists of the following sections:

- (a) An index of the service classes, arranged by class number; commodities for which the class is suitable for design; and major features peculiar to the class.

- (b) A list of notes describing piping requirements and criteria applicable to all classifications
- (c) Charts, graphs, and tables providing specific engineering information to project engineers for assistance in choosing suitable classes
- (d) The group of individual material service classes.

A sample of each of these sections is shown in Figures 9-1, 9-2, and 9-3.

9.3.1 Description of a Material Service Classification

The design of each standard material service classification is based on suitable metallurgy, limitations in pressure and temperature of piping components, and corrosion allowances. The code calculations that accompany these parameters make it possible to write specifications defining required wall thicknesses for pipe, flanges, and fittings. See the items listed in Figure 9-2 as follows:

- (Items) A. Pipe and Fittings — List required wall schedules and weights
- B. Flanges — are rated in accordance with ANSI Standard B16.5

SERVICE CLASS INDEX

REV	SERVICE CLASS	COMPATIBILITY	FLANGE RATING	FLG FACE	TEMP RANGE DEG F	NOMINAL CORR ALLOW	FIFE PTL	SMALL FITTING	VALVE BODY MATERIAL	VALVE TRIP
0	AA2L	Cooling Water, Utility Water, Cooling Water, Utility Air, Zeolite Treated Water	125	FF	20-150	1/16"	CS	3000 THC	BRONZE CI	BRONZE
0	AF2L	Process Water, Instrument Air	125	FF	20-150	1/16"	CS GALV	300 THC PI	BRONZE CI	BRONZE
0	AF2L	Fire Water (Below Ground)	125	FF	20-150	1/16"	CS	None	BRONZE CI	BRONZE
0	AF2V	Firewater (Below Ground)	250	RF	20-150	1/16"	CS	None	BRONZE CI	BRONZE
0	AF2L	Steam, Cond, FFW (ANSI-E31.3) 20-350F CFF-FLCT LIGLIC HYDROCARBONS 20-150F	125	FF	SEE COMPCC	1/16"	CS	3000 SW	CS CI	13 CR
0	FA2E	CARBONATE (CO2 REMOVAL) 141-200F CAUSTIC SCCA (SEE SERVICE CLASS) ETHANOLAMINES 141-200F	150	RF	SEE COMPCC	1/16"	CS	3000 THC	CS CI	13 CR
0	EA2C	CARBONATE (CO2 REMOVAL) 141-200F CAUSTIC SCCA (SEE SERVICE CLASS) ETHANOLAMINES 141-200F	300	RF	SEE COMPCC	1/16"	CS	3000 THC	CS	13 CR
0	EM4E	ETHANOLAMINES	150	FF	201-250	1/8"	CS	6000 THC	CS CI	18-B SS
0	EM4C	ETHANOLAMINES	300	RF	201-250	1/8"	CS	6000 THC	CS	18-B SS
0	EM2E	ETHANOLAMINES	150	RF	251-400	1/4"	CS	6000 THC	CS CI	18-B SS
0	EM2C	ETHANOLAMINES	300	RF	251-400	1/4"	CS	6000 THC	CS	18-B SS
0	ETPC	CAUSTIC SCCA (SEE SERVICE CLASS)	150	RF	170-250	1/4"	CS	6000 THC	CS CI	PCNCL
0	ETPC	CAUSTIC SCCA (SEE SERVICE CLASS)	300	RF	170-250	1/4"	CS	6000 THC	CS	PCNCL
0	CA2E	GEN HYDROCARBONS 20-500F GEN FC W/S OF H2S (ALL CCNC) 20-500F FUEL GAS, FUEL OIL 20-500F LUBE & SEAL OIL (UPSTREAM FILTER) 20-500F ETHANOLAMINES 20-140F CARBONATE (CO2 REMOVAL) 20-140F CAUSTIC SCCA (SEE SERVICE CLASS) STEAM, COND, FFW (ANSI-E31.3) 20-500F	150	RF	SEE COMPCC	1/16"	CS	3000 SW	CS CI	13 CR
0	CA2C	GEN HYDROCARBONS 20-500F GEN FC W/S OF H2S (ALL CCNC) 20-500F FUEL GAS, FUEL OIL 20-500F LUBE & SEAL OIL (UPSTREAM FILTER) 20-500F ETHANOLAMINES 20-140F CARBONATE (CO2 REMOVAL) 20-140F CAUSTIC SCCA (SEE SERVICE CLASS) STEAM, COND, FFW (ANSI-E31.3) 20-500F	300	RF	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CE2P	GEN HYDROCARBONS 501-750F GEN FC W/S (ALL CCNC) 501-550F STEAM (ANSI-E31.3) 501-750F	150	RF	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CF2C	GEN HYDROCARBONS 501-750F GEN FC W/S (ALL CCNC) 501-550F STEAM (ANSI-E31.3) 501-750F	300	RF	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CF2H	GEN HYDROCARBONS 20-750F GEN FC W/S (ALL CCNC) 20-550F STEAM, COND, FFW (ANSI-E31.3) 20-750F	600	RF	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CF2L	GEN HYDROCARBONS 20-750F GEN FC W/S (ALL CCNC) 20-550F STEAM, COND, FFW (ANSI-E31.3) 20-750F	900	RTJ	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CE2N	GEN HYDROCARBONS 20-750F GEN FC W/S (ALL CCNC) 20-550F STEAM, COND, FFW (ANSI-E31.3) 20-750F	1500	RTJ	SEE COMPCC	1/16"	CS	6000 SW	CS	13 CR
1	CC2P	GEN FC W/H2 & H2S (ALL CCNC) 20-550F GEN FC W/H2 20-700F HYDROGEN 20-700F	150	RF	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CC2C	GEN FC W/H2 & H2S (ALL CCNC) 20-550F GEN FC W/H2 20-700F HYDROGEN 20-700F	300	RF	SEE COMPCC	1/16"	CS	3000 SW	CS	13 CR
1	CC2H	GEN FC W/H2 & H2S (ALL CCNC) GEN FC W/H2 HYDROGEN	600	RF	20-550	1/16"	CS	3000 SW	CS	13 CR

Figure 9-1. Typical Service Class Index.

REV	SIZE	DESCRIPTION	CODE	NOTES	REV	SIZE	DESCRIPTION	CODE	NOTES			
PIPE					VALVES							
1/2-1	1/2	SCH 80 A106 B	54LS L11GB1BB	55	GATE							
2	-10	SCH 40 A53 B	54LS L11EA2AB		1/2-1 1/2	800 LB CS SW	SMITH 800-SW	L20KA1BA	D			
12		STD WT A53 B	54LS L11MA2AB		2	-24	300 LB CS RF	PACIFIC 350-S		L20FA7BA		
14	-24	SCH 40 A53 B	54LS L11A2AB		GLOBE					E		
FITTINGS					1/2-1 1/2	800 LB CS SW	SMITH 800-SW	L21KA1BA	E			
1/2-1	1/2	90 DEG ELL	L30SADBC	A	2	-6	300 LB CS RF	PACIFIC 360-S		L21FA7BA	F	
		45 DEG ELL	L30SADAC		CHECK					F		
		STR TEE	L31SADBC		1/2-1 1/2	800 LB CS SW	HORIZ SMITH 800-SW	L22KA1BA	F			
		RED TEE	L31SADDC		2	-3	300 LB CS RF	PACIFIC 380-S		L22FA7BA	F	
		CAP	L37SADXC		4	-24	300 LB CS RF	WAVER MISSION 30-SPF	L23FA7BC	F		
		UNION	L33SAD1C		SEE GENERAL NOTES 1-21, SPEC L-1, SHEETS 4A-4H						F	
		SOCKOLET	L36SADTC		54 SEE BRANCH REINFORCEMENT TABLE FOR SUPPLEMENTARY HYDROTEST REQUIREMENTS					F		
		NIPOLET	L36SAD4C		55 SUB LETTERS FOR * IN ACCORD W/GEN NOTE 4.4 & ADDENDUM 5T						F	
		COUPLING	L34SADHC		63 SIZE LIMIT 6 IN					F		
2	-12	STD WT CS BW			A	93 SEE SUP TABLE OF WALL THICKNESS FOR 14 AND LARGER					F	
		90 DEG LR ELL	L50MA1BCB			102 1/2-1 1/2 GEN NOTE 18, 1, 2-20 NONE REQD, 22-24 GEN NOTE 18.2						F
		45 DEG ELL	L50MA1ADB								F	
		STR TEE	L51MA1B0B									F
		CONC RED	L55MA1DAB								F	
		ECC RED	L55MA1DBB									F
		CAP	L57MA1R0B								F	
		WELDQLET	L56MA1H0B						F			
14	-24	SCH 40 CS BW		A							F	
		90 DEG LR ELL	L50MA1BCB									F
		45 DEG LR ELL	L50MA1ADB								F	
		CONC RED	L55MA1DAB									F
		ECC RED	L55MA1DBB								F	
		CAP	L57MA1R0B									F
FLANGES						PIPE MATERIAL..... CARBON STEEL					F	
1/2-1	1/2	300 LB RF SW	L40FA7BMC			B	FITTING MATERIAL... CARBON STEEL					F
1/2-24		300 LB RF BLIND	L43FA700C		VALVE MATERIAL... CARBON STEEL					F		
2	-10	300 LB RF WN 40	L42FA70EB		VALVE TRIM..... API-600 NO. 1						F	
12		300 LB RF WN STD	L42FA7DMB		RATING..... 300 LB ANSI 816.5 RF					F		
14	-24	300 LB RF WN *	L42FA7D*B		CORROSION ALLOW... 0.063 (NOMINAL)						F	
1	-10	300 LB RF SPEC BLIND	L45FA7E0G		MAXIMUM HYDROTEST... 1100 LB (LIMITED BY FLANGES)					F		
12	-24	300 LB RF BLND/SPCR	L45FA7F0G		SEAL WELDING..... SEE GEN NOTE 13.1.2						F	
2	-12	300 LB RF WN STD	L40FA7DMC		BENDING..... SEE NOTE 102					F		
14	-24	300 LB RF WN *	L40FA7D*C								F	
PIPE NIP					PRESS/TEMP LIMITS BASED ON FLANGES SEE NOTE NO. 93					F		
1/2-1	1/2	SMLS CS	L11GB1BB	B	SERVICE						F	
		PE - CUT FROM PIPE	L34NA3JD		GEN HYDROCARBONS (SEE GEN NOTE 2.6)					F		
		TOG - XS			GEN HC W/ S (ALL CONC) LIMIT 550F						F	
					STEAM (ANSI-831.3)					F		
SWAGE NIP					TEMP PSIG PSIG						F	
1/2-1	1/2	SMLS CS	L35NA1QB		DEG F MIN MIN					F		
		8BE - CONC XS	2L35NAHQB								F	
		YSE - CONC XS								F		
GASKETS											F	
1/2-24		304 SS 1/8TH SP WD	L41FFCA							F		
		300 LB RING									F	
BOLTING										F		
		A193-B7 STUD W/2 PH	L420FMB0C						F			
MISC										F		
		CONICAL STRAINER	L59FA7YA						F			
		ADJUST CH SPKT RIM	L79BKAAA							F		
		CHAIN FOR SPKT RIM	L79BJA						F			

Figure 9-2. Typical Service Class Sheet.

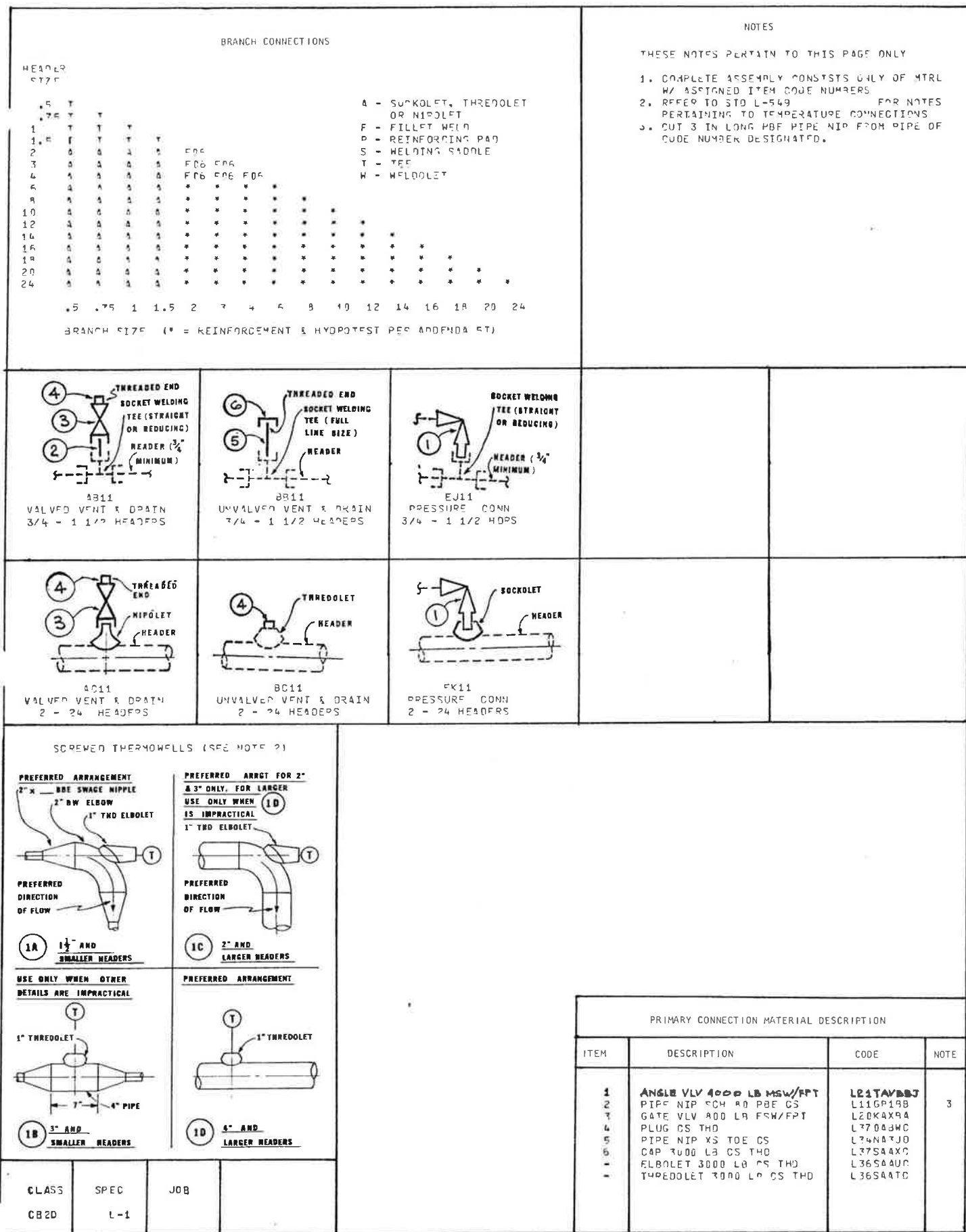


Figure 9-3. Typical Back Page of a Service Class.

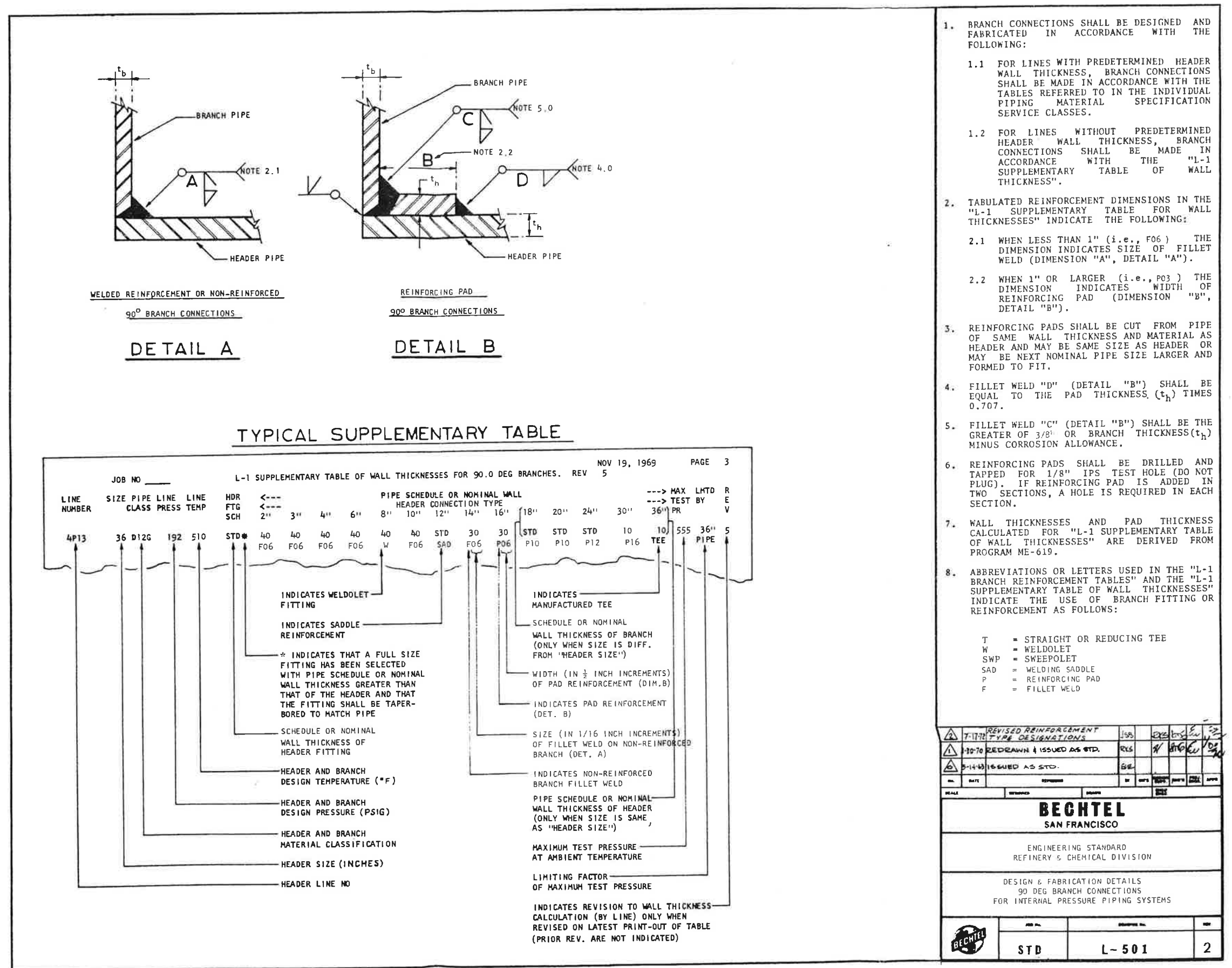


Figure 9-4. Standard Drawing L-501.

C. Miscellaneous – Show Special Items; Pipe
Nipples and Swages; Bolts and Gaskets that
are suitable for use in Mechanical Joints

The Piping Engineer will select the appropriate valving in accordance with codes and community requirements and will list his selections on the individual service class by pressure ratings, material, and end connections. Again, referring to Figure 9-2:

- (Items) D. Gate Valves – List requirements for shutoff operations
- E. Globe Valves – List throttling requirements
- F. Check Valves – List requirements for the prevention of back-flows

The service class also describes the temperatures and pressure limitations that apply to the listed commodities.

9.3.2 Branch Reinforcement Tables and Primary Connection Details

A page is included at the back of each individual service class (see Figure 9-3) that provides data to designers regarding branch connection criteria and primary connection details. The following details are given:

- The Branch Reinforcement Table is developed to indicate the types of branch connections used for any combination of header and branch for sizes up to a predetermined size or a 24-inch maximum. The type of connection is indicated by a code number as shown in the adjacent legend; i. e. : F06 is a fillet weld of 6/16 fillet size (code minimum 3/8 inch); P08 is a pad size of 8 halves or 4-inch size. Refer to Standard Drawing L-501 (see Figure 9-4).
- Primary Connection Details (Standard Assemblies) for vents, drains, and instrument connections are shown with the required piping components to be used in design and for construction. The code numbers shown below the Assemblies are unique and are used for identification in our computer program (BIPS) for controlling material. Each piping item required for the Standard Assembly is identified by a number in a circle and is listed in the lower right-hand corner on the back page of the individual service class. (Figure 9-3 is an example of the back page of Service Class CB2D).

9.3.3 Use of L-531 in Specific Projects

Standard Specification L-531 is suitable in its entirety for use in what is called a "grass-root" refinery project; that is,

a new installation capable of processing from crude feeds to the most refined of petroleum by-products. Occasionally, a project consists of an expansion or additions to existing installations, and only a limited number of service classes are required. In these cases, L-531 is converted into a job oriented Piping Material Specification; the project specification is then designated as L-1 (i. e., 10640-L-1).

A review of the process requirements for a project enables the piping engineer to select the required service classes. Client criteria is evaluated and incorporated in the service classes. Specification L-1 is then developed, and two additional sections are made part of the specification. These are:

- (e) Supplementary tables of wall thicknesses (see description below)
- (f) Revision lists, describing changes made to the classes and criteria in any of the specification revisions.

9.3.4 Supplementary Tables of Wall Thicknesses

In the design of service classes of 600-pound and higher ratings, wall calculations of large sizes require the specification of heavy walls. The evaluation of the wall thicknesses of a previous rating at the maximum allowable conditions by ANSI B16-5 standard, will show that various schedules may be used

within the range of pressures between one rating and the following higher rating. Economy dictates that for sizes above a predetermined size (common schedules between consecutively rated classes), the walls of the higher rating be calculated on the basis of actual service pressure and temperature on a line-by-line basis.

After line tables are issued, piping engineering lines to be calculated are reviewed for code conditions (shown in line tables). Computer calculations using piping engineering program ME-619A will provide tabulated information of the calculated lines. A sample computer printout shown in Figure 9-5.

9.4 STANDARD PIPING SPECIFICATIONS

The following Standard Piping Specifications are described in this section:

- L-501, Piping Design Basis
- L-502, Plant Design, Piping Layout
- L-503, Shop Fabrication of Piping
- L-509, Field Fabrication of Piping
- L-511, Plant Design, Equipment Layout

JOB NO 7488				L-1 SUPPLEMENTARY TABLE OF WALL THICKNESSES FOR 90.0 DEG BRANCHES.										NOV 19, 1969		REV 1		PAGE 1	
LINE NUMBER	SIZE	PIPE LINE SPEC	LINE PRESS TEMP	HDR FTG SCH	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	MAX LMTD R E V
					WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	WLET	TEST BY PR
4P13	18	D12G	192 510	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1100 FLGS
4P15	20	D12G	113 510	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1020 20" PIPE
4P37	20	D12G	43 650	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1020 20" PIPE
4P38	16	D12G	43 650	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1100 FLGS
4P43	14	D12G	112 650	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1100 FLGS
4P45	26	D12G	102 675	10	40	40	40	40	40	40	40	40	40	40	40	40	40	40	555 24" PIPE
4P52	30	R11	39 317	.375	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	3/8F	120 24" PIPE
4P53	24	R11	39 317	10	40	40	40	40	40	40	40	40	40	40	40	40	40	40	135 20" PIPE
4P63	14	D12G	39 525	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1100 FLGS
4P93	24	R11	32 150	10	40	40	40	40	40	40	40	40	40	40	40	40	40	40	120 20" PIPE
4P182	16	D12G	43 650	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1100 FLGS
4P309	14	D12G	255 510	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1100 FLGS
4P310	20	D12G	44 650	STD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1020 20" PIPE

Figure 9-5.

9.4.1 Standard Specification L-501 — Piping Design Basis

This specification outlines the overall design basis required to engineer a piping design that conforms to applicable codes and accepted practices.

It provides the basis for the development and interpretation of P&ID's, line designation tables, and material specifications.

The information includes:

- (1) A list of codes and regulations and their respective limits of applicability
- (2) Criteria to be utilized in the calculation of design pressure/temperature, overpressure protection, and in vacuum design
- (3) Rules governing the application of valving
- (4) Rules governing the application of piping material specifications

9.4.2 Standard Specification L-502 — Plant Design, Piping Layout

This specification describes requirements governing piping layout and mechanical design. It is intended to establish a design pattern which will produce a safe, economical and reliable installation.

Engineering Standard Specification L-501, Piping Design Basis (described in Section 9.4.1) specifies the design conditions that apply to piping systems. Engineering Standard Drawings A-521 and A-522 set some minimum requirements and clearances for piping and equipment layout.

In accordance with this specification, piping shall be arranged to satisfy ease of operation, accessibility for maintenance, economy, appearance and allowance for future additions.

Some of items covered are:

(1) Layout

Piping Routing

Pipe Flexibility

Critical Piping

(2) Equipment Piping

Column and Vessel Piping

Exchanger Piping

Pump and Turbine Piping

Compressor Piping

Burner and Steam Snuffing

Fired Heaters

(3) Valves

Valve Requirements

Valve Locations

Vents and Drains

(4) Utility Piping

Steam Piping

Steam Traps

Steam Out Connections

Steam Tracing and Winterizing

Utility Stations

Auxiliary Piping for Pumps and Turbines

(5) Instruments

Control Valve Manifolds

Level Instruments

Orifice Runs

Instrument Access

(6) Materials

Junction of Different Services

9.4.3 Standard Specifications L-503 – Shop Fabrication of Piping

This specification describes the work to be provided by an independent contractor in the fabrication of the piping systems which Bechtel has engineered.

It provides information needed by the contractor to ensure that the fabricated piping will conform to codes and Bechtel requirements.

The following information is included:

- (1) A list and description of associated documents
- (2) A list of applicable codes and their limits of jurisdiction

- (3) Materials and fabrication requirements, including requirements for fabrication drawings, nondestructive examination, marking and shipping, and documentation
- (4) A description of the functions that Bechtel will provide toward expediting and scheduling.

It is particularly important for the designer to include the information that Bechtel is obligated to provide on piping drawings and referenced drawings.

9.4.4 Standard Specification L-509 - Field Fabrication of Piping

This specification describes the work to be provided by the field construction forces, either of Bechtel or an independent contractor. In general, the information contained herein is similar to that in the shop fabrication specification.

Again, the most significant information to be provided is that which relates to Bechtel's obligation to provide specific data for the construction of the system. It is particularly important to show the types of information and the degree of direct assistance that will be provided by Bechtel.

9.4.5 Standard Specification L-511 – Plant Design, Equipment

Layout

This specification offers guidelines on the layout and spacing of plant equipment and units, to provide for safe and easy operation, maintenance, and fire prevention and control. Some of the items covered are:

(1) Plant Layout

Piping Layout
Equipment Layout
Pumps
Compressors
Vessels
Exchangers
Air Coolers
Fired Heaters and Equipment
Pipeways

(2) Clearance and Accessibility

Overhead Clearances
Horizontal Clearances
Access for Maintenance

(3) Design for the Use of Mobile Maintenance Equipment

Crane Usage
Tube Bundle Extractors
Furnace Tube Removal
Mobile Equipment

(4) Platforms, Stairs and Ladders (Access and Layout Requirements)

Platforms at Large Elevated Structures

Platforms with Stair Access

Platforms with Ladder Access

Ladder Requirements

(5) Spacing Between Facilities

Process Areas

Tankage Areas — Off Plot

(6) Miscellaneous Requirements

Tank Dike Enclosures

Roads

Railroads

Satellite Shelters

9.5 PIPING MATERIAL CODE SYSTEM

Piping materials used by Bechtel in the design of piping systems are catalogued by a code identification system. A piping item code number is a unique combination of letters and numbers arranged in a specific order for the purpose of identifying piping components.

9.5.1 Code Identification System

The code identification system is used to achieve brevity for material control purposes and simplification in the requisitioning, purchasing, and warehousing operations during construction.

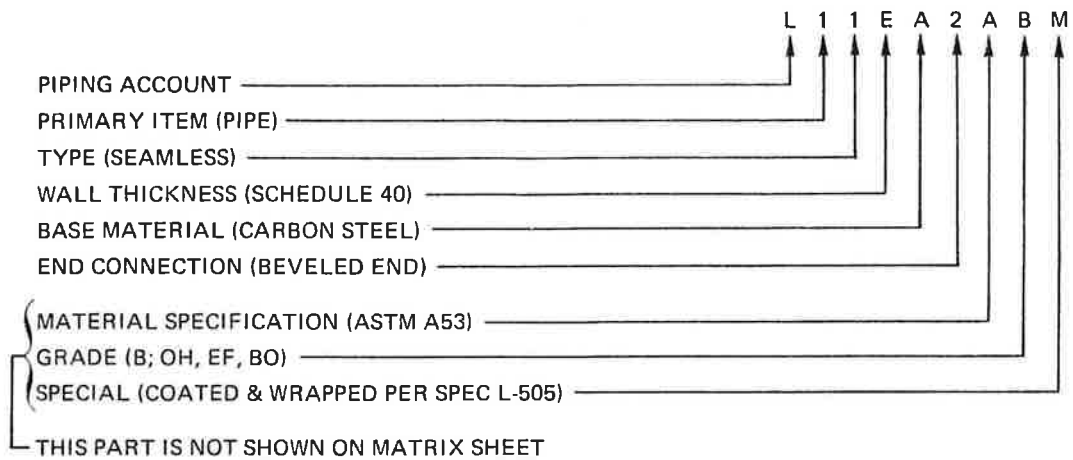
This code is derived from an item composition matrix of nine characters; each either a letter or a number. For piping components the first digit is always the letter "L". The second digit describes specific categories, and the remaining digits indicate variables such as material, schedule, rating, etc.

The piping categories are:

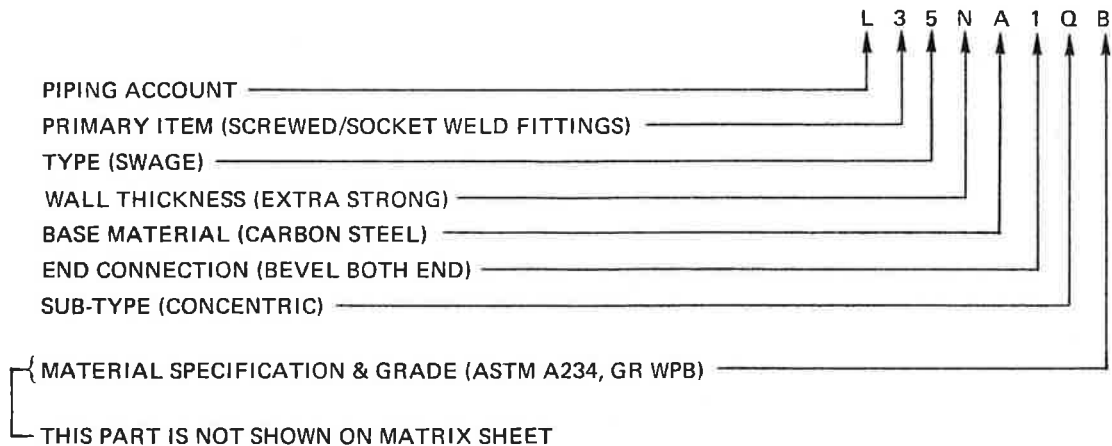
- L1 --- Pipe
- L2 --- Valves
- L3 --- Screwed/socket welding fittings
- L4 --- Flanges
- L5 --- Welding/flanged fittings
- L6 --- Bolts, nuts, gaskets

Categories L7 through L9 are assigned to nonstandard items of a more unorthodox matrix arrangement.

An example is given on the next page of the ordering description stock code number for carbon steel seamless pipe, schedule 40 of ASTM designation A53 GR B, to be coated and wrapped for underground service, coded in accordance with the matrix for category L1. (See Figure 9-6 for an example of the matrix used in developing stock code numbers for pipe.)



In another example, the coding of a swage nipple, beveled both ends, of carbon steel to ASTM designation A234 GR WPB, extra strong weight, would be developed from the L3 matrix (see Figure 9-7) as shown below:



3	4	5	6	7	8	9
TYPE	WALL THICKNESS	PIPE MATERIAL	END CONNECTION	SPECIFICATION	GRADE	SPECIAL
	SCHEDULE		0 THREADED			
		A CS		A A53	A A (OH, EF, BO)	0
	B 10				B B (OH, EF, BO)	A
	C 20			C A120	C A	B
	D 30			D A134	D B	E G C LI-4
	E 40			E A135		E G D LI-5
	F 60				F C45	E
	G 80			G A139	G C50	J F LI-1
	H 100				H C55	J G
	J 120			J A155		J H
	K 140					J I
	L 160					K
	M STD WT					L
	N XS					M
	P XXS					N
	Q 0.281					P
				R A524	R CMS 75	0
				S A587		R LI-7
	T 0.250				T X42	S
	U 0.312				U X46	Y T LI-8
	V 0.375				V X52	Y U
	W 0.500			W API-5LS	W X52 (2)	Y V
				X API-5L		Y X LI-8 & 9
				Y API-5LX		Y LI-9
1 SEAMLESS			1 PLAIN		1 A285, GR C	Z
2 ERW (85%)			2 BEVELED	2 SA53	2 LI-10	D I LI-3
3 (1)				3 SA155	3 A285, GR A	2 LI-2
4 ERW (80%)			4 THD & COUPLED		4 A285, GR B	D 3
5 ERW (85%)						D 4
6 ERW (90%)						5
7 ERW (100%)						6
8 SAW (90%)						7
9 CAST (100%)						8
						9

(1) USE FOR FURNACE BUTT-WELDED, FURNACE LAP-WELDED, SPIRAL WELDED.

(2) 7200 TENSILE

LI PIPE

L35 SWAGE NIPPLE

Figure 9-7.

All items specified in a material service class are coded in accordance with the above criteria. This system provides an orderly means of material control for any project.

9.5.2 Piping Material Stock Code List

All piping material components must be properly described for purchase. Piping Engineering develops a short description for inventory reports and a long description for the requisition and purchase of all items.

The composite of all piping long descriptions and code number is called the Piping Stock Code List.

For example, the following is a long description of a gate valve:

Code No.

L20BA7B4Y	150 LB raised face gate valve, OS&Y, bolted bonnet, solid wedge, renewable seats, cast carbon steel body and bonnet per ASTM A216 GR WCB, 13 CR trim with teflon inserts in wedge or seat rings, bevel gear operated, Pacific 150-17 or equal.
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9.6 PIPING MATERIAL CONTROL

Piping material control consists of requisitioning, takeoff, and inventory control of all pipe, fittings, valves, and special piping items. San Francisco Engineering is responsible for requisitioning all construction piping materials (except consumables) for the field. The detailed procedure for piping materials control is shown in Engineering Instruction L-23.

9.6.1 Material Takeoff

The detailed procedure for Piping Material Takeoff is shown in Engineering Instruction L-22. Quantities for the initial requisitions are determined from an initial takeoff from P&IDs, plot plans, and preliminary routing drawings. This takeoff is kept current during the entire engineering period and is updated as changes in design are defined.

An "actual" takeoff of all piping materials is made from isometric and orthographic drawings. The material required to install each detail is listed directly on the isometric through the medium of the BIPS computer program. The orthographic drawing material is taken off by line number.

9.6.2 Requisitions

Requisitions must be written months prior to construction in order to allow the needed delivery time for valves and other piping items. The first requisitions are generally written to cover the longer-delivery items.

9.6.3 Piping Material Control Reports

All piping materials are currently being summarized by the computer using the BIPS system. Thus, material required in the field to install and field fabricate all piping can be taken off, posted, and summarized efficiently and accurately. Instructions in making piping material takeoffs, and descriptions of the types of material reports available are shown in the BIPS User's Manual.

9.7 SUMMARY

The designer has a very important role in this phase of engineering. He must know how to read the material specification, and should have a basic understanding of how the specifications are developed. He must also be familiar with the piping stock code system and the computerized material control reports used.

The responsibility of the Piping Engineering and Material Control section begins with formulation of the initial piping specifications and continues through material requisitioning and takeoff. The Material

Control section must also follow through to ensure that all piping materials needed to complete a project reach the field on schedule.

Considerable coordination with Project, Design, Purchasing, Suppliers and Construction is required throughout a project. Coordination will be more readily achieved and we will produce a better job if designers and draftsmen have a thorough understanding of this phase of engineering.

9.8 ISOMETRIC MATERIAL TAKEOFF DATA

The procedure to be used for manually drawn isometrics and using the BIPS Computer Material Control Program is defined in Section 7 of the BIPS User's Manual.

An example of the combined material takeoff forms — Cards 861 and 862 — is shown in Figure 9-8.

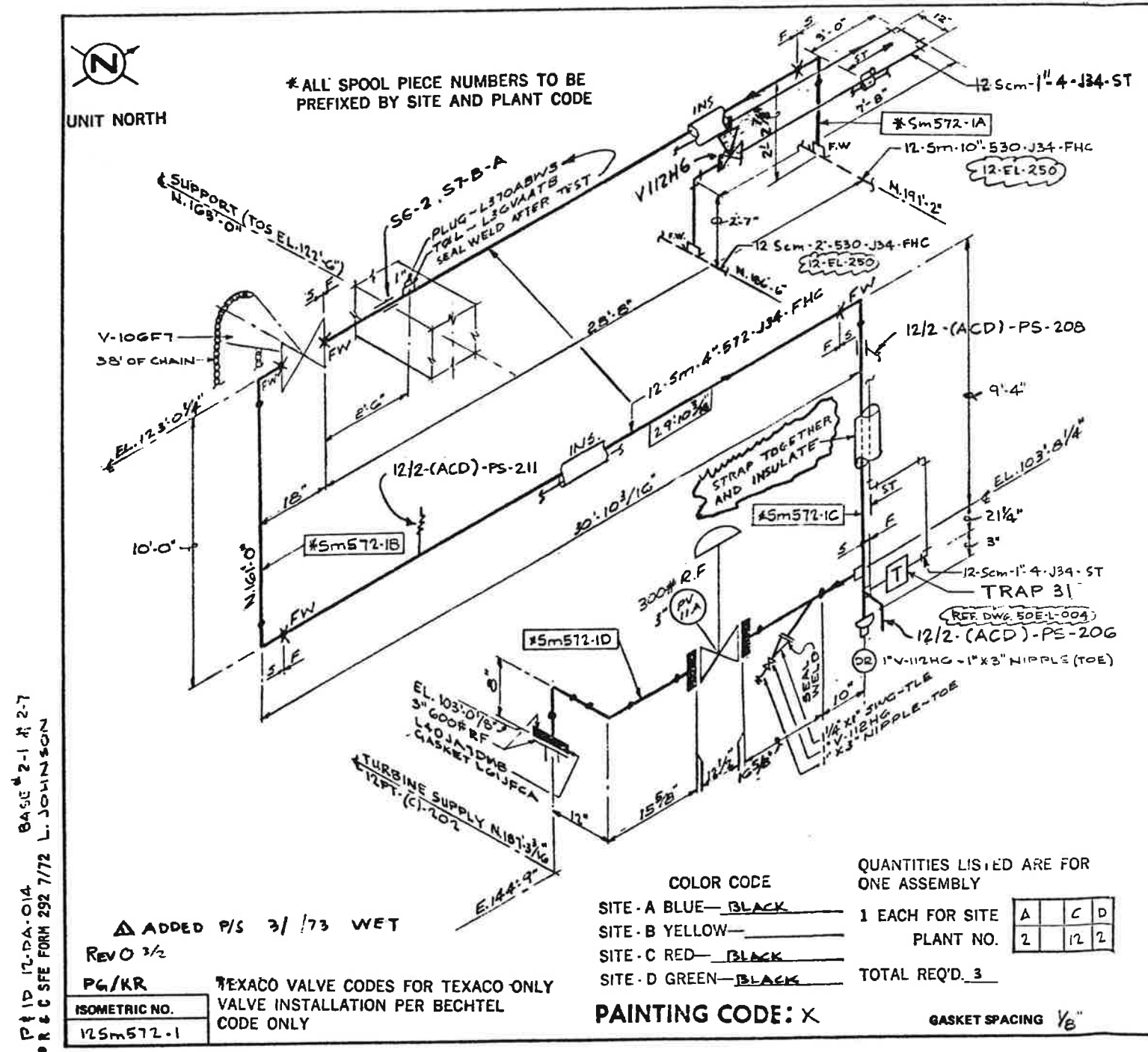
The example used highlights an actual isometric material input, utilizing generic terms and item code numbers, and lists all field and shop material.

After the material input cards are key-punched and processed, the computerized list of material (the right-hand segment) for the isometric is attached with the picture portion to be issued as the completed isometric drawing. See Figure 9-9.

PRELIMINARY & FORECAST MATERIAL PIPING TAKE-OFF														
Card No.	Card Type	JOB No.	LINE NO.	SIZE	MATERIAL CLASS	SCH	PIPE	STRAIGHT FITTINGS	VALVES	ASSEMBLIES	NON SPEC. AND SPECIALTIES ITEMS	FIRST SIZE	SECOND SIZE	Card No.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	6	196936	125M572	4	34	5	20	4	1	11	10R2, 1C, 1BRT,	40	74	1
2				4			50							2
3				3			2							3
4				1			40				1TRAP3.1,			4
5														5
6														6

ACTUAL MATERIAL PIPING TAKE-OFF														
Card No.	Card Type	JOB No.	LINE NO.	SIZE	MATERIAL CLASS	SCH	PIPE	STRAIGHT FITTINGS	VALVES	ASSEMBLIES	NON SPEC. AND SPECIALTIES ITEMS	FIRST SIZE	SECOND SIZE	Card No.
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
7	6	296936	125M572	4	34	5	20	4	1	11	10R2, 1C, 1BRT,	40	74	7
8				4			50							8
9				3			2							9
10				10			40				1-1/4			10
11				3										11
12				3										12
13				1										13
14				1										14
15				1										15
16				1										16
17				1										17
18				1										18

Figure 9-8.



LIST OF MATERIAL				DIMENSIONAL INFORMATION				REFERENCE			
CODE	DESCRIPTION / SIZE	FIELD	SHOP	FROM	TO	DISTANCE	CUT LENGTH	V. VERTICAL	PT. INSTR.		
L11EA2AB	PIPE SMLS SCH 40 CS	58	28					H. HORIZONTAL	VT. VENT		
L11GB1BB	PIPE SMLS SCH 80 CS	15						H. MITER	DR. DRAIN		
L11LB1BB	PIPE SMLS SCH 160 CS	90						—WTHREADED END			
L20FAEBA	GATE VLV 300 LB BW 40 CS 12CR TRIM	1						—BEVEL FOR WELD			
L20KA1BB	GATE VLV 800 LB SW CS 12CR TRIM	3						—PLAIN END			
L30SA0BB	ELBOW-90 3000 LB SW CS	2						—FIELD WELD			
L31SA0BB	TEE-3000 LB SW CS	1						—F BY FIELD			
L31SA0BB	TEE-RED 3000 LB SW CS	4						BOLT HOLES TO STRADDLE N/S-F/W & UNLESS NOTED			
L33SA0BB	UNION 3000 LB SW CS	2						INSULATE		X	
L34LA3JD	STRT NIPPLE SCH 160 POE/TOE CS	3						STEAM TRACE		X	
L35NA0BB	SWAGE NIPPLE XS TLE/BSE CS	1						SHOP FABRICATE		X	
L35NA10B	SWAGE NIPPLE XS BBE CS	1						FIELD FABRICATE			
L35NA10B	MISSING DESCRIPTION	1						HEAVY WALL			
L36VAATB	THREDOLET 6000 LB CS	1						ALLOY			
L36VADTB	SOCKOLET 6000 LB CS	1						PRESS			
L37SAAXB	CAP 3000 LB SCRD CS	3	2					TEMP			
L37DABVB	PLUG SCRD CS	1						WGT-EMPTY			
L40FA7DMC	FLANGE 300 LB RF WN STD WT CS	2						WGT-FULL			
L40JA7DMB	FLANGE 600 LB RF WN STD WT CS	1						ASSEMBLIES			
L50MA1BCB	ELBOW-90 LR STD WT BW CS	2						LINE NO	SIZE	CLS.	
L56NA1H0B	WELDOLET STD WT BW CS	1						12 SM	572 4	J34	
L57MA10B	CAP STD WT BW CS	1						12 SCH	4 1	J34	
L59ME1DBF	Y-STRAINER	1									
L61FFCA	1/8 SPWD GASK FOR 300 LB RF 304/ASB	2									
L61JFCA	1/8 SPWD GASK FOR 600 LB RF 304/ASB	1									
L62FMB0C	STUD BOLT A193 B7 W/2 HEX NUTS	16									
L70VDA04C	STEAM TRAP 80 CS INV BUCKET	1									
L79BJA	CHAIN FOR CHAIN OPERATOR	38									
L79BKAAA	CHAIN OPERATOR W/CHAIN GUIDE	1									
L59MA1H0B	WELDOLET STD WT BW CS	1									
	4 X 10 IN										
				NOTES AND REVISIONS							
				Δ ADDED MAT'L LIST							
								IFC			
								SUPP'T ENG			
								STRESS ENG			
								SUPERVISOR			
								CHECKER			
								BY			
								DATE			
								REV NO.			
								0 1 2			

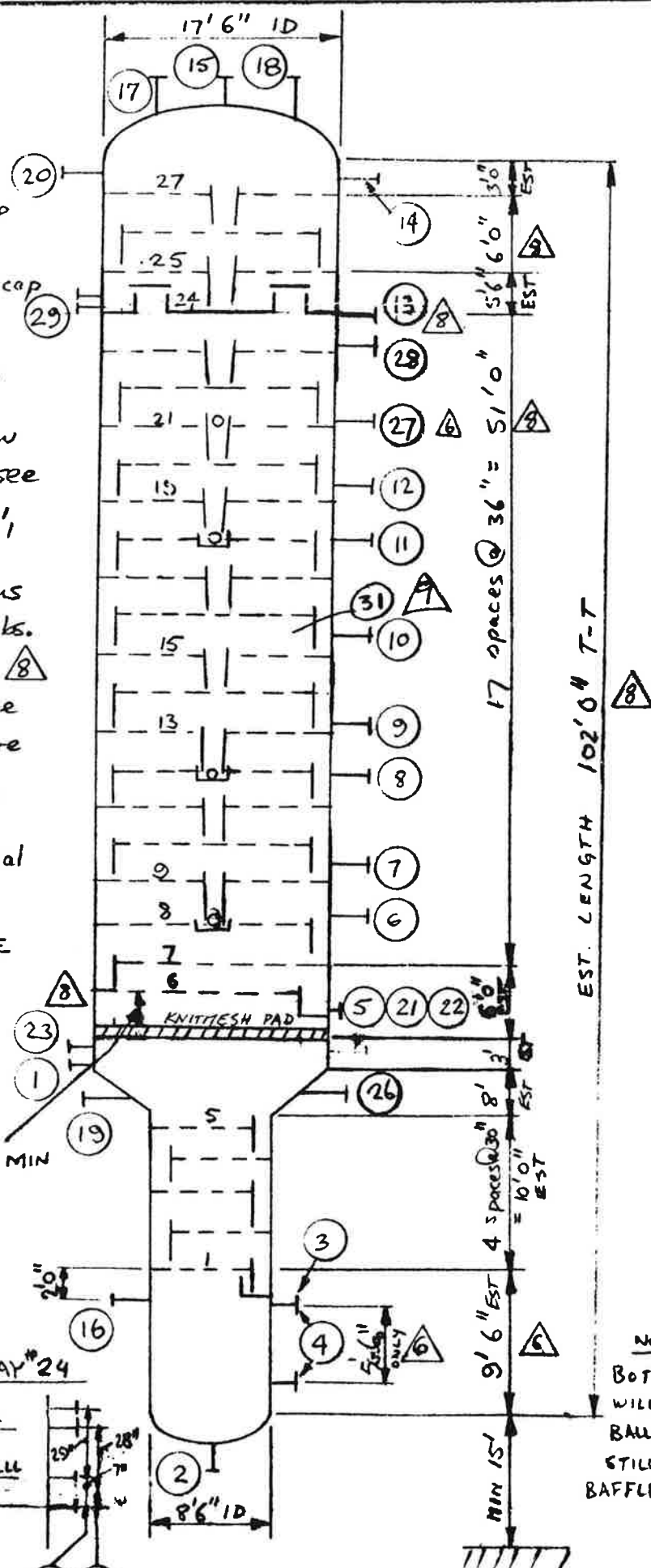
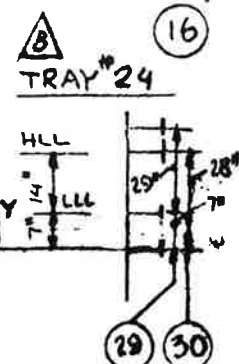
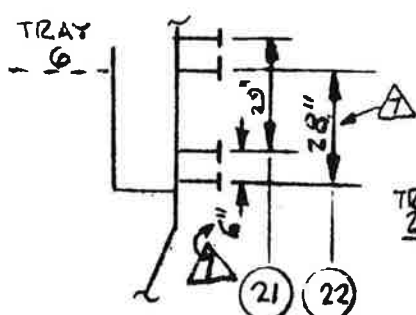
Figure 9-9.

NOTA.

1. Trays 1-5 are valve, single pass.
2. Trays 6-8 are bubblecap single pass
3. Trays 9-23, 25-27 are bubblecap two pass
4. Trays 9, 13, 19 have drawoff sumps
5. Tray 6 has total draw
6. For internal types see Bechtel standards BS01, BS02, BS03
7. Flash zone conditions 680°F & 120 mmHg abs.
8. Tray 24 is total trap
9. Tray spaces may be reduced to 30" where mechanically possible.
10. See vessel IC-251 Job 5099 for typical vapor horn nozzle.

11. KNITMESH PAD TO BE 6" THICK YORK MESH DEMISTER TYPE 931 316 SS

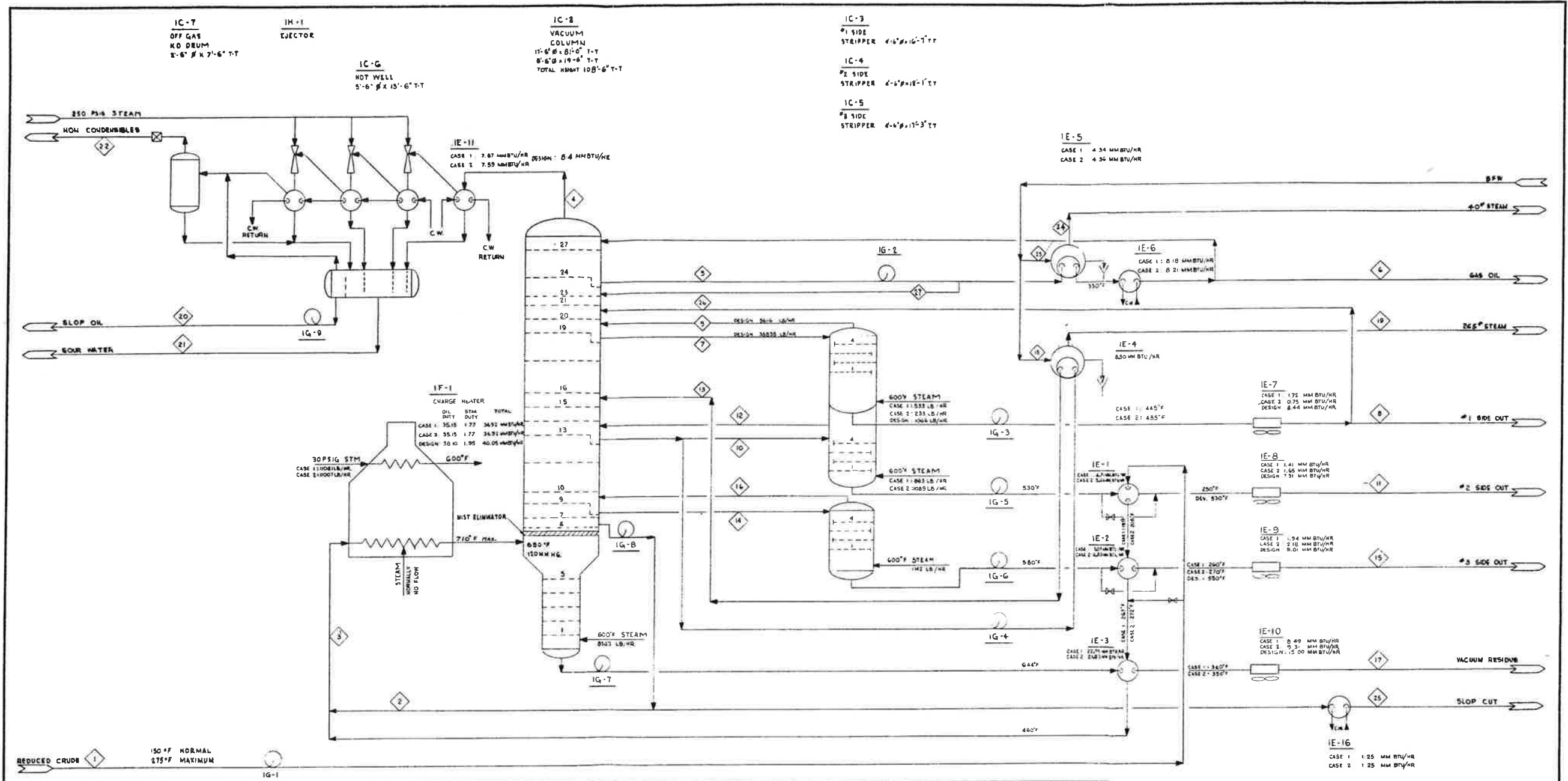
DETAIL: TRAY #6.



EST. LENGTH 102'0" T-T

NOTE
Bottom LC
WILL BE INTERNAL
BALL FLOAT TYPE
STILLING
BAFFLE REQD.

PROCESS INFORMATION		FLUID		FLOW	DENSITY	TEMP. °F		PRESS. PSIA					
				LB/HK	LB/CU. FT.	NORMAL	MAX.						
OPERATION DATA	TOP	VAPOR		12096	-	220		50					
		LIQUID		63765	52.3	120							
	BOTTOM	VAPOR		8543	-	600		140					
		LIQUID		117891	58.3	644	680						
FOR INTERNAL TRAFFIC SEE TRAY DATA SHEET													
VAPOR PRESS. @ MAX. AMBIENT TEMP. 0 PSIA 100°F													
MECHANICAL DESIGN		PRESS. MARGIN: SPEC. MIN. 25 + = 25 PSI											
		MIN. REQ'D. DESIGN PRESS AT TOP 25 PSIG ACTUAL PSIG											
		SYSTEM PSV SET AT 25* PSIG, LOCATED ON IC-2											
		MIN. OPER. TEMP. 100 °F @ 12.2 PSIA											
		EXTERNAL PRESS. DESIGN: FULL VAC. FOR: NORM. OPER.											
METALLURGY		SPECIAL REQMTS. (CODE, ETC.) CODE ONLY											
		VESSEL SUPPORT DATA: SKIRT ✓ LEGS LUGS											
		SADDLES PER DWG. C-527											
		HEIGHT 15 MIN. ABV. GR. FIRE PROOFING YES											
		PROCESS 1.31% SULFUR IN O.H. CONTAMINANTS: 3% " " BOTTOMS											
MATERIALS		COMPONENT		OTHER THAN CARBON SIL.		CORR. ALL (OTHER THAN MIN.)		SPECIAL REQUIREMENTS:					
		SHELL & HEADS		TYPE 410S CLAD		MIN CLAD THICK.		POST WELD HEAT TREATMENT (OTHER THAN CODE) FOR: NONE					
		INT'L WELD - IN		TYPE 410S		0.1" TOTAL		FOR: LETHAL SERVICE (SEE DW-2) FOR: NONE					
		REMOVABLE		TYPE 410S		NONE TOTAL							
NOZZLES		NOZZ.	SERVICE	NO.	EST. SIZE	SPEC'L. RATING	INT'L TYPE OR NOTE	NOZZ.	SERVICE	NO.	EST. SIZE	SPEC'L. RATING	INT'L TYPE OR NOTE
		31	TR LG	2	2"	RF		29	LC, LAL TRAY 24	2	1 1/2"	RF	
		22	LG IN DRAFF	2	2 1/2"	RF		23	TR (FLASH ZONE)	1 1/2	1"	RF	
		18	PSV	1	6"			19	PRC (FLASH ZONE)	1	1"		
		4	LG	2	2"		BAFFLE AT TOP INT. CEE NOTE	20	PR (TOP OF COLUMN)	1	1"		
		3	LC	1	4"			21	LC	2	2"		
		11	#1 DRAW & PUMP AROUND	4"	6			28	HOT REFLUX RETURN	4"	4"		
		10	#2 PUMP AROUND RETURN	6"				27	#1 PUMP AROUND RETURN	2"	2"		
		9	#2 STRIPPER VAPORS	14"				26	PUMP VENT INLET	2"	2"		
		8	#2 DRAW & PUMP AROUND	8"				17	VENT	4"	4"		
7	#3 STRIPPER VAPORS	12"				16	BOTTOMS STRIPPING STEAM	18"	18"				
6	#3 DRAW	4"				15	VAPORS TO PRECONDENSER	30"	30"				
5	OVER FLASH DRAW	3"			SPECIAL VORTER BREAKER VAPOR HORN	14	TOP REFLUX RETURN	4"	4"				
2	BOTTOMS	6"				13	GASOIL & TOP REFLUX DRAW	6"	6"				
1	FEED	20"				12	#1 STRIPPER VAPORS	14"	14"				
4/1/66 ADDED N 31 376-4 TRAY 24 NOW TOTAL TRAP: ADD HOT REFLUX TO TRAY 23: BELOW TRAY 6. KNITMESH PAD NOW REPLACES REV 5: PUMP AROUND RETURN ADD 2 TRAYS, ALTER RESIDENCE TIMES IN BOTTOM OF COLUMN. DESIGN BASIS ISSUED FOR JOB NO. VESSEL DESIGN DATA SHEET SERVICE UNIT VACUUM FRACTIONATOR VACUUM PROCESS INSTRUM. UNIT PROJECT VESSEL NO. 1C-2 3													



	STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
		COMPONENT	FRESH FEED	OVERFLASH RECYCLE	HEATER CHARGE	VAPOR TO ELECTROLYZ	DATA OIL DRAW	DATA OIL PRODUCT	#1 DRAW	#1 PRODUCT CITROLINA	VAPOR FROM #1 STRIPPER	#2 DRAW	#2 PRODUCT TECNOL	VAPOR FROM #2 STRIPPER	PAWPAROUND RETURN	#3 DRAW	#3 PRODUCT NEUTRO	VAPOR FROM #3 STRIPPER	BOTTOMS	BFW	2nd # STEAM	40P OIL	40W WATER	NC	BFW	40P STEAM	OVERFLASH	#1 PAWPAROUND	HOT REFLUX
CASE I	BP&D	14500	319	14819	—	1115.0	580	1395	1218	—	2293	1972	—	10539	3061	2610	—	8120	—	—	—	300(DES)	—	—	—	—	319(DES)	1218(DES)	5550
	API	17.0	22.3	17.0	—	31.5	31.5	29.3	29.3	—	26.6	26.6	—	26.6	23.0	23.0	—	10.7	—	—	—	31.0	—	—	—	—	22.3	29.3	31.5
	#/HR	20308	4260	20588	12096	141026	7346	17919	15644	2808	29943	25753	5083	197097	40667	34674	7135	117891	9434	8482	3810	3130(DES)	1015	5038	4534	4280	15644	69915	
	PSIG	—	925	717	817	—	736	847	732	848	—	722	866	—	776	718	881	—	951	942	—	869	1.0	—	942	—	892	848	736
	TEMP °F	—	—	—	—	18.6	310	310	350	350	72.4	391	391	85.5	391	461	461	91.8	—	18	—	—	—	30	16	16	406	950	170
CITROLINA TECNOL & NEUTRO PROD.	FLOW GPM	435	12	505	—	383	17	49	37	—	83	59	—	363	113	79	—	248	20	—	8.8	63	—	13	—	10	37	190	
	ACFM	—	—	—	—	81200	—	—	—	4314	—	—	5930	—	—	6900	—	—	25	—	—	210	—	—	58	—	—	—	
	TEMP °F	150	650	470	220	425	120	465	150	455	550	150	540	460	600	150	590	200	250	411	100	100	100	250	287	200	150	425	
	PSIG	50	75	50	50	60	50	71	50	71	92	50	92	10	110	50	110	50	265	265	50	50	2	40	40	50	50	5	
	STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
		COMPONENT	FRESH FEED	OVERFLASH RECYCLE	HEATER CHARGE	VAPOR TO ELECTROLYZ	DATA OIL DRAW	DATA OIL PRODUCT	#1 DRAW	#1 PRODUCT TRANSMOR	VAPOR FROM #1 STRIPPER	#2 DRAW	#2 PRODUCT	VAPOR FROM #2 STRIPPER	PAWPAROUND RETURN	#3 DRAW	#3 PRODUCT NEUTRO	VAPOR FROM #3 STRIPPER	BOTTOMS	BFW	2nd # STEAM	40P OIL	40W WATER	NC	BFW	40P STEAM	OVERFLASH	#1 PAWPAROUND	HOT REFLUX
CASE II	BP&D	14500	319	14819	—	10760	750	637	532	—	2893	2488	—	10539	3061	2610	—	8120	—	—	—	300(DES)	—	—	—	—	319(DES)	1907(DES)	5.50
	API	17.0	22.3	17.0	—	30.6	30.6	29.3	29.5	—	27.1	27.1	—	27.1	23.0	23.0	—	10.7	—	—	—	31.0	—	—	—	22.3	29.3	30.6	
	#/HR	20308	4260	20588	12012	137008	9554	8046	6813	1456	97661	32366	6385	197097	40667	34674	7135	117891	9434	8482	3810	3130(DES)	1015	5038	4534	4280	24463	65603	
	PSIG	—	925	717	817	—	743	854	736	848	—	719	863	—	755	718	881	—	951	942	—	869	1.0	—	942	—	892	848	743
	TEMP °F	—	—	—	—	18.6	320	320	345	345	87.7	383	383	84.4	383	461	461	91.8	—	18	18	—	—	30	16	16	506	950	170
TRANSMOR MADOR & NEUTRO PROD.	FLOW GPM	435	12	505	—	968	22	22	16	—	105	75	—	363	113	79	—	248	20	—	8.8	63	—	13	—	10	38	126	
	ACFM	—	—	—	—	80700	—	—	—	1986	—	—	7620	—	—	6900	—	—	25	—	—	210	—	—	58	—	—	—	
	TEMP °F	150	650	470	220	425	120	455	150	445	550	150	540	460	600	150	590	200	250	411	100	100	100	250	287	200	150	425	
	PSIG	50	75	50	50	60	50	71	50	71	92	50	92	10	110	50	110	50	265	265	50	50	2	40	40	50	50	5	

THE PRESENTED CONDITIONS OF FLOW, QUANTITIES, TEMPERATURES, PRESSURES, COMPOSITIONS AND VISCOSITIES, AND DESIGN DATA, WERE OBTAINED FROM THE PROCESS DESIGN AND ARE FOR DESIGN PURPOSES ONLY. AND WHILE USUALLY CORRECT IN OPERATION, AND NOT NECESSARILY EXACT OR GUARANTEED OPERATING CONDITIONS.

- NOTES: 1 EXCHANGERS IE-6 & IE-8 ARE OVERSIZED TO ALLOW FOR HOT FEED
- 2 REVISION 1: ADD: DRAINER PAD, 2 TRAYS FOR INTERMEDIATE REFLUX ABOVE TRAY 19, IE-16. REPLACE PRODUCT AIR COOLERS WITH TEMPERED WATER COOLERS. REVISE IE-5 TO STEAM GENERATOR ADDED STREAM 26
- 3 REVISION 3: MIST ELIMINATOR NOW BELOW TRAY 6, TRAY 14 TOTAL DRAIN TRAY, AND HOT REFLUX TO TRAY 11, BELLE IE-10, IC-1, INCREASE HEIGHT IC-2 TO 108'-6" IC-5 TO 17'-3" PRODUCT COOLERS REVISED TO AIR COOLERS.