PLAINTIFF'S EXHIBIT

CHV-670

II. PROCESS REQUIREMENTS

SECTION II - PROCESS SPECIFICATIONS

A - GENERAL

II-A-1.0 SCOPE

1.01 This specification covers all process equipment for the catalytic section of a 11,500 BPOD modified Houdriflow catalytic cracking plant with mechanical catalyst elevators to be installed at the El Paso Refinery of the Standard Oil Company of Texas. Hydrocarbon processing equipment includes only the feed preheating furnace through the reactor. The feed preparation equipment, synthetic crude column, and gas recovery plant are not included.

II-A-2.0 OBJECTIVE

2.01 The general objective of this unit is to convert heavy straight run gas oil from West Texas crudes into high quality gasoline, a C_3-C_4 fraction, and a minimum of fuel oil components.

II-A-3.0 DESIGN BASIS

3.01 The catalytic cracking plant shall be designed for the following two cases:

Case 1: 5750 BPOD fresh gas oil feed
5750 BPOD recycle
80.7 volume percent conversion (based on 365°F at 90% gasoline)
Coke deposition 8500 lbs/operating hour

Case 2: 8300 BPOD fresh gas oil feed
3200 BPOD recycle
71.9 volume percent conversion (based on 365°F at 90% gasoline)
Coke deposition 8500 lbs/operating hour

Feed stock inspections and approximate stock balances are shown in Table 1.

Coke deposit throughout the specification refers to actual coke laid down on the catalyst including allowance for actual hydrogen contained in the coke and in which sulfur included in the coke is expressed as equivalent carbon.

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3.02 The stock balance shown for Case 1 is based on the results of pilot plant work by the Houdry Process Corporation. The stock balance for Case 2 is COMPANY'S estimate for this operation. CONTRACTOR shall state yields to be guaranteed for Case 1. Yields for Case 2 need not be guaranteed, but unit shall be designed to operate for both Case 1 and Case 2.

II-A-4.0 PRODUCT SPECIFICATIONS

4.01 Specifications for light and heavy catalytically cracked gasolines are given in Table 2.

II-A-5.0 FLEXIBILITY

5.01 Although design conditions are as specified herein, it is expected that the equipment offered by CONTRACTOR will have reasonable flexibility. If additional useful flexibility can be provided at nominal cost (such as installing a larger pump), CONTRACTOR should so indicate, giving the approximate cost thereof.

5.02 In a unit of this type there may be items of equipment whose loads may change quite rapidly with changes in operating variables. (For example, steam generating systems for cooling catalyst in the kilns may be sensitive to the over-all heat balance of the unit.) It is expected that in such cases CONTRACTOR will exercise his judgment based on experience with previous plants to provide adequate equipment.

B - PLANT LIMIT CONDITIONS

II-B-1.0 FEED STOCK

1.01 Combined fresh and recycle gas oil feed to the preheating furnace will be supplied by COMPANY at 500°F. CONTRACTOR shall specify pressure required to get through furnace and into reactor.

C - PROCESS INFORMATION AND GUARANTEES REQUIRED FROM CONTRACTOR

II-C-1.0 INFORMATION

CONTRACTOR shall supply the following information:

1.01 Complete process flow diagram showing operating conditions, sizes of equipment, etc. In addition, a piping and instrument diagram is required in accordance with Section V-A-7.01.

1.02 Complete heat and material summaries including quantity, temperature, pressures, enthalpy, and characteristics of all major streams and a summary of yields of all products.

1.03 Sizes, duties, capacities, pressure, and temperature ratings of all principal process equipment.

1.05 Presentation of comparative studies made to arrive at major design decisions.

II-C-2.0 GUARANTEES

CONTRACTOR shall guarantee the following:

2.01 Plant capacity and yields in the reaction mix from the reactor of debutanized gasolines, C_3-C_4 components, light and heavy catalytic gas oils, dry gas, and total C_4 plus content. Octane numbers of gasolines, clear and with 3 ml. of TEL.

2.02 That the gasoline when recovered from reaction mix will meet specifications for gum and stability shown on Table 2 without further treatment other than caustic washing, lead sulfide sweetening, and addition of inhibitor.

2.03 Coke burning capacity adequate to assure design yields and also a minimum coke burning capacity of 8500 lbs per operating hour.

2.04 Catalyst circulation and catalyst consumption to maintain equilibrium activity on which yield guarantees are based as well as makeup for mechanical losses.

2.05 Catalyst circulation rate and temperature suitable for maintaining heat balance on the unit and coke burning capacity of the kiln.

2.06 Normal dust content of the regeneration gas vented to atmosphere.

2.07 Total utility cost using incremental unit costs shown on the Basic Design Data GT-E-4546.

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Details of final guarantee will be agreed upon by COMPANY and CONTRACTOR and will be set forth in a separate document of agreement.

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TABLE I

EL PASO REFINERY EXPANSION PROGRAM

PRELIMINARY CATALYTIC CRACKING STOCK BALANCE

Source of Fresh Feed		Case 1 Blend of heavy gas oils from Yates, Texas-New Mexico, and Porterville-Tunstill crudes	Case 2
Feed Rates			
Fresh Feed, BPOD		5,750	8,300
Recycle, BPOD		5,750	3,200
Fresh Feed Properties			
Gravity, °API		22.4	26.0
Viscosity, SSU at 130°F		211	69
Sulfur, Wt. %		1.34	1.25
Distillation, °F (Vacuum Assay)			
10%		742	575
50%		881	810
90%		1,056	1,025
Recycle Gas Oil Properties			
Gravity, °API		14.0	13.0
Viscosity, SSU at 130°F		35.1	37.0
Distillation, °F. (Vacuum Assay)			
10%		470	500
50%		590	625
90%		710	710
Conversion - Vol. %		80.7	71.9
Yield - Fresh Feed Basis			
Hydrogen	Wt. %	0.2	0.2
Hydrogen Sulfide	"	1.1	1.0
Methane	"	1.0	1.0
Ethylene	"	0.5	0.5
Ethane	"	1.1	1.0
Propylene	"	2.7	2.4
Propane	"	2.1	1.9
Isobutane	Vol. %	9.4	9.4
Butylenes	"	5.2	4.8
n-Butane	"	2.2	2.2
Debut. Gasoline (365°F at 90%)	Vol. %	59.7	51.1
Light Cat. Gas Oil	"	12.0	21.2
Syn. Crude Tower Bottoms	"	7.3	6.9
Coke - Lbs./oper. hr.		8,500	8,500

Notes: (1) Average reactor temperature in both cases 875°F

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TABLE 2

EL PASO REFINERY EXPANSION PROGRAM

SPECIFICATIONS REQUIRED FOR
LIGHT AND HEAVY CATALYTIC CRACKED GASOLINES

Required Specifications	Light Gasoline	Heavy Gasoline
ASTM Dist. °F. Max.		
90%	325	365(2)
E.P.	-	-
Copper Strip (ASTM D-130.30 except Run at 150°F.)	OK	OK
Stability Tests (1)		
Induction Period Hrs. (ASTM D-526-46)	6+	6+
Gum after 5 hr. induction, mg. (ASTM D-381-46)	12 max.	12 max.
Cu dish gum, mgs. (FSS 330.11)	20 max.	20 max.
Color, Saybolt (ASTM D-156-38)	+12 min.	+12 min.
Octanes (Pilot Unit Results)		
F-1 Clear	90.3	89.8
F-1 +3 cc TEL	97.7	97.1
F-2 Clear	79.9	79.7
F-2 +3 cc TEL	87.4	86.8

Notes: (1) To be determined after caustic washing, PbS sweetening and addition of 3.0 cc TEL/Gal. and 30 Lbs. U.O.P. No. 5 inhibitor/1000 Bbls.

(2) Light and heavy gasolines to make 365°F. at 90% when blended together. All inspections refer to whole gasoline of 365°F. at 90% point.

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III. PERFORMANCE OF WORK

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SECTION III - PERFORMANCE OF WORK

A - DESIGNS

III-A-1.0 COMPANY REPRESENTATIVE

1.01 COMPANY will send a representative to CONTRACTOR'S design office to review and approve designs and specifications of process equipment or material to see that they conform to the proposal. COMPANY representative shall develop procedures for handling correspondence, approval of material orders, equipment quotation analyses, approval of drawings, schedules, and other administrative or engineering aspects of work to the satisfaction of COMPANY.

1.02 Approval by COMPANY representative shall in no way relieve CONTRACTOR from sole responsibility for plant design and construction.

III-A-2.0 DRAWINGS, DESIGNS, AND SPECIFICATIONS

2.01 During the design and construction period, CONTRACTOR shall currently furnish COMPANY with four prints of each drawing and Engineering or Construction Specifications as completed. In addition, preliminary prints shall be furnished periodically as directed by COMPANY representative to inform COMPANY regarding work in progress.

2.02 After construction CONTRACTOR shall revise all drawings to agree with actual installation except that minor construction drawings such as piping spools, structural details, and small foundations need not be revised.

2.03 All process and engineering designs, drawings, and specifications which CONTRACTOR prepares or causes to be prepared hereunder shall become the property of COMPANY; and the originals thereof, together with copies of process and engineering designs, drawings, and specifications prepared and delivered to CONTRACTOR by COMPANY, shall be delivered to COMPANY upon completion of the payments provided in the contract, or upon termination of the contract. CONTRACTOR shall identify by a special stamp or legend those drawings prepared by CONTRACTOR covering special equipment on which CONTRACTOR or party for whom CONTRACTOR is a representative holds Letters Patent, and COMPANY agrees that these shall not be used directly or indirectly by COMPANY to reproduce the articles covered by such drawings, without prior approval of CONTRACTOR or party specified above.

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2.04 All new drawings shall be prepared on COMPANY'S standard drawing sheets; necessary sheets will be supplied by COMPANY. Drawing numbers shall be assigned from a block of numbers to be specified by COMPANY. CONTRACTOR'S existing drawings, if any, may be used, but COMPANY drawing numbers and title block shall be added. CONTRACTOR may use his own drawing numbers in addition to COMPANY numbers if he so desires. Drawings shall be indexed in accordance with COMPANY practice.

III-A-3.0 PROVISIONS FOR SPARE PARTS

3.01 Spare Parts Lists - Requests for quotations on such spare parts as may be reasonably required shall be included by CONTRACTOR in his requests for bids on equipment. These are to be priced separately from the equipment to which they pertain, and are not to be included in the basic plant quotation. CONTRACTOR shall recommend which of these spare parts should be ordered and what quantities should be stocked.

3.02 Consolidated Spare Parts Lists - Certain spare parts such as tubes for heat exchangers, valves, instruments, motors, and ball bearings which are similar to items in common use in other portions of the Refinery, and which in general are not made directly by the supplier of the equipment concerned, may be ordered by COMPANY as part of its own program of consolidated spare parts for the entire Refinery. CONTRACTOR need not obtain quotations on these spares but shall make recommendations on quantities and specifications to COMPANY'S representative.

3.03 Construction Spare Parts - Spare parts mentioned above for protection of operation will not include any construction spare parts deemed necessary by CONTRACTOR to provide for possible breakage during construction. Such construction spares or extras are to be included in the contract price. Any remaining construction spare parts not required during the construction period may be credited to the job at COMPANY'S option.

III-A-4.0 SCHEDULE OF DESIGN AND CONSTRUCTION

4.01 Within three weeks after the award of the contract CONTRACTOR shall prepare a schedule indicating time in weeks after notification of award of contract the start and completion of all phases of the work including design, material ordering, construction, startup, acceptance tests, and preparation of plant records, maintenance material lists, and spare parts

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requisitions. Thereafter CONTRACTOR shall submit monthly progress reports covering engineering, drafting, material ordering, material delivery, and field construction work; reports should include a description of the month's work and should state the percent completion and expected final completion date of each phase of the work.

4.02 COMPANY desires that plant be completed and turned over to COMPANY by May 1, 1952, for acceptance tests as covered in Section III-D-1.0.

III-A-5.0 LOCAL VENDERS

5.01 Where economical, COMPANY prefers that CONTRACTOR purchase from local suppliers and sub-contractors. COMPANY will supply a list of local venders to be included on bidding lists. CONTRACTOR'S purchases shall not necessarily be restricted to suppliers on this list.

B - CONSTRUCTION

III-B-1.0 GENERAL CONDITIONS

1.01 Work Space, Storage Area, Rail Spurs, and Access Roads - A portion of the areas indicated on the attached plant layout will be available to CONTRACTOR for work space and storage. Rail spurs and access roads are shown on the same diagram. Refer to COMPANY Drawing GT-2948 for these areas.

Permanent refinery roads suitable for conveyance of heavy and large equipment will be provided by COMPANY prior to start of construction. Access will be through the refinery construction gate. COMPANY will provide parking areas for CONTRACTOR'S employees.

1.02 Construction Buildings - New sales buildings will be erected by others prior to the Plant construction period. These will consist of 24,500 square feet of warehouse facilities, including lighting, heating, and plumbing facilities (see Drawing GT-2948). The warehouse will be serviced by a railroad spur, oiled driveways and area lighting. A portion of these facilities will be turned over to the CONTRACTOR to satisfy his requirements for an office, small tools storage and small construction item storage. CONTRACTOR shall specify what his requirements will be during the construction period. It is contemplated that these facilities will serve for CONTRACTOR'S field office and warehousing facilities without further expense by CONTRACTOR except

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possibly for additional internal partitions. The CONTRACTOR shall erect all other offices, warehouses, weldshops, toilets, change rooms, and other facilities necessary for purposes of construction and located in the vicinity of the plant area. The CONTRACTOR shall remove all such buildings and facilities upon completion of the work. In his bid, CONTRACTOR shall specify the size, number, and type of any additional buildings he proposes to erect.

1.03 Sub-Contractors - COMPANY may choose to list acceptable sub-contractors to be included among bidders on sub-contracted work. In all instances sub-contractors shall be approved by COMPANY.

1.04 Concrete - Satisfactory ready-mix concrete is available locally.

1.05 Safety Orders - CONTRACTOR shall comply with all pertinent safety orders, and shall familiarize himself with COMPANY safety regulations.

1.06 Refinery Rules and Safety Precautions - CONTRACTOR shall take all reasonable precautions to protect the work, workmen and the public; and shall provide, where necessary, barriers, guards, temporary bridges, lights, and watchmen. Where work is done on COMPANY'S premises, all of COMPANY'S safety rules shall be strictly observed and smoking shall be limited to such locations and occasions as are specifically authorized by COMPANY. CONTRACTOR shall not, without prior written consent of COMPANY, perform or permit any work hereunder or in connection with this agreement while on the premises of COMPANY which involves a fire or explosion hazard, including welding, torch cutting, and disposal of debris by burning.

1.07 COMPANY Construction Representative - COMPANY will maintain construction representatives in the field to perform the following functions:

(a) Establish field liaison between CONTRACTOR and COMPANY
(b) Review progress of construction
(c) Inspect facilities during construction
(d) Represent COMPANY in matters pertaining to construction quality and accounting practices.

1.08 CONTRACTOR'S Construction Representative - CONTRACTOR shall maintain construction representatives in the field to perform the following functions:

(a) Establish field liaison between CONTRACTOR and COMPANY
(b) Represent CONTRACTOR in matters pertaining to construction quality and accounting practice.
(c) Represent CONTRACTOR during startup and acceptance test

3.08 CONTRACTOR shall arrange for welding tests in accordance with American Welding Society Standard Qualification Procedure B-3.0-41T, dated April 1941. Welders shall be required to pass the tests before performing any operation during the construction of the project. COMPANY reserves the right to require additional tests during construction if there is doubt about the competence of the welders.

3.09 CONTRACTOR shall check the type of packing and shall repack, if necessary, the stems of valves and shafts of pumps.

3.10 CONTRACTOR shall perform hydrostatic tests on all equipment and lines after erection, as designated on CONTRACTOR'S drawings and specifications. All hydrostatic tests will be witnessed by a COMPANY representative. CONTRACTOR shall furnish test pump and gages for use in hydrostatic testing. Refer to Section V-S for details of hydrostatic tests required.

3.11 CONTRACTOR shall correct all defects revealed by any test or inspection. Where the defect is due to negligence of CONTRACTOR, the cost of correction shall be borne by CONTRACTOR and shall not be included in the "Cost of the Work" as defined in the Contract.

III-B-4.0 PURCHASE AND HANDLING OF MATERIALS AND EQUIPMENT

4.01 CONTRACTOR shall purchase all material.

4.02 CONTRACTOR shall supply the necessary expediting service.

4.03 CONTRACTOR shall provide all transportation of materials and equipment including loading, unloading, and transportation to the site of the plant.

4.04 CONTRACTOR shall receive, unload, and tally all materials and equipment at the site of the plant.

4.05 CONTRACTOR shall arrange for the prompt unloading of all materials received outside the allotted storage area.

III-B-5.0 CLEANUP

5.01 Prior to completion of work CONTRACTOR shall remove all excess materials, debris, and construction waste from the plant construction and storage sites, and leave the plant in a neat and orderly condition. Disposal of materials, debris, and waste shall be in accordance with COMPANY instructions.

C - START-UP

III-C-1.0 START-UP

1.01 Upon completion of construction COMPANY will inspect the Plant for conformance to contract specifications with respect to mechanical design, safety, and physical aspects

as they pertain to operability. When the Plant meets these requirements COMPANY will so indicate by a written memorandum to CONTRACTOR. The acceptance of the workmanship and construction constitutes agreement that COMPANY is willing to initiate processing operations in order to determine if Plant fulfills CONTRACTOR'S warranties and guarantees, and shall in no way relieve CONTRACTOR of his obligations relative to warranties. Operation of the Plant prior to performance acceptance by COMPANY and while not making test runs shall be under the control and direction of COMPANY, but shall be in accordance with a procedure to be agreed upon with CONTRACTOR and in the presence of CONTRACTOR'S representatives. Upon CONTRACTOR'S request, and at COMPANY'S convenience, COMPANY shall operate the Plant during such periods on the specified charge stock and under conditions as agreed upon so as to determine whether the Plant may fulfill the operating guarantees during a test run, or what adjustments, if any, might be necessary to enable the Plant to make a successful test run.

1.02 CONTRACTOR shall schedule work so that acceptance of the Plant as specified above will be accomplished on or prior to the date for completion of work as stated elsewhere.

1.03 CONTRACTOR shall maintain an adequate qualified engineering staff at the Plant during startup and for a period of 30 operating days thereafter. "Startup" will be interpreted to be in the initial introduction of oil into the Plant. This service shall be included in the contract price.

III-C-2.0 TRAINING OF OPERATORS

2.01 COMPANY may require from the CONTRACTOR qualified personnel to assist in training operators. The expense of such services shall not be included in the contract price.

D - ACCEPTANCE

III-D-1.0 ACCEPTANCE TESTS

1.01 After completion of construction, as defined above, and within 45 operating days (not including shutdown time) after COMPANY has received CONTRACTOR'S written request for a test run, COMPANY shall commence a test run on the plant for the purpose of establishing the ability of the plant to meet the operating guarantees, and COMPANY shall notify CONTRACTOR in writing of the date of starting such test run.

1.02 If the plant meets the operating guarantees on the first test run, it shall forthwith be accepted in writing by COMPANY, but if it does not meet such operating guarantees then, during the 180 calendar day period immediately subsequent to the date of the start of the first test run, or until a test run shall demonstrate the ability of the plant to meet the operating guarantee, whichever shall first occur, COMPANY shall make the plant available to CONTRACTOR on 30 days written notice from CONTRACTOR for making such alterations and additions thereto as CONTRACTOR may desire to make to enable the plant to make a successful test run; provided however that, if COMPANY elects not to shut down the plant for such alterations and additions as requested by CONTRACTOR, COMPANY shall negotiate a settlement with CONTRACTOR.

Acceptance by COMPANY after the test run shall not relieve CONTRACTOR of liability for failure of unit to run at design rates for a period of six months before the first cleaning shutdown.

The cost to CONTRACTOR of making such alterations and additions to plant as CONTRACTOR may desire to make in an attempt to enable the plant to meet guarantees shall be chargeable to COMPANY to the extent provided in the definitions of "Cost of the Work," as defined in the Contract.

1.03 All test runs shall be conducted under the conditions set forth in the guarantees and in accordance with CONTRACTOR'S instructions and under the direction of CONTRACTOR'S engineers, such instructions to be in accordance with mutually acceptable operating practices and conditions. A test run shall comprise 15 consecutive days of operation of the plant and all data shall be averaged over this 15-day period; provided that interruptions to a test run shall be allowed as follows:

(a) Interruptions to a test run for minor alterations or repairs shall be allowed, not to exceed 24 hours each, and the time of the test run period shall be extended by the time of such interruptions.

(b) If the interruptions are caused by failure of charging stock, utility supply or other conditions beyond reasonable control, and do not exceed 5 days, the test run shall proceed promptly after allowing a reasonable period for leveling out of conditions. The sum of normal operating periods before, between and after such interruptions shall be considered as the required test period when it totals 15 operating days.

(c) Periods of unstable operation beyond CONTRACTOR'S reasonable control shall not exceed 5 operating days during a test run.

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E - WARRANTY

III-E-1.0 PROCESS GUARANTEES

It is the intent of COMPANY, under this specification, to purchase a unit that will operate at design rates for periods of at least six months without shutdown. In recognition of this principle CONTRACTOR shall guarantee (in addition to the guarantees itemized in Section II):

1.01 That the unit will operate at design feed rate and yield, as specified in Section II, for periods of at least six months. CONTRACTOR shall not, however, be liable for failure to run six months except where such failure can be shown to result from design deficiencies.

1.02 That the furnace will not limit the operation of the unit. CONTRACTOR shall be liable for necessary corrections where unsatisfactory operation of the furnace can be demonstrated to be due to flame impingement, poor distribution either of fluids in the tubes or heat density or other design factors.

1.03 That the product streams will be delivered to the plot limits at pressures and at temperatures specified on the Basic Design Data.

1.04 That the utilities consumed will not exceed and utilities produced will not be less than the quantities shown on EF-244 submitted with the CONTRACTOR'S proposal in response to the request for bids.

III-E-2.0 MECHANICAL GUARANTEE

2.01 CONTRACTOR shall guarantee the plant free of defects in design, materials, equipment, or workmanship for a period of one year after acceptance by COMPANY in accordance with paragraph III-C-1.01. Any equipment or materials found to be defective as evidenced by mechanical failure, excessive vibration, or excessive erosion within the period of one year's operation shall be replaced (including installation) at the mutual convenience of COMPANY and CONTRACTOR by CONTRACTOR and at CONTRACTOR'S expense with equipment that is satisfactory for one year's operation.

2.02 CONTRACTOR'S liability by reason of defective materials, operating equipment or workmanship shall be limited to the obligation to repair or replace such defective materials, operating equipment or work to the extent provided herein including installation, and there shall be no liability unless CONTRACTOR is notified and given an opportunity to inspect and repair or replace such defective materials, operating equipment or work.

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2.03 CONTRACTOR shall endeavor to obtain mechanical guarantees from vendors for periods of one year after initial operation of equipment.

III-E-3.0 DESIGN GUARANTEE

3.01 The CONTRACTOR shall guarantee to accept full process design and plant design responsibility.

F - INFORMATION REQUIRED FROM CONTRACTOR

III-F-1.0 INFORMATION REQUIRED IN BID

1.01 Indicate extent and organization of technical assistance to be furnished in accordance with paragraph III-C-1.03 above.

1.02 Indicate daily fee for qualified personnel COMPANY may require in accordance with paragraph III-C-2.01 above.

IV. ACCOUNTING REQUIREMENTS

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SECTION IV - BASIS OF CONTRACT AND ACCOUNTING REQUIREMENTS

A - BASIS OF CONTRACT

IV-A-1.0 CHARGES

1.01 The purpose of this section of the specification is to present the general basis for CONTRACTOR'S proposal and to convey the general COMPANY intent. This section will be revised at a later date and the contents incorporated into the contract.

1.02 All charges shall be assigned to one of three categories.

(a) Those charges which are fixed with the execution of the contract. These will be referred to herein as "Lump-Sum Items."

(b) Those charges which are fixed as to unit rate at the time of the execution of the contract, but on which an escalation will be allowed. These will be referred to herein as "Charges Subject to Escalation."

(c) Those charges for which COMPANY will pay the cost at the time the purchase price is agreed upon. These will be referred to as "Cost Items."

1.03 Lump-Sum Items shall consist of:

(a) CONTRACTOR'S Fee. This shall be CONTRACTOR'S (including his subcontractor's) entire compensation for profit, overhead, salaries and expenses of CONTRACTOR'S officers, executives and all members of CONTRACTOR'S off-job office forces for services normally incidental to the administration of an engineering and construction project (including the time and expenses of members of CONTRACTOR'S organization inspecting the work at the site, who are not engaged exclusively on the work for the entire job); said compensation shall include, without being limited to these items, the following:

Cost of maintaining CONTRACTOR'S home office, attorneys' fees, premiums on any insurance CONTRACTOR may elect to carry covering legal and contractual obligations or any costs or payments made by CONTRACTOR in compliance with the provisions of the liability provisions of the Contract. Such losses or damages shall be borne by CONTRACTOR.

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No change or adjustment shall be made in this Fee on account of changes in costs or prices or conditions of construction, unless it is agreed by both CONTRACTOR and COMPANY that a material change in the scope of the work has been made.

(b) Engineering and Drafting performed in CONTRACTOR'S offices (or those of his subcontractor) or in the field. Engineering and Drafting is to be interpreted as to apply to all labor required to present complete construction drawings and details to the field for fabrication and erection. This shall include all charges for overhead, State and Federal payroll taxes, and employees benefits.

(c) Supervision. This shall include adequate supervision during all phases of design, engineering and construction, including construction superintendent, and other field supervisors and engineers.

(d) Material purchasing, inspection, and expediting. This shall include all charges assignable to materials purchasing, inspection and expediting required to meet the requirements of this specification and the schedule agreed to by CONTRACTOR and COMPANY. This shall include all charges for overhead, payroll taxes, employees benefits and payments to Workmen's Compensation Fund.

(e) Field office expense. This shall include the cost of erecting, or installing CONTRACTOR'S field office, including installation and rental of office furniture and equipment, typewriters, adding machines, etc., and purchase of office supplies in connection with this work. This shall also include charges for dismantling at the completion of the project and the expense of leaving the area in an orderly fashion. This will include the wages and salaries of accountants, materials men, inspectors, etc., as required to properly conduct the work. There is to be no escalation on the wages of individuals of the field office staff.

(f) Subsistance and Travel Expense. This shall include all subsistance, travel allowances, expense and other benefits paid to any person on CONTRACTOR'S payroll, or on the payroll of his subcontractors or the expenses of any person or persons to whom the CONTRACTOR may engage for services.

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(g) Equipment Rental. This shall include charges for construction equipment owned by CONTRACTOR or rented from others. This shall include the cost of moving it to the site, and return. The rental "lump sum" shall include the cost of all repair work, the costs of gasoline or other fuel, lubricants, operating labor and "down time" required to accomplish any repair work.

(h) Tools Charge. This shall include the cost of all tools both recoverable and nonrecoverable, and shall include all consumable tools such as wire brushes, chisels, goggles, etc.

(i) Permits, Licenses, etc. This shall include amounts paid by CONTRACTOR for all necessary permits, licenses, cost of process designs, process licenses, fees or deposits necessitated by the design or construction work and for premiums or insurance required or occasioned by the work.

(j) Construction Utilities. This shall include all power, lighting, water, fuel, etc., consumed by CONTRACTOR during the construction period. In addition, it shall include all charges for communications.

(k) All other costs not clearly falling in paragraphs 1.04 and 1.05.

1.04 Charges Subject to Escalation shall consist of:

(a) Direct Field Labor of individuals engaged exclusively in the work. The extent of escalation allowed shall be the difference between the hourly craft rate at the time of the performance of the direct field labor and the hourly craft rate stated in the Contract. The man-hour requirement for direct field labor shall not be escalated. Therefore, the Contract will include both "straight-time" manpower requirement and "overtime" manpower requirement for all crafts. Craft rates are not to include overhead, profit, or any of those items listed in 1.02 (b).

Rates in all cases shall include taxes and payments to the Workmen's Compensation Fund as an addition. Craft Foremen will be considered to fall within the category of direct labor but the field office staff and field supervision will not.

1.05 Cost Items shall include:

(a) The cost of materials. This shall consist of the net amounts paid by CONTRACTOR to vendors of material purchased for the work herein. These amounts shall allow COMPANY all discounts for quantity purchases, immediate payment, or other discounts available to CONTRACTOR, and including any sales or use tax CONTRACTOR is required to pay thereon. This shall include freight charges f.o.b. cars at plant site.

IV-A-2.0 INFORMATION TO BE SUBMITTED WITH PROPOSAL

2.01 CONTRACTOR shall itemize in detail his labor forecast for the entire job. This is to include straight-time and overtime required of each craftsman and foreman together with their hourly rate. This, then, after COMPANY review will become a part of the Contract, as outlined in paragraph IV-A-1.03, and will be the basis on which escalation will be allowed.

B - ACCOUNTING REQUIREMENTS

IV-B-1.0 COST CONTROL

1.01 Accounting Records - CONTRACTOR shall maintain adequate accounting records during progress of the work to submit monthly cost control statements in conformity with the attached sample form EF-335 entitled "Expenditure Control Statement." Costs shall be broken down essentially in accordance with the sample item list EF-294 attached. Final item lists will be supplied by COMPANY prior to accumulation of charges. The cost records shall be maintained in such form as to permit COMPANY'S investigation of all items in order to insure that they have been placed in the proper category.

1.02 CONTRACTOR shall provide all reasonable assistance and facilities for the conveniences of COMPANY representatives in checking CONTRACTOR'S accounting procedures and in auditing CONTRACTOR'S records during the course of work and after its completion.

1.03 In addition to preparation of monthly cost control statement called for in 1.01 above, CONTRACTOR shall estimate each month the amount of his billings to the COMPANY by month for the next three months.

V. PLANT DESIGN

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SECTION V - PLANT DESIGN REQUIREMENTS

A - GENERAL

V-A-1.0 SCOPE

This section covers COMPANY preferences and normal practices applying to the design and selection of equipment and facilities required in the plant.

V-A-2.0 RESPONSIBILITY FOR DESIGN

2.01 CONTRACTOR shall be solely responsible for the adequacy of the design of all equipment and facilities required for the plant including but not limited to the following:

(a) Adequacy to meet process specifications as described in Section II.

(b) Conformance to applicable local and state codes and ordinances. Where more than one code and/or specification applies, the most stringent provision shall govern. Codes and specifications listed hereunder are not necessarily governing.

(c) Conformance to requirements of the agreed specification.

(d) Conformance to COMPANY'S Basic Engineering Design Data GT-E-4546.

(e) Sound and economic engineering design for all portions of the plant.

2.02 CONTRACTOR shall not be responsible for the validity of process design data furnished by COMPANY.

V-A-3.0 ECONOMIC CONSIDERATIONS ON SELECTION OF EQUIPMENT

3.01 Where operating, maintenance, or replacement savings are possible by the economic selection of equipment or facilities, CONTRACTOR shall provide equipment or facilities such that the final incremental cost will be paid out in two years or less by savings before taxes, except for specific equipment requirements specified herein.

3.02 All items of major equipment (C through K) shall be selected after obtaining competitive bids. No item of major equipment shall be purchased until approval has been indicated by COMPANY representative. Studies to justify the choice of equipment shall be presented upon request of COMPANY representative.

V-A-4.0 CODES AND DESIGN CONDITIONS PERTAINING TO OVER-ALL PLANT

4.01 Codes and design conditions pertaining to the over-all plant are shown on Basic Design Data, attached.

4.02 Designs for Earthquake Forces - Rigid structures (structures with a fundamental natural period of vibration less than 0.4 seconds) shall be designed to withstand a seismic force of 0.05 gravity. Flexible structures (structures with a fundamental natural period of vibration equal to or greater than 0.4 seconds) shall be designed to withstand dynamic lateral forces induced by seismic action.

V-A-5.0 Plant Area

5.01 Plant location will be as noted in attached General Layout Drawing GT-2948 and Plot Plan GT-4540. Note that Plot limit refers to the northern boundary of existing pipeway C and in general to the entire periphery of the process area. Plant limits refer to internal imaginary lines within the plot limits which show boundaries between individual plants (e.g., Catalytic Cracking Plant and Vacuum Flasher Unit). COMPANY will furnish plant area rough graded to an elevation of approximately 3740 ft. CONTRACTOR shall increase rough grade to a finish grade elevation as required for adequate plant drainage. CONTRACTOR shall provide the necessary fill material.

5.02 CONTRACTOR shall carry all process and utility lines to locations designated on the plot plan, GT-4540, and referred to in Section V-B-1.02, V-L-1.08, and V-L-5.01. Tie-ins at designated points shall be made by CONTRACTOR or COMPANY as specified in the aforementioned sections.

5.03 Plant layout shall be patterned after the general arrangement shown on Drawing GT-4540. Locations of equipment should not be scaled from this drawing. This drawing is intended only to indicate a general orientation and CONTRACTOR is not bound to it. Only the confines of the area are a firm requirement.

V-A-6.0 PLANT RECORDS

6.01 Record Books - CONTRACTOR shall prepare six copies of Drawing Record (Photostat) book, six copies of Equipment Manual, and four copies of Inspection Record Book per instructions on Drawing GA-89559, "Record Book Preparation Instructions for Domestic Refineries." Record books shall be in COMPANY'S hands by the time the plant is ready for operation and shall include drawings prepared by CONTRACTOR for use in constructing the plant per GA-89559.

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6.02 Manufacturers' Drawings - CONTRACTOR should note requirements for manufacturers' drawings and data and shall be responsible for obtaining and including same in record books per Drawing GA-89559. API-ASME or ASME Code certificates are required for all vessels, columns, exchangers, etc., built to API-ASME or ASME Code specifications.

6.03 Safety Instruction Sheets - CONTRACTOR shall prepare Safety Instruction Sheets on Forms Mfg. 600-1 through 600-6 per COMPANY Manufacturing Department Procedure No. 31. Safety Instruction Sheets shall be issued with Record Books before plant completion.

6.04 Maintenance Material Lists - CONTRACTOR shall prepare Maintenance Material Lists for plant equipment on Form GO-453. Completed form shall list all spare parts ordered, and all information required for re-ordering. The listing shall be itemized by equipment under the same classifications used on COMPANY'S Item List.

6.05 Equipment Inspection Record Forms - CONTRACTOR shall prepare the following inspection record forms for each unit of appropriate equipment for inclusion in the Inspection Record Books:

Title	Form
Equipment Inspection Record Tanks	Mfg 336
Equipment Inspection Record - Tubular Heat Exchange Units	Mfg 321
Relief Valve Setting Table and Inspection Report	Mfg 353
Equipment Inspection Record - Motors	Mfg 323
Equipment Inspection Record - General	Mfg 325
Equipment Inspection Summary	Mfg 328
Operating Record	Mfg 330
Gage Point Location and Measurement Record	Mfg 322

6.06 CONTRACTOR shall prepare the forms or drawings listed below (or CONTRACTOR'S own equivalent) and include copies thereof in appropriate record books regardless of whether or not they are used in construction:

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Title or Description	Form No.	Section
Drawing Index Form - fill out and reproduce left side only to and including "Order No." Prepare separate index for Contractors and Suppliers' drawings	EF-154	A
Summary of Utility Requirements	EF-244	A
Equipment Inspection Schedule - listing necessary type of inspection and frequency for safety in operation	Mfg 369	A
API-ASME Code Pressure Vessel Design Sheets	EF-65	C or D
Design Sheet for Vertical Vessel Supports	EF-66	C
Design Data for Heat Transfer Equipment	EF-18	E
Furnace Design Data Sheet	EF-194	F
Pump Data Sheets below as applicable:		
Power Pumps	EF-12	G
Steam Pumps	EF-13	G
Centrifugal Pumps	EF-153	G
Rotary Pumps	EF-264	G
Centrifugal, Rotary, and Steam Pump Packing Schedule	EF-69	G
Steam Turbine Data Sheet	EF-221	G
Motor Data Sheet	EF-176	G
Reference Data for Relief Valves	EF-36	J
Reference Data for Recording and Controlling Instruments	EF-42	J
Reference Data for Pressure Gages, Temperature Points, and Gage Glasses	EF-43	J
Orifice Plate Data Summary	EF-53	J
List of Material and Schedule for Steam Traps (List of Material need not be filled out)	EF-302	L
Insulation for Hot Vessels(List of Material need not be filled out)	EF-224	N

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Insulation of Hot Lines (List of Material need not be filled out). In addition, diagrams or schedules shall be prepared showing type and thickness of insulation on each insulated line.	EF-222	N
Fireproofing Specification for Column and Vessel Skirts (Material order data need not be filled out)	EF-168	N
Building Design Data	EF-348	R
Painting Specification	EF-68	S
Initial Field Hydrostatic Test Specification; in addition, diagrams or schedules shall be prepared showing pressure to which each line is tested.	EF-121	S
Schedule of Lubricants and frequency of lubrication for all equipment requiring lubrication	--	S

6.07 COMPANY will supply adequate copies of all of the above forms to CONTRACTOR as requested. One copy of each form is included in the appendix attached.

V-A-7.0 INFORMATION DESIRED FROM CONTRACTOR

7.01 CONTRACTOR shall submit a preliminary Plot Plan and a Piping and Instrument Diagram with his bid.

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SECTION V - PLANT DESIGN REQUIREMENTS

B - UTILITIES

V-B-1.0 GENERAL

1.01 The plant shall be set up for operation at design capacity during power outages and full capacity production of 400 psig saturated steam shall be maintained. Common spares may be used for pumps provided that this leaves the unit operable during power outage.

1.0 Utilities produced or consumed by plant will be furnished or accepted by COMPANY at points designated on Drawing GT-4540 by the line L-L, and mentioned in this section, under the conditions tabulated on Basic Engineering Design Data, GT-E-4546, or as described herein.

1.0 CONTRACTOR shall provide all necessary utility systems, including sewers and drains, within the plant area. COMPANY will connect utility lines to refinery systems at the line designated by L-L on Drawing GT-4540. In general the utility lines will be located in the central portion of the pipeway designated "New Pipeway 'D'".

V-B-2.0 SPECIFIC INSTRUCTIONS

2.01 Steam - COMPANY will supply steam at plant limits at pressures and temperatures shown on Basic Design Data GT-E-4546. COMPANY will accept high pressure saturated steam generated at 400 psig. It will not be necessary to balance the nominal 30 psig system supply and demand. Deficiencies and Surpluses will be balanced between other plants. All normal pump and blower drivers shall be steam operated with motor spares except as noted in Section V-K-1.03 and V-K-1.04.

(a) The Kiln Air blower turbine shall be driven with a nominal 400 psig steam condensing. The catalyst elevator drive turbine shall be driven with nominal 400 psig steam exhausting at 110 psig back pressure. Both of these drivers shall be designed to operate normally with 385 psig saturated steam. For startup these turbine drivers shall be designed to operate with 400 psig steam with 100°F of superheat. See Section V-G-5.02 for information on alternate drivers to be included in CONTRACTOR'S proposal.

(b) Drivers under 75 horsepower shall operate on 110 psig steam exhausting at 30 psig back pressure.

CONTRACTOR shall provide oil separators in exhaust lines from machinery which may discharge oil with the steam if this steam is to be discharged into the refinery system, either as steam or as condensate.

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Consideration shall be given to maximum production of 400 psig saturated steam by the catalytic cracking plant with the balance at 120 psig. Note that these pressures are slightly higher than the supply pressures at the Plant limits.

2.02 Condensate - Condensate shall be handled at Plant tie-in line L-L as follows:

(a) Badly contaminated condensate shall be dumped into the drainage system.

(b) Condensate that may contain light hydrocarbon condensate shall be run into the cooling tower basin.

(c) Clean condensate shall be collected in the low pressure treated feedwater system.

2.03 Fuel - Fuel gas will be available for plant startup. Maximum utilization of waste product gases shall be made in normal plant operation. A fuel oil standby system shall not be provided.

2.04 Electric Power - Service to the plant will be 440 volt, 3 phase, 60 cycle. A 100 kw, 440 volt turbogenerator furnished by COMPANY will be located adjacent to the plant area, and will be capable of handling all essential motor-operated valves, and lighting loads during periods of power failure.

2.05 Water - CONTRACTOR shall provide drinking and sanitary service water connections at the plant tie-in line L-L.

2.06 Cooling Water - COMPANY will provide fresh water for cooling at 75 psig at ground level at the plant tie-in line L-L and will accept returned cooling water at temperatures shown on Basic Design Data GT-E-4546.

CONTRACTOR shall furnish a closed bearing cooling water system with heat exchange to Plant cooling water system and with at least 25 percent excess cooling and circulating capacity above the immediate Plant requirements.

2.07 Feedwater - COMPANY will provide treated feedwater at 450 psig or at any pressure specified by CONTRACTOR. Water quality is suitable for generation of steam at pressures up to 400 psig.

2.08 Air - COMPANY will provide filtered and dry instrument air and utility air at plant tie-in line L-L. Supply pressures will be as indicated on Basic Design Data.

2.09 Drains and Sanitary Sewers - These systems are discussed in detail in Section V-S.

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V-B-3.0 FIRE SYSTEM

3.01 COMPANY will provide fire fighting water at the plant tie-in line L-L at 150 psig. The main hydrant system will be external to the plant and will not be a part of this specification. CONTRACTOR shall provide fire fighting facilities from plant fire water system consisting of branch lines with hydrants with 1-1/2-inch gate type valves and hose boxes similar to Drawings GE-99618 or GE-S99623. Fire system provided by CONTRACTOR shall be of such extent as to allow any point within the main pipe trenches, pump slabs and manifolds to be reached by at least two hose streams from hoses not over 100 ft long. CONTRACTOR shall furnish piping, hoses and racks.

3.02 CONTRACTOR shall provide steam hoses for fire fighting and plant cleanup, with hoses at least 30 and not over 50 ft long. Steam hose nozzles shall conform to Drawing GC-79186. These hoses shall be in addition to those covered by paragraph 3.01, and shall be spaced to provide adequate coverage. Hoses shall be rated to withstand an operating pressure of 150 psig steam.

V-B-4.0 UTILITY CONDITIONS AND COSTS

4.01 Utility conditions and costs are shown on Basic Engineering Design Data GT-E-4546.

V-B-5.0 INFORMATION REQUIRED FROM CONTRACTOR

5.01 CONTRACTOR shall submit with his bid a tabulation of utilities produced and consumed, similar to COMPANY'S form EF-244. Such tabulation shall include requirements during start-up, normal operation, and power outage. Steam required for start-up will be furnished by COMPANY boiler capacity.

5.02 CONTRACTOR shall specifically state steam producing capacity of the kiln cooling coils at all stages of catalyst activity.

5.03 CONTRACTOR shall submit power requirement for lighting loads and essential motor-operated valves to be supplied by auxiliary turbogenerator in the event of power failure. (See Section V-B-2.04)

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SECTION V - PLANT DESIGN REQUIREMENTS

C - PRESSURE VESSELS

V - C-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This section applies to equipment classified as pressure vessels, drums or tanks.

1.02 Codes - Pressure vessels shall be designed and fabricated in accordance with the latest edition of the API-ASME Unfired Pressure Vessel Code, unless legal requirements dictate the use of the ASME Code.

1.03 Lateral Loads - Vessels shall be designed to withstand the wind and earthquake loading in accordance with Basic Design Data.

1.04 Minimum Thickness of Shell and Heads - Minimum total thickness of any shell or head shall be 1/4 inch.

1.05 Internals - It is desired that replaceable internal parts of all vessels and tanks be designed for the maximum economical operating life, based on corrosion rates and erosion rates established by CONTRACTOR. Where it is impracticable to design for a life of 10 years or longer, CONTRACTOR shall state the expected life of the various elements based on his previous experience. No part of any equipment shall have an expected serviceable life (without major repair) of less than 1-1/2 years.

1.06 Design Temperature and Pressure - It is preferred that the design pressure be set at a minimum of 15 percent higher than the maximum operating pressures encountered under any operating case, startup, or shutdown condition. In no case shall the design pressure be less than 20 psig or less than the hydrostatic head when the vessel is full of liquid, whichever is the greater. The design temperature shall be set at an amount higher than the maximum metal operating temperature commensurate with good engineering practice, but not less than 25°F above the maximum metal operating temperature. All columns and pressure vessels shall be checked for vacuum stability and the design limits shall be recorded on the Design Data (see paragraph 2.02). For vessels in vacuum service, external reinforcing rings are preferred to internal reinforcing rings.

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1.07 Nozzles - It is preferred that all connections to vessels be flanged or "stub weld" type with a minimum nozzle size of 2 inch. However, smaller screwed bosses per Drawing GB-78876, or equal, may be employed for instrument piping, gauge glass, and vent connections, but in no case shall the size be smaller than 3/4 inch. Nozzles construction and attachment shall be in accordance with GB-68801.

1.08 Flange Facing - Flange facing and rating shall conform to the latest edition of the API-ASME Unfired Pressure Vessel Code except the use of small tongue and groove facing is required in lieu of ring joint and the use of raised face flanges shall be limited to temperatures below 450°F except for large flue gas, air, and catalyst lines. Small tongue and groove facing shall be used on all 300-pound flanges in LPG service. Groove facing shall be on vessel.

1.09 Internal Piping

(a) Internal pipe turns may be miters or welding elbows.
(b) Carbon-steel piping shall be as follows:

Size	Minimum Schedule
2"	160
3" - 12"	80
Over 12"	1/2" wall or plate

1.10 Vacuum Relief - When emptying contents or during steaming out, partial vacuum may occur in a vessel. To safeguard the vessel (not otherwise designed) against this possibility, a suitable automatic relief device shall be provided.

V-C-2.0 DESIGN STANDARDS

2.01 Specifications - It is preferred that all unlined and alloy-lined welded carbon steel pressure vessels conform to COMPANY'S Specifications 430 and 431, or equal, respectively. These have been written to apply to shop-fabricated vessels. If any sections conflict with good field fabricating practice, CONTRACTOR should so advise.

2.02 Standard Data Sheet - The design computations for pressure vessels and vertical vessel supports may be made on COMPANY forms EF-65 and EF-66. Note that forms EF-65 and EF-66, or equal, are required for plant records per Plant Design Requirements Section V-A.

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2.03 Manholes and Handholes - The following are normal COMPANY practices regarding manholes and handholes.

(a) Means of access shall be provided on vessels if required for operation or maintenance.

(b) In cases where handholes are adequate, eight-inch and four-inch are preferred in that order.

(c) Manholes shall be in accordance with COMPANY Drawing GB-87280. In general 18-inch I.D. manholes shall be used. Vessels shall have 24-inch I.D. or larger manholes where removal of internal parts or installation of internal staging may be necessary for purposes of inspection or working on internals or lining.

(d) Steps or rungs shall be provided to reach corrosion gage points.

(e) Flanged-in type elliptical boiler manways shall not be used on process vessels.

2.04 Corrosion Gage Points - Corrosion gage points per Drawing GE-31902 shall be installed in at least 2 locations in each vessel. Locations shall be selected where severest corrosion is expected. These may be installed in shop or field, but location will be subject to approval of COMPANY representative. CONTRACTOR shall make initial gage point measurements and shall enter them on Mfg 322.

V-C-3.0 MATERIAL SPECIFICATIONS

3.01 The materials for vessels are listed below:

	Material
(a) Hot Catalyst Section	
Internal insulation sheathing	5% Cr-Mo
Internal liquid feed pipe and nozzle	5 Cr-Mo, type 410
Sleeve around internal feed pipe and nozzle	Type 410 steel
Slide valve, catalyst chute, internals (above reactor section head in contact with hot catalyst)	Type 502S steel *
Catalyst slide valve stem	Type 304 steel

* High Silicon 5% Cr-Mo steel, such as Sicromo 5S and Croloy 5 Si.

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	Material
(b) Reactor Section	
Lining (except bottom head)	Type 410 steel **
Catalyst chute (below reactor section top head)	Type 410 steel
Catalyst orifice	Stellited type 410 steel
Catalyst feed pipes	Type 410 steel
Upper and lower discharging channels	Type 410 steel
Bottom head of reactor section	Carbon steel
Catalyst distribution pipes (through bottom head of reactor section)	Schedule 80 carbon steel
(c) Steam Purge Section	Carbon steel
(d) Upper Kiln Section	
Top Head	Carbon steel
Catalyst distribution pipes	Schedule 80 carbon steel
Sheathing (over soft insulation)	Type 502S steel
Refractory tile	Varnon tile or equal
Air inlet channels and grating	Type 502S steel
Cooling coils	1-1/4 Cr - 0.5 Mo steel
Cooling coil sleeves	Type 502S steel
Cooling coil tube supports	25-12 Cr-Ni steel
Sheathing (over shell insulation around cooling coils)	Type 410 steel
Bottom head	Carbon steel
(e) Lower Kiln Section	
Refractory tile	Varnon tile or equal
Air inlet channels and grating	Type 502S steel
Catalyst withdrawal cone structure	2-1/2 Cr - 1 Mo steel
(f) Catalyst System	Select material on basis of structural design

** Type 410 steel for lining should have 0.06% carbon maximum and 0.5% Molybdenum minimum

3.02 A preliminary review of drawings of the Houdry Process Corporation in the series of HF-600 to HF-660 has revealed certain material inadequacies. The following items represent additional material requirements over those shown on their preliminary drawings:

(a) Baffle plates at gas outlet and air inlet of kiln shall be 4-6 chrome type 502S.

(b) The outer pipes of the upper air inlet system shall be schedule 40.

(c) The pipes through the purge tube sheet shall be schedule 80.

(d) The price differential for fabricating the pancake cooling coils which are intended to be "spare" or "overdesign" (see V-C-4.09) of 1-1/4 Cr 0.5 Mo 0.75 Si and 5 Cr-Si (type 502S) shall be presented.

(e) The liquid feed piping within the reactor shall be 5 Cr Mo (type 410).

(f) Screwed couplings shall be avoided on the liquid feed line within the reactor.

(g) The inner tubes of the upper air inlet caps shall be 5/16 carbon steel or 3/16 type 502S.

(h) All major load carrying or pressure containing welds in alloy shall be made with rod of generally similar composition to the plate material. Except for 1-1/4 chrome steel, all welds in chrome alloys shall be made by preheating and stress relieving. Austentic 25-20 Cr-Ni weld rod shall be used to join chrome alloys in the form of light sheet materials such as the channels and clips in the disengaging section.

V-C-4.0 SPECIFIC REQUIREMENTS

4.01 The reactor and kiln shall be designed as an integral structure with the reactor mounted above the kiln.

4.02 All catalyst handling, storage, and makeup facilities, including a fines storage hopper shall be provided. Provisions shall be made for separate storage of fresh and hot catalyst. Storage capacity shall be sized as follows:

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(a) Fresh catalyst storage - sized to hold 50 tons of fresh catalyst.

(b) Hot catalyst storage - sized to hold the entire catalyst capacity of the operating unit.

(c) Fines storage hopper - sized to hold at least 15 tons of fines production.

4.03 The unit shall be designed to operate with either S-R clay or synthetic bead catalyst.

4.04 The reactor shall have provision for a bed depth twice as great as required for design conditions with equilibrium catalyst activity.

4.05 The reactor shall be designed for operation up to a temperature of 925°F. This applies only to the reactor and shall not influence design of the balance of the unit.

4.06 The seal leg between the upper hopper and the reactor shall be designed to permit a reactor operating pressure 4 psi greater than the maximum normal reactor operating pressure. CONTRACTOR shall state if this results in appreciable increased cost or delay in completion of designs.

4.07 CONTRACTOR shall design the reactor for pressure of 7 psig at the reactor outlet connection for reaction mix to the synthetic crude column.

4.08 The kiln shall contain three burning zones. The first two burning zones shall be followed by cooling zones consisting of cooling coil sections.

4.09 The cooling zones shall contain at least three coils in addition to those shown to be required by the calculations for operation at design conditions. At least one of the extra coils shall be in each cooling zone (see V-C-3.02 (d)).

V-C-5.0 INFORMATION REQUIRED FROM CONTRACTOR

5.01 The following information is required:

(a) Which vessels will be designed and built in accordance with API-ASME Code?

(b) Which units will be stress relieved or radio-graphed?

(c) State design pressure and temperature for each vessel.

(d) State plate thickness and corrosion allowance for each vessel. In the case of vessels of varying diameter, state complete design data (pressure, plate thickness, corrosion allowance) for each diameter. Also state circumferential and longitudinal bending stresses at the junction of cone and cylinder.

5.02 State recommended specifications for any interior insulation that is proposed. Include operating temperatures of plant equipment requiring this insulation. If monolithic lining is proposed, state the additional cost of suspended tile lining of Vernon quality, or equal.

5.03 Details of any corrosion resistant lining method proposed.

5.04 Drawings of internal construction of major process equipment.

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SECTION V - PLANT DESIGN REQUIREMENTS

E - HEAT EXCHANGERS

V-E-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This section applies to all units of heat transfer equipment.

1.02 Codes - All waste heat boilers and other steam generating units shall comply with the latest edition of the ASME Boiler Code insofar as it is applicable and shall comply with local safety orders. All other units of heat exchange equipment shall comply with the latest edition of the API-ASME Unfired Pressure Vessel Code insofar as applicable. All unfired heat exchangers in which steam is generated, such as tar steam generators, shall comply with the latest edition of the ASME Boiler Code. So-called double pipe exchangers and heat exchange units fabricated from pipe will be acceptable without conformity to the API-ASME Unfired Pressure Vessel Code but they shall conform to the requirements of the ASA Code for pressure piping.

1.03 Fouling Allowance - It is desired that CONTRACTOR furnish equipment with fouling allowances such that at least one year's operating time without cleaning both from a heat transfer and pressure drop standpoint will result unless multiple units are provided to allow cleaning in service. Exceptions will be made in the case of exchangers handling cracking furnace residuum or comparable stocks. Fouling allowances given in the latest edition of Standards of Tubular Exchanger Manufacturer's Association are considered minimum acceptable. CONTRACTOR shall make greater allowance for fouling in services in which he believes it advisable.

1.04 Design Pressure and Temperature - In general, the design pressure and temperature limitations for heat transfer equipment shall be compatible with the design of adjacent equipment. Further, these design limits shall conform to manufacturers' standards insofar as possible. The design temperature shall be set at an amount higher than the maximum metal operating temperature commensurate with good engineering practice, but in no case less than 25°F above the maximum metal temperature. For shell and tube units, including reboilers, it is preferred that the design pressure be selected 15 percent higher than the maximum pressure obtainable under any operating case, startup, or shutoff. In general the design pressure shall not be less than 50 psig.

1.05 Tube Size, Gage and Length - Tube size, gage, and length shall be in accordance with Basic Design Data. 1-inch O.D. 11 BWG minimum wall, or 1-1/2-inch O.D. 12 BWG minimum wall tubes will be acceptable for unusual services.

1.06 Nozzles and Bosses - Connections 2-inch and larger shall be flanged nozzles. Where tongue and groove flanges are required, the groove facing shall be on the exchanger. Connections 1-1/2-inch and smaller shall be screwed bosses. The minimum size connection shall be 3/4-inch. Exceptions will be made in the case of double pipe units. Vent and drain bosses shall be provided on all channels and shells except where instrument bosses or nozzles can be used for that purpose.

1.07 Spare Gaskets - Two complete sets of spare gaskets shall be furnished with each exchanger.

1.08 Test Equipment - CONTRACTOR shall advise COMPANY of number and size of test jigs and/or test rings required. COMPANY will advise what test equipment is desired. Cost of test equipment shall not be included in the bid.

V-E-2.0 DESIGN STANDARDS

2.01 Specification - All shell and tube equipment shall conform to COMPANY'S Specification 391, or equal, and all units of other types shall conform to Specification 391, or equal, as far as applicable. Specification 391 is not to be interpreted to exclude fixed tube sheet construction.

2.02 Cooling Water Limitations - Cooling water temperature and maximum allowable exchanger water outlet temperature shall be per Basic Design Data. Means shall be provided to prevent fixed gases which may be evolved from the water from blanketing the tubes. One method of accomplishing this is to maintain a positive pressure of 10 psig at the water outlet of all coolers and condensers.

2.03 Tube Layout - Rectangular pitch with 1/4-inch cleaning lanes shall be used in kettle-type reboilers, steam generators with tar or slurry on the shell side, heavy bottom streams, or other shell streams where excessive fouling and frequent external cleaning of the bundle is anticipated or expected to be a problem. Triangular pitch may be used only in the case of steam or fresh water on the shell side. Where a unit is proposed with the shell cover attached permanently to the shell, tubes must be arranged on square pitch layout in order that the bundles may be hydrostatically tested.

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2.04 Centering Device - Dowel pins or a suitable centering device shall be provided for proper alignment of the floating head with the floating head tube sheet in the case of floating head exchangers with more than two tube passes.

2.05 Clamp Ring Construction - "Clamp-Ring" construction of floating heads is acceptable if dowel pins are provided.

2.06 Shell Baffles - Longitudinal baffles should be avoided except in those cases where decided economics can be realized by their use. For services where shell side fouling is expected, consideration shall be given to half-moon side to side cross flow baffles. For these services "Disc and Donut" and orifice baffles shall be avoided.

2.07 Tube Sheets - The minimum tube sheet thickness shall be 1 inch.

2.08 Extended Surface Units - Extended surface type equipment is acceptable for nonfouling stocks only.

2.09 Arrangement of Units - When multiple units are proposed and where a choice lies between parallel and series installation with only a small difference in investment, parallel units are preferred.

2.10 By-passing - Where two or more heat exchange services are in series, (i.e., feed bottoms and feed overhead) by-passes shall be provided around each bank of exchangers performing one service. Valving around each exchanger in a single service is not necessarily required. Exchangers shall not be oversized because of this requirement.

2.11 Air Cooled Units - Air cooled equipment is acceptable where it can be justified on an over-all project basis.

2.12 Provision for Blinding - A jack screw attachment shall be provided to permit gasket replacement and blinding between units of shell and tube exchangers which are directly flanged together or connected by a short straight piping spool. The jack should be attached to one or both feet of the exchanger, as required.

2.13 Provisions for Testing - All units shall be designed so that they can be completely tested in the field.

2.14 Standardization - It is preferred that heat exchange units of the same type of construction (i.e. all shell and tube) shall be selected to afford a maximum of interchangeability consistent with economic design. Tube size and length shall be standardized for each type of unit (shell and tube, reboilers, etc.).

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2.15 Corrosion Allowance - Steel shells, channels, tube sheets, floating heads, and baffles shall be provided with 1/10 inch corrosion allowance unless otherwise specified. Non-ferrous tube sheets and floating heads require no corrosion allowance.

V-E-3.0 MATERIAL

3.01 Specification - Materials for heat transfer equipment shall conform to Specification 391 for shell and tube exchangers and all other equipment where applicable with the exceptions noted below.

3.02 Cooling Water Service

1) Materials in contact with fresh cooling water shall be as follows:

a) Tubes - Admiralty (any inhibited Admiralty) except in units where the presence of ammonia is anticipated because of injection or process production. Admiralty shall not be used where stock temperatures exceed 350°F. Where ammonia is present 70-30 Cu-Ni containing 0.25-0.60% iron shall be used. Cu-Ni tubes shall not be used at stock temperatures above 500°F.

b) Tube Sheets - Naval rolled brass tube sheets shall be used with Admiralty tubes. 70-30 Cu-Ni tube sheets shall be used with Cu-Ni tubes.

c) Channel Sections and Floating Heads - Steel or cast iron. Cast iron is to be avoided where thermal shock is a possibility.

V-E-4.0 INFORMATION REQUIRED FROM CONTRACTOR

(a) Which bundles weigh more than 10,000 pounds?
(b) Which bundles are interchangeable?
(c) List materials for major exchanger parts by groups of units in similar services.
(d) Which units will be provided with by-pass and block valves to allow removal of the unit from service without a shutdown?
(e) Which units are not floating head type construction?
(f) Which units will be stress relieved?
(g) Where clad shells or channels are proposed, details of the cladding at the gasket surfaces of the body flanges shall be presented.
(h) Complete summary of heat exchange equipment is required with the proposal tabulating all the pertinent design data, including fouling allowance provided.

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SECTION V - PLANT DESIGN REQUIREMENTS

F - FURNACES

V-F-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This section covers direct-fired tube-still type heaters and, as far as applicable, other types of auxiliary heaters.

V-F-2.0 DESIGN CONDITIONS

2.01 Design of tube-still heaters shall be based on over-all economic considerations. There is no general preference for either horizontal or vertical types to the exclusion of the other. Although it may not be economical under present conditions, consideration shall be given to air preheaters or steam generators and the design made in a manner such that these may be added in the future with a minimum of modification. It is not the intent to penalize unduly those designs in which such economizing features would be impossible to include. In these cases the exception will be indicated in the proposal.

2.02 Self-supporting steel stacks shall be used. Minimum height shall be at least 120 ft high. Unlined steel stacks shall have a corrosion allowance of 1/8 inch. Each stack shall be equipped with a painter's trolley.

2.03 No stream of fluid passing through the furnace shall be divided into two or more smaller streams or "passes" if two phases are present in the tubes at the proposed division point in the furnace.

2.04 If the fluid enters the furnace in more than one coil or "pass", each coil shall be provided with a globe throttle valve downstream of orifice flanges. (Flow recorders are not to be provided for this installation.) Globe valves shall have stem stops so that flow cannot be completely shut off.

2.05 Means shall be provided to maintain any steel in stack, flues or tube assemblies which are in contact with sulfur-laden flue gases at a minimum temperature of 350°F to forestall sulfur corrosion.

2.06 Forced or induced draft fans may be used in these heaters if economical. If used they shall be designed to operate without mechanical difficulty at a stack temperature of at

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least 250°F higher than the furnace manufacturer specified for 25% overload. No fan furnished shall have a critical speed condition below 125% of maximum operating speed. Prior to leaving the supplier's plant, the fan shall be run for one hour at 10% over design speed. Fans shall be designed to operate continuously at a capacity 25% greater and a pressure of 56% greater than the normal requirement. In addition the fans shall be capable of a "test block" performance of 20% greater capacity and pressure than the 25% overload condition.

V-F-3.0 BURNERS

3.01 Heaters shall have gas burners. If a floor-fired furnace is proposed the burners shall be accessible from below without excavation.

3.02 Burners shall be so located and of such a type that the flame will not impinge upon the tubes.

V-F-4.0 FURNACE MATERIALS

4.01 Headers in hydrocarbon service shall be either mule ear (Key 1900) or screw lock (Key 7000) or equal. Cap seats shall be of the long taper type to provide maximum corrosion allowance. Holding members and screws shall be forged from AISI 4140 steel conforming to COMPANY'S Specifications 203 and 510, or equal.

4.02 All tube sheets shall be insulated with Quigley Insulag, or equivalent, on the hot side.

4.03 Tube supports shall be 25-12 Cr-Ni steel in the radiant section, conforming to ASTM Specification A297 Type HH.

4.04 Alloy steel castings shall conform to COMPANY'S Specification No. 11 or 12, as applicable, or equivalent.

4.05 End and convection bank supports shall be High Chromium cast iron (Pyrocast or equal).

V-F-5.0 REFRACTORY AND INSULATION

5.01 Suspended type walls are preferred. Suspended wall is defined as any wall whose refractory is supported individually or in groups by structural steel.

5.02 Refractory materials shall be of first quality high duty fire brick and fire clay.

5.03 The burner port material shall be of "super duty" fire clay refractory, or equivalent.

5.04 Air-set mortars shall be employed.

5.05 Alloy wire mesh shall be used for holding breeching and stack linings in place.

5.06 Furnace and stack floors shall be ventilated and insulated to prevent temperatures in the concrete foundation from exceeding 500°F.

5.07 The furnace walls shall be insulated and sealed against air infiltration.

V-F-6.0 MISCELLANEOUS

6.01 Header compartment doors shall have positive locking devices.

6.02 All radiant tubes shall be visible for their entire length through peepholes.

6.03 Permanent steam snuffing connections shall be provided into all header compartments and steam-out connections shall be provided into each firebox.

6.04 Steam-out connections shall be provided for each furnace pass.

6.05 Location of furnace skin point thermocouples shall be recommended by CONTRACTOR and shall have protection tubes per Drawing GB-79684, or equal.

6.06 Access and explosion doors shall be provided for safety and maintenance.

6.07 Plug racks shall be provided and shall be located near the headers that they serve and shall be so designed that positive identification of the plugs is possible.

6.08 Tube layout shall provide for mechanical cleaning.

6.09 Furnace shall have connections for steam-air decoking with effluent lines to breeching. Air connections shall be provided for operation of turbine tube cleaners.

6.10 Breeching shall be above-grade and be provided with drain connections.

V-F-7.0 INFORMATION REQUIRED FROM CONTRACTOR

7.01 The following information is required from CONTRACTOR:

(a) How is the unit passed?
(b) Type and manufacturer of burners.
(c) Tube material and size.
(d) Method of tube cleaning and expected losses.
(e) Tube thickness broken down into minimum thickness and corrosion allowances.
(f) Type of refractory.
(g) Type of insulation.
(h) Type and material of headers.
(i) Tube support hanger material.
(j) Tube sheet material.
(k) Type of stack.
(l) How many skin point pyrometer connections are provided?
(m) How many permanent thermocouple wells are provided?
(n) CONTRACTOR shall furnish the following details concerning the inert gas generator and/or air heater, if any:

(1) Complete description of unit to be furnished with drawings of a typical unit showing principal features and important details.

(2) Any codes applicable to these units.

(3) Design pressure and temperature.

(4) Materials of construction, including type of lining.

(5) Type and extent of automatic controls.

(o) CONTRACTOR shall furnish a pressure and temperature profile for each heater offered.
(p) Heat absorption rates in both radiant and convection sections.
(q) Thermal efficiency of furnace; flue gas temperatures to and from the convection section.
(r) Monetary difference between horizontal and vertical type fired heaters.

SPECIAL PROVISIONS

F - FURNACES

V-F-8.0 SPECIFIC MATERIAL REQUIREMENTS

8.01 Heater tubes should be selected to give a minimum life of 10 years. The following corrosion rates should be used for selecting materials and corrosion allowances.

°F Temperature	Inches Penetration Per Year					
	Carbon Steel	2-1/4 Cr 0.5 Mo	4-6 Cr 0.5 Mo	6-8 Cr 0.5 Cr	8-10 Cr 1 Mo	Type 304S
500	0.02	0.01				
550	0.025	0.02	0.01			
600	0.04	0.025	0.015	0.01		
650	0.13	0.07	0.04	0.03	0.02	
700	0.22	0.11	0.07	0.04	0.035	
750	0.35	0.18	0.11	0.07	0.05	
800	0.5	0.25	0.18	0.11	0.07	0.02
850		0.35	0.25	0.18	0.09	0.02
900			0.35	0.25	0.11	0.02

8.02 Headers shall be provided on both ends. Header materials shall correspond to the following tube materials:

Tube Material	Header Material
Carbon Steel 2-1/4 Cr 1/2 Mo	Carbon Steel (2-1/4 Cr 1/2 Mo (5 Cr 1/2 Mo
5 Cr 1/2 Mo) 7 Cr 1/2 Mo) 9 Cr 1 Mo)	9 Cr 1 Mo
304	18-8 Cr-Ni Cb

V-F-9.0 SPECIFIC REQUIREMENTS

9.01 CONTRACTOR shall submit a summary with his proposal tabulating all pertinent design data.

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9.02 CONTRACTOR shall inform COMPANY of the cost of a fresh catalyst preheater. The preheater shall be arranged for utilizing varying combinations of hot flue gas from the kiln and cold air from blowers to maintain desired temperatures in fresh catalyst preheater. After being informed of the cost COMPANY will decide whether fresh catalyst preheater will be included in unit. In any case provision shall be made in the layout for future addition of this unit.

9.03 The preheating furnace shall be designed so that it will be capable of operation with a top transfer temperature of 800°F, which is 100°F greater than that actually required for operation for Case 1 listed in Section II-A-3.01. COMPANY requires the furnace to be designed for a minimum of six months' operation, at design feed rate, between shutdowns.

9.04 An air heater shall be provided for start-up to bring the circulating catalyst up to operating temperature.

9.05 The kiln stack shall extend at least 15 ft above the highest operating platform of the Reactor-Kiln Support structure.

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SECTION V - PLANT DESIGN REQUIREMENTS

G - PUMPS AND TURBINES

V-G-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This section applies to all liquid pumps and steam drivers for process or utilities.

1.02 Selection of Type of Pump - The type of pump to be used for any given service shall be determined from design and economic considerations. There is no blanket preference for centrifugal pumps or reciprocating pumps to the exclusion of the other type. Steam and motor driver selection is discussed in the specific instructions of Section V-B.

1.03 Inspection During Fabrication - All centrifugal pumps shall be inspected during fabrication except pumps of small size and standard construction for very mild or non-critical services. Reciprocating pumps of large size or of special construction shall be inspected. Turbines shall be inspected, except that small size standby turbines (less than 15bhp) need not be inspected.

1.04 Witnessed Performance Tests - Witnessed performance tests shall be made on all process pumps and on pumps for other critical services. Witnessed performance tests are not required for steam turbines. Testing of turbines normally consists of witnessing the manufacturer's routine tests to set the speed governor, the overspeed trip governor, and a check of the operation of the lubrication system if the turbine has a forced lubrication system.

1.05 Hydrostatic Testing - All pump cases shall be hydrostatically tested. Centrifugal pumps shall be tested to 1-1/2 times the equivalent maximum cold working pressure, or the factor listed below times the maximum working pressure at the operating temperature. The maximum working pressure is the maximum suction pressure plus the shutoff differential pressure developed by the pump with the maximum impeller pumping water at 10% over rated speed.

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Hydrostatic Test Factor

Operating Temperature	Carbon Steel or 12% Chrome Steel	4-6% Cr Steel or 18-8% Cr Steel
0-650°F	1.5	1.5
700°F	1.6	1.5
750°F	1.8	1.5
800°F	2.1	1.6

The test pressure for reciprocating and rotary pumps shall be 1-1/2 times the manufacturer's maximum allowable working pressure.

V-G-2.0 DESIGN STANDARDS

2.01 General Specifications for Pumps and Turbines - The following general specifications or equal shall apply to pumps and turbines:

E-511	Centrifugal Pumps
E-947	Vertical Sump Pumps
MS-1110	Reciprocating Pumps - Direct-Acting Steam-Driven and Power-Driven
E-458	Rotary Pumps
E-404	Steam Turbines

2.02 Pump Location - Pumps shall generally be located outdoors.

2.03 Cradle-Mounted, Close-Coupled, and Centerline-Mounted Centrifugal Pumps - Centrifugal process pumps shall be of the separately coupled type rather than the close-coupled design having an integral pump and motor shaft, except for small water pumps.

Single-stage centrifugal pumps handling stock over 300°F and multistage pumps handling stock over 200°F shall be centerline mounted.

2.04 Lubrication of Centrifugal Pumps - It is preferred that horizontal centrifugal pumps be oil lubricated. Vertical pumps may be either oil or grease lubricated.

2.05 Bearing Closures - Centrifugal pumps installed out-of-doors shall be provided with labyrinth slinger bearing housing closures and spring loaded oil seals (Garlock standard "Klozures", or equal) on all bearing housing. Spring loaded seals are not required on pumps handling cold water.

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2.06 Cooling Jackets - Stuffing boxes shall be water jacketed if:

(a) The liquid temperature is 300°F or greater.

(b) The suction pressure is 250 psig or greater (applies only to centrifugal pumps; jacket is not necessary with mechanical seals).

(c) The vapor pressure of the fluid pumped is 10 psia or greater.

Centrifugal pump bearing housings shall be water jacketed for stock temperature over 350°F.

The coolant for stuffing box and bearing housing jackets and gland quenching shall be fresh water.

2.07 Glands - Glands for centrifugal hydrocarbon pumps shall be of the cowl type, tapped for connection of a water quench line. Glands shall be of the split type. Glands on hydrocarbon pumps shall be made with completely enclosed bolt holes. Slotted holes open at one end are not acceptable. Where practicable, studs are preferred to swing bolts for securing glands. Glands for centrifugal pumps handling inflammable liquids shall be tapped for connection to a water quench line.

2.08 Wearing Ring Clearances - The wearing ring clearances of centrifugal process pumps shall be in accordance with the table below. Performance curves, guaranteed efficiency, and selection of drivers shall be made on the basis of the performance with the actual clearance rather than on manufacturer's standard price book curves.

Clearance for Cold Service (to 350°F)

Wearing Ring Diameter	Diametral Clearance Inches
2"	0.015
4"	0.018
6"	0.021
8"	0.024
12"	0.030
16"	0.036

The above clearances shall be increased by the amounts indicated for the following conditions:

(a) Temperature greater than 350°F shall be increased .005" per 100°F

(b) Services requiring case and impeller wearing ring of same material which tends to gall (18-8, Monel, etc.) shall be increased .005"

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2.09 Shaft Sleeves - Shaft sleeves shall be long enough to extend past the gland on centrifugal pumps to enable operators to determine whether leakage along the shaft is through the packing or between the sleeve and the shaft.

2.10 Dynamic Balance of Impellers - Impellers of centrifugal pumps shall be dynamically balanced according to the following schedule:

(a) All multistage pumps
(b) All pumps 1700 rpm and above having impellers 6" in diameter or more
(c) All pumps operating at 3500 rpm and above

2.11 Mechanical Shaft Seals - Mechanical shaft seals are acceptable for centrifugal or rotary pumps for services where they offer definite advantages over soft packing. No general preference for or against their use is implied. Where practicable, single seals are preferred to double seals.

2.12 Lubrication of Steam Pumps - Direct-acting steam pumps shall be provided with mechanical lubricators of the Manzel or McCord type or equal for steam cylinder lubrication. Multiple feeds and compartments shall be provided if the liquid end packing requires lubrication.

2.13 Turbine Governors - On turbines over 100 horsepower, orifice or oil-relay type governors are acceptable.

2.14 Sentinel Relief Valves - All turbines shall be provided with sentinel relief valves set to sound at 10 psi below the maximum allowable back pressure of the turbine.

2.15 Standard Auxiliary Equipment for Centrifugal and Rotary Pumps - All centrifugal and rotary pumps shall normally be provided with the following auxiliary equipment:

(a) Baseplates of the drain-lip type. The material may be either cast iron or steel. Up to 200 horsepower pump baseplates shall be extended for mounting drivers. Over 200 horsepower the baseplates for pumps and drivers may be separate.

(b) Flexible shaft couplings. Flexible shaft couplings shall be of the gear type, Fast, Waldron, Poole or equal. Under one horsepower other types of coupling are acceptable.

(c) Coupling guards to completely enclose all moving shafts. In general, guards on horizontal pumps shall be provided in conformance with Drawing GE-K-99519.

(d) Lubricators. All pumps and drivers not equipped with forced lubrication shall be provided with 4-ounce or larger constant level lubricators of the Alvor or Trico type or equal.

2.16 Flange Ratings - The rating and facing of all flanges shall be in accordance with the instructions of Plant Design Requirements V-L. ASA 125# C.I. flanges are not acceptable on centrifugal pumps handling hydrocarbons.

2.17 Lantern Rings - Lantern rings shall be provided in all pumps that operate under one of the following conditions:

(a) If pump takes suction at subatmospheric pressure (lantern ring for sealing fluid) or

(b) on reciprocating pumps if liquid handled is propane or lighter (lantern ring for lubricant introduction).

2.18 Pump Vents and Drains - Vents from pumps handling hydrocarbon stocks above the flash point shall be run in closed piping to a safe place of disposal (to vessel or relief line or other point depending upon situation). Pumps taking suction at pressures lower than atmospheric shall be vented to a line or vessel under a pressure as low or lower than the pump suction. In general this shall be to the vessel from which the pump is taking suction.

Pump case drains may be run to nearest drain ditch sewer inlet or pipe trench, or other place of safe disposal depending on the nature of the liquid. When separate drains and vents, on pumps in nonhazardous service, are run to a common header, it shall be arranged so that liquid flow from each pump is visible to the operator.

2.19 Throat Bushings - Renewable type throat bushings in centrifugal process pumps shall be locked to prevent their blowing out in the event of a gland failure. Throat bushings locked only by being pressed in from the low pressure side of the stuffing box are not acceptable. Throat bushings made in the form of flat washers need not be retained provided the diametral clearance between the shaft sleeve and the opening in the pump casing does not exceed 1/32 inch.

V-G-3.0 MATERIAL STANDARDS

3.01 Pump Case Material - All pumps in process areas shall have steel cases if they (a) operate with liquid temperatures over 350°F, or (b) operate at pressures over 350 psig or (c) handle light hydrocarbons - butane or lighter, or (d) have an unusual fire hazard connected with them. Other pumps may have cast iron cases.

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3.02 Gland Material - Glands for hydrocarbon pumps shall be steel. Centrifugal pump glands shall be bronze-lined or bronze-bushed.

3.03 Shaft Sleeve Material - Process pumps not equipped with mechanical shaft seals shall have replaceable shaft sleeves; sleeves for continuously operating process pumps shall be faced with either Stellite No. 1 or Colmonoy. Bronze sleeves may be used for low pressure water service. Integral hardened stainless steel shafts may be used where economical on small pumps.

3.04 Trim and Internals (Wear Rings and Throat Bushings or Cylinders and Pistons)

(a) Centrifugal process pump wear rings shall in general be of the following materials:

(1) Low temperature - to 250°F (non-corrosive)

Carbon steel impeller ring
Cast iron (or Ni-C.I.) case ring

(2) Moderate temperature - 250°F to 500°F (or corrosive service)

11-13 Cr hardened impeller ring) 300 Bhn minimum.
11-13 Cr hardened case ring) Minimum hardness difference 50 Bhn

(3) High temperature - (over 500°F) or high pressure (over 300 psi) carbon steel stellited impeller ring

11-13 Cr hardened case ring

(4) Slurry pump (high temperature)

11-13 Cr stellited and grooved impeller ring
11-13 Cr stellited (no groove) case ring

(b) Cast iron or bronze trim is acceptable in reciprocating process pumps unless alloy steel is necessary to resist corrosion or for high temperature.

(c) Bronze trim may be used in fresh water pumps.

(d) 18-8 chrome-nickel stainless steel trim shall be used in salt water pumps.

3.05 Impellers - Cast iron impellers may be used up to 400°F. Between 400°F and 550°F impellers shall be carbon steel. Above 550°F, 11-13% chrome alloy steel impellers shall be used. In all salt water pumps 18-8 Cr-Ni impellers shall be used.

V-G-4.0 INFORMATION REQUIRED FROM CONTRACTOR

4.01 The following information shall be furnished for all pumps and turbines:

(a) Service
(b) Normal Driver
(c) Spare Driver
(d) Normal Horsepower Required
(e) Horsepower Rating of Driver
(f) Speed
(g) Steam Condition, Supply and Exhaust
(h) Water Rate
(i) Percent of Time Operating

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SECTION V - SPECIAL PROVISIONS

G - PUMPS AND TURBINES

V-G-5.0 SPECIFIC REQUIREMENTS

5.01 The kiln circulating water pump shall be centrifugal pump driven by a 110/30 psig turbine. This service shall be spared.

5.02 CONTRACTOR shall submit price and water rate for the following alternate drivers for the Kiln Air Blower.

(a) Turbine driven with 15 psig saturated steam condensing. Turbine shall deliver full power when operating on 10 psig saturated steam.

(b) Turbine driven with mixed 15 psig and 400 psig steam condensing (with low pressure end designed to be able to use 10,000#/hr of 15 psig steam at all times).

5.03 Reliable turbine drivers are required for the Kiln air blower and the catalyst elevator. Turbines offered by CONTRACTOR on his proposal shall be subject to COMPANY acceptance. COMPANY experience shows that the following points should be considered in specifying turbines for these services.

(a) Turbines shall be suitable for operating continuously without a spare for periods of from 6 to 12 months.

(b) Turbines shall have collar thrust bearings and sleeve radial bearings.

(c) Turbines shall have non-sparking linkage on the over-speed trip.

(d) Turbine shaft at the gland shall be so designed that it will be continually operable in a corrosive atmosphere.

If CONTRACTOR furnishes turbine drivers that do not meet the above requirements, he shall so state in his proposal.

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SECTION V - PLANT DESIGN REQUIREMENTS

J - INSTRUMENTS

V-J-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This specification shall be applicable to all instruments and component parts of instrument installations.

1.02 Standardization of Parts - Normal COMPANY practice is to standardize on instruments performing a similar function, within a plant (i.e. flow instruments), but to select instruments and controls on the basis of design and price for the several control functions required. All instruments need not be of the same manufacture.

1.03 Safety Relief Valve Selection - It is preferred that relief valve selection be in accordance with the April 1948 University of Michigan Engineering Research Institute Bulletin Number 31 entitled "The Design and Construction of Pressure Relieving Systems," using the Stroop-Maker formula for calculating fire loads. Relief valves shall be provided on the cold side of exchangers and coolers as necessary to relieve liquid or vapor in case of closed block valves. Relief valves shall be Crosby or Consolidated.

1.04 Piping and Valves - Instrument piping and valves shall be per Plant Design Specification Section V-L except where modified herein.

1.05 Utility Instruments - Instruments adequate for measuring all utilities consumed or generated by the plant shall be furnished. See Basic Design Data GT-E-4546.

1.06 Use of Alarms - Alarms shall be provided as necessary to protect plant operation and major process equipment. Normal COMPANY practice is to provide alarms in services such as, but not limited to, the following:

(a) Steam drum high and low level
(b) Reflux drum high and low level where overflow or loss of level would be hazardous
(c) Power failure
(d) Compressor suction knockout pot level and automatic compressor shutdown
(e) Furnace feed line flow alarm where failure of flow endangers furnace
(f) High temperature on furnace top transfer lines
(g) Cooling water (cooling tower circulation and engine jacket water circulation)
(h) Instrument air pressure

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Alarms shall be installed so as to allow testing without interference with plant operation.

1.07 Transmission - Pneumatic transmission shall be used wherever possible in preference to electrical transmission.

1.08 Sample Connections - Circulating sample connections shall be provided as necessary to maintain process control. Samples shall generally be withdrawn upstream of control valves (or pressure side of pump) and circulated to a point downstream of control valves (or suction side of pump). Samples must be cooled.

V-J-2.0 DESIGN STANDARDS

2.01 Control Valves - It is preferred that minimum body size be 3/4 inch, that cast iron valves 8 inches and smaller have 250-pound flanges minimum rating, that valves operating above 400°F have air-fin cooled packing glands, that valves 2 inches and larger have flanged body connections, and that valves 1-1/2 inches and smaller have screwed body connections.

2.02 Pressure Gages - Pressure gages with screwed or snap rings and metal cases are preferred. Bronze Bourdon tubes shall be used on steam, water and other non-inflammable fluids not corrosive to bronze, and at working pressures below 600 psig. Steel tubes shall be used in all hydrocarbon services and for all other services over 600 psig. On service above 1000 psi, cases shall be equipped with blow-out discs and shatter-proof cover glasses. Field-mounted and board-mounted gages shall be six inch diameter.

2.03 Liquid Level Instruments - All level instruments shall be of the type which can be isolated from the vessel to which they are attached without disturbing the normal functioning of the vessel.

2.04 Gage Glasses - All gage glasses in process service shall be either through-vision or reflex type with steel chambers and covers as manufactured by Jergusen or equal. Gage glasses shall be mounted on separate vessel connections from level instruments.

2.05 Seal Pots - Seal pots shall be used wherever necessary for proper operation of instrument lines or to minimize corrosion or clogging.

2.06 Instrument Housing - Instruments located outdoors shall be suitably protected for year-around operation.

2.07 By-Pass Valves - All control valves shall be provided with globe valve by-pass and gate (plug valve in the case of LPG service) block valves so that the control valve may be removed from service without shutdown.

2.08 Orifice Flanges - Orifice flanges shall be in accordance with Drawing GB-99507, or equal. Throat taps shall be used on lines 6 inches and larger in diameter.

2.09 Flushing - Where clogging of instruments is anticipated, consideration shall be given to continuous flushing with Hills-McCanna pumps, or equivalent.

2.10 Thermowells - All thermowells in process streams and salt water shall be 18-8 Cr-Ni or better as the process demands.

V-J-3.0 CONTROL ROOM INSTRUMENTS

3.01 All instruments and alarms that should be under the continual observance of the plant operators shall be board mounted. Steel panels are preferred.

3.02 Instruments on the panel shall be arranged in sequence of plant flow.

3.03 All instruments located on the control board shall be flush-mounted.

3.04 Extra panel space shall be provided for at least six instruments and three alarms.

3.05 A means shall be provided to maintain a nonhazardous atmosphere around all sparking instruments. Where economical explosion-proof instruments shall be used.

3.06 No hydrocarbon lines shall be carried into the control house.

3.07 Alarms shall be located on an annunciator panel. Panalarm Products, Inc., Series 400, plug-in annunciator cabinets, or equivalent, are acceptable. COMPANY representative shall give approval before purchase. Provision shall be made for three future alarms.

V-J-4.0 INFORMATION REQUIRED FROM CONTRACTOR

4.01 Materials and Trim - Include information on the type of materials and trim for control valves, relief valves, thermowells and primary flow measuring elements for each general service condition.

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SPECIAL PROVISIONS

J - INSTRUMENTS

V-J-5.0 SPECIFIC REQUIREMENTS

5.01 Control Room Instruments - CONTRACTOR shall state number and kind of board-mounted instruments to be installed in Gas Recovery Section Control House (see Section V-R).

5.02 Instrument Piping - Instrument transmission lines from the process equipment to the control house shall be furnished and installed by CONTRACTOR. It is preferred that transmission lines be placed in instrument troughs and parallel lines in the plant area insofar as is practicable. The tie-ins from utility lines to board-mounted instruments shall be by CONTRACTOR.

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SECTION V - PLANT DESIGN REQUIREMENTS

K - MECHANICAL EQUIPMENT

V-K-1.0 GENERAL

1.01 Scope - This section applies to all mechanical equipment except pumps and drivers.

1.02 Turbines - The provisions of Section V-G shall apply to all turbines, whether used as drivers for pumps, or for other purposes.

1.03 Mechanical Elevator - Catalyst shall be circulated through the reactor kiln section by a mechanical elevator with a rated capacity of 500 tons/hr. The elevator shall be suitable for handling catalyst at 1100°F. The hot catalyst elevator shall be as manufactured by the Jeffrey Manufacturing Company of Columbus, Ohio. The general arrangement, materials, and construction shall be similar to the elevators being furnished for Richmond Thermofor Catalytic Cracking Units, 1951 Alterations. Catalyst elevator drive shall be a steam turbine operating from 400 psig to 120 psig and shall not be spared. Elevator drive bearings and shaft shall be provided with a inert gas or steam seal. The following elevator spare parts shall be provided by CONTRACTOR.

Item	Quantity	Description
1	1	Complete set of chain for one elevator
2	1	Complete headshaft with traction wheels and rims
3	1	Complete set chain attachments
4	1	Complete set miscellaneous bolts and nuts
5	20	Chain keepers
6	1	Complete set guide wear plates
7	20	Buckets
8	1	Pair bearing liners
9	1	Pair foot shaft bearings
10	1	Bull gear
11	1	Bull pinion
12	1	Complete set of gears and pinions for low speed reducer
13	1	High speed right angle gear reducer
14	1	Fluid coupling
15	1	Back-stop assembly
16	1	Brake assembly

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1.04 Blower - The kiln air blower shall be driven by a turbine operating on 400 psig steam condensing. This service shall not be spared. Blower and turbine shall be furnished with an integrally mounted turbine-driven auxiliary lubricating oil pump. The air blower shall be guaranteed to supply sufficient air for combustion of 8,500 lbs/operating hours of coke at normal kiln operating conditions. It is desired that the blower also be capable of providing an air supply of approximately 20% in excess of that guaranteed (see V-K-3.07).

1.05 Passenger and Freight Elevator - A combination passenger-freight elevator shall service the main structure. The elevator shall have approximately 40 square feet of platform and a design capacity of 4000 pounds at 300-350 feet per minute. Control shall be by full automatic push button system. Landings shall be provided at least at alternate working levels on the structure.

V-K-2.0 DUST DISCHARGE AND NOISE LEVEL

2.01 Maximum Allowable Discharge - Not more than 400 grains of particles with diameters of 10 microns or larger shall be discharged to the atmosphere per thousand standard cubic feet of flue gas.

2.02 Equipment Noise Level - All equipment in the plant shall be provided with mufflers or vibration dampeners where necessary to reduce the noise to a level which will not interfere with efficient operation of the plant.

V-K-3.0 INFORMATION REQUIRED FROM CONTRACTOR

3.01 CONTRACTOR shall furnish information as requested below where equipment of the types listed is to be provided in the Plant.

3.02 Complete description of all air compressors or blowers to include:

(a) Type of unit, horsepower, and speed
(b) Method of lubrication
(c) Type of capacity control, if required
(d) Type of bearing seals to prevent entrance of dust and moisture

3.03 Description of all cyclones, electric precipitators, or other dust separating apparatus to include:

(a) Type of unit and location in plant
(b) Approximate size and quantity of dust particles (note guarantee requirements in Section II-C-2.06) expected in cleaned air
(c) Expected service life
(d) Applicable codes in any

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3.04 Description of combination passenger-freight elevator to include:

(a) Type of unit
(b) Sizes, capacity, and speed
(c) Location of landings

3.05 Description of silencing equipment, if any, to include:

(a) Type of unit and location in plant
(b) Maximum intensity of sound in decibels at ten feet

3.06 Description of any other item of mechanical equipment to be provided in plant whose value is in excess of $5,000 and which has not been covered elsewhere in this specification.

3.07 CONTRACTOR shall furnish the following information in his proposal regarding the renozzling (addition of hand valves) to utilize the maximum potential power of the kiln air blower turbine.

(a) Maximum quantity of air available from the Kiln Air Blower (expressed as a percentage of the normal design rate).

(b) Additional cost of renozzling per hand valve

(c) Number of hand valves to be added

(d) Maximum turbine power available

CONTRACTOR shall note that the maximum allowable speed of the blower may limit the increase in capacity. Also that the blower manufacturer shall be required to guarantee the blower capacity only for the normal design rate.

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SECTION V - PLANT DESIGN REQUIREMENTS

L - PIPING

V-L-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This section applies to all process and utility piping.

1.02 Codes - Piping shall comply with the applicable ASA Standards and the ASA Code for Pressure Piping. Flange ratings shall conform to the American War Standard, ASA B-16e5-1943, except that small tongue and groove facing shall be used in lieu of ring joint and may be rated equal to ring joint. Feedwater and outlet piping at steam generators shall meet the requirements of the ASME Boiler Code insofar as applicable. Tongue and groove flanges on the API-ASME Code vessels shall be rated equal to raised face per ASA B-16e5-1943.

1.03 Identification - Piping shall be suitably identified by stencillin after insulating and painting. See Plant Design Specification Section V-S.

1.04 Steam-out - All process piping shall have sufficient flexibility and be provided with connections to permit steaming out. Steam-out connection shall consist of one-inch boss, nipple, steel valve, and steel plug. It is normal COMPANY practice to steam test equipment and lines in hydrocarbon service. Therefore, consideration shall be given to the flexibility of all process lines even in LPG service. Consequently, process lines shall be designed for the temperatures reached during steam-out. Special consideration shall be given to the flexibility of pump suction lines.

1.05 Weather Conditions - All lines shall be designed for year-around operation or shutdown.

1.06 Vents and Drains - Permanent provision shall be made to vent high points and drain low points in all lines. Pockets shall be minimized. Connection shall be steel boss, nipple, valve, and steel plug. Alloy boss, nipple, valve, and plug shall be used for alloy piping.

1.07 Line Sizing - Lines and valves shall be of an economic size. In general, pump discharge valves may be the same size as pump outlets; control valve by-pass should have the same capacity as the control valve; size of block valves at control valves should be based on allowable pressure loss. Usually they will be the same size as the control valve.

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1.08 Plot Limit Tie-Ins - Piping tie-ins at plot limits shall be made by COMPANY. CONTRACTOR shall terminate every process line at plot limits with steel block valve. Other lines shall be terminated with appropriate valves.

1.09 Access - All valves shall be readily operable from permanent walks and platforms. Chain wheels and extension handles are permissible. Steam valves shall not be installed with stems pointing down.

1.10 Blinding - Piping shall be sufficiently flexible to provide for the insertion of blinds; spectacle blinds shall be provided to block off all major lines and pieces of equipment. Spectacle blinds shall be provided at all plot limit block valves.

1.11 Buried Lines - The use of underground piping shall be limited to water and drainage lines.

1.12 Pipe Trenches and Overhead Lines - In general it is desired that all major process lines be carried in concrete-lined pipe trenches, see Section V-S-4.01. Where a run of pipe connects two elevated pieces of equipment and the horizontal run is not long compared with the vertical runs required to reach pipe trench elevation, the line may be carried overhead. In addition, it is not desired to require piping to be in trenches where such a routing would be unnecessarily awkward or costly. For example, piping from a reflux drum to a nearby pump may often be most easily carried overhead. However, general use of overhead pipeways shall be avoided.

All lines crossing the plot limits shall be in concrete-lined pipe trenches unless specific design considerations make such location impractical, as in the case of drains.

1.13 Steam Traps - All steam lines shall be suitably trapped to keep lines free of condensate and to protect operating equipment. Steam traps shall be installed per Drawing GB-L-99596, or equal. Steam traps shall discharge to a closed condensate system.

1.14 Pump Suction Screens - Conical screens shall be provided for all pumps for start-up except that flat screens may be used where installation or removal of a conical screen would be particularly difficult.

1.15 Expansion - It is preferred that expansion be taken care of by flexibility in piping. Expansion joints may be used in relief lines, or where space limitations make their use necessary.

1.16 Bleeders - Bleeders shall be provided above all valves in steam lines where water may be trapped if valve is closed during plant operation or shutdown.

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1.17 Relief Piping - Block valves are not required upstream or downstream of relief valves. If block valves are provided means shall be included for locking them in the open position. Bypasses around relief valves shall be provided only where necessary to vent equipment or permit steaming out.

1.18 Steam Lines to Drivers - Steam lines to pumps and turbines shall be equipped with a gate valve at the header and a globe valve near the driver. A steam trap or drain connection should normally be provided at the low spot between these valves. One block valve shall be provided in the exhaust line. Small bypasses shall be provided around control valves on standby steam turbines equipped with automatic starters.

1.19 Column and Vessel Blocks - Block valves shall be provided adjacent to all liquid connections on columns, vessels, and tanks.

V-L-2.0 DESIGN STANDARDS

2.01 All piping designs shall conform to Drawing GT-2848, Classification Sheet for Refinery Piping, except as noted herein.

2.02 Fabricated steel piping shall be in accordance with COMPANY Specifications 351, 352 or 353 as applicable, or equivalent.

V-L-3.0 MATERIAL STANDARDS

3.01 All materials shall conform to GT-2848, Classification Sheet for Refinery Piping, except as modified herein. Alloy steel castings shall conform to COMPANY'S Specification No. 11 or 12, as applicable, or equivalent.

3.02 Pipe - All process pipe 18 inches and under shall be seamless, and all pipe 1-1/2 inch and smaller shall be Schedule 80. Cement-lined steel pipe need not be seamless and drinking water lines shall be galvanized Schedule 40 welded or seamless. Pipe smaller than 3/4 inch shall not be used in process piping or in connections thereto, except that instrument leads shall not be smaller than 3/4 inch except for orifice taps. 1-1/4, 2-1/2, and 5-inch piping is not acceptable. Bosses shall be in accordance with Drawings GD-L-31368 or GB-78876, or equal.

3.03 Pipe Joints

(a) Welded construction in all sizes is preferred for all installations and is required in all process lines 2 inch and larger. Flanges shall be used only at connections and where required for blinding and inspection. Removable spools shall be provided where necessary for maintenance.

(b) Threaded connections 1-1/2 inch and smaller shall be made up without pipe dope and seal welded as follows:

(1) LPG or other corrosive chemical or hazardous services. Seal weld all joints except in small meter manifolds.

(2) Gas, volatile (vapor pressure 10 psig or greater), other hydrocarbons over 100 psig or 350°F, and steam over 400°F.

(3) All joints from process equipment to the first valve shall be seal welded if failure of the joint would permit uncontrolled flow or create a hazard. This will include seal welding pressure side of valve.

(c) In sizes 1-1/2 inch and smaller, socket weld fittings and valves are preferred to screwed fittings if the installed cost is no more than the screwed fittings required by GT-2848.

3.04 Valves, Fittings and Flanges

(a) Steel valves, fittings and flanges shall be used according to the following schedule:

(1) All process piping in plant area.

(2) To and including the first valve on all tanks and other vessels if failure would create a hazard or result in excessive loss.

(3) Steam piping over 250 psig or 450°F, but below 600 psig.

(4) Remotely controlled emergency valves or valves in other locations where it is essential that equipment be operable during a fire.

(5) Fuel Oil and fuel gas lines.

(6) Main steam headers and the first valve to steam branch headers.

(7) As required for tie-ins.

(8) Water lines above frost line except that brass valves are permitted on small lines such as pump gland cooling lines.

(b) Valve Stems

(1) Rising stem outside screw and yoke valves shall be used in sizes 2 inch and larger for refinery services. (See 3.05).

(2) For valves under 2 inch, inside screw, rising stem are preferred, except that outside screw and yoke with stainless steel or monel stem may be used.

(3) Stainless steel valve stems only shall be used in hot oil service or where sulfur corrosion is known to occur. Monel may be used as well as stainless steel in mild temperature oil and gas service. Brass stems and handwheel bushings shall not be used in oil or gas service, or where melting of a stem during a fire would result in an additional hazard.

3.05 Plug Valves - The following limitations shall apply to the use of plug valves:

(a) In general, plug valves shall not be used in lines where valves are operated infrequently, except that plug valves shall be used in place of gate valves in all LPG service.

(b) All plug valves 6 inch and larger shall be gear-operated.

(c) Plug valves shall be equipped with screwed bonnets or a minimum of four bonnet bolts.

(d) All plug valves shall be of the lubricated type. Where "Hyperseal" plug valves are required, no substitutes will be accepted. Positive shutoff lubricant screw shall be provided for all plug cocks per Drawing GC-14296.

(e) Multiport plug valves are preferred for backwash connections in heat exchanger salt water service.

3.06 Underground Piping - Steel pipe installed underground shall be protected from soil corrosion with a single wrapped coating consisting of an asphaltic primer, one flood coat of asphalt, and 15# asbestos base pipe line felt. Piping under concrete shall be protected with Somastic Pipe Coating.

3.07 Flange and Valve Guards - Lead guards shall be provided for flanges and valves in caustic, acid, or hazardous chemical service per Drawing GB-88595, or equal.

V-L-4.0 INFORMATION REQUIRED FROM CONTRACTORS

4.01 Materials - Advise where alloy steel will be used in lines and valve bodies.

4.02 Remote-Operated Valves - Where are remote-operated valves used and how are they actuated?

4.03 Tracing - Which lines will be traced?

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SPECIAL PROVISIONS

L - PIPING

V-L-5.0 SPECIFIC REQUIREMENTS

5.01 Special Tie-ins - Process piping tie-ins at tie-in line L-L (see plot plan Dwg. GT-4540) shall be made by COMPANY. CONTRACTOR shall furnish and install piping and supports for Vapor line from Reactor to Synthetic Crude Column. CONTRACTOR shall connect line to Column flange, located at an elevation of approximately 25 ft above grade.

5.02 Special Material Standards

(a) Furnace top transfer line to Reactor - Type 347 steel *

(b) Vapor line - Reactor to Synthetic Crude Distillation Column - Type 347 steel *

(c) Expansion bellows - Type 347
321
316

(d) Valve in furnace top transfer line - 5% Cr Mo with 11-13% Cr trim

5.03 Stress Relieving - All austenitic type welded piping shall be stress relieved at 1500-1550°F for 2 hours per inch of thickness, but not less than 2 hours.

5.04 Catalyst Piping - Lines carrying catalyst shall be designed for the longest life economically feasible. At certain points where erosion is known to be particularly severe and localized, a minimum estimated operating life of 1-1/2 years shall be provided. Where practicable, design shall provide for points of severe wear being sectionalized for economical maintenance, by means of flanged units, wear plates, etc.

* If type 347 steel is not available, the following alloys may be substituted in this order of preference:
Type 321
Type 304 (extra low carbon)
Type 304

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SECTION V - PLANT DESIGN REQUIREMENTS

M - STRUCTURES

V-M-1.0 GENERAL

1.01 Scope - This section applies to all steel, concrete and timber structures except buildings. Design and construction shall comply to the Uniform Building Code, latest edition, where applicable.

1.02 Safety - Normal COMPANY practice in layout of platforms, walkways, ladders, and stairs is shown on the attached drawings, GB-M14074, GB-14347, and GB-14348.

1.03 Access - Platforms and stairs shall be provided for all points which must be serviced or reached once each 8-hour shift. All other points which require less frequent access during operation or for maintenance purposes shall be provided with platforms and ladders or stairs. In addition, access between levels of main structures or buildings shall be by stairs.

1.04 Maintenance Platforms - Maintenance platforms and ladders shall be provided for reaching any manhole, valve (or valve operating chain or extension), safety valve, removable head, cover, channel head, or instrument point. Platforms shall be provided around top flange of vertical reboilers. The width of platforms in front of manholes shall be not less than 36 inches while platforms at horizontal heat exchange equipment shall extend a suitable distance beyond the faces of the covers to permit access during both operation and maintenance. In addition, platforms shall provide space for rigging of tackle for pulling bundles but not for working on bundles above grade elevation. Where practical, it is preferred that heat exchangers be located at grade elevation for ease of access and maintenance. In case of stacks of large exchangers where the upper unit is too high for convenient access, CONTRACTOR shall provide permanent supports for temporary timber staging for servicing the upper unit. Maintenance platforms shall be designed to carry all equipment live loads which can be placed on them by fixed davits or monorails, with the exception of tube bundles.

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1.05 Slide Pole Escape - Where slide pole escapes are provied they shall be located on the windward side with respect to prevailing winds. The slide pole shall be installed with drops of not over 25 feet. Alternate poles shall be offset four feet from one another, and the clearance radius around each pole shall be two feet. Slide poles shall be four inch, Schedule 40 steel pipe, sandblasted and painted. If the slide poles are located on the edge of the structure, safety cages shall be provided.

1.06 Davits and Monorails - Davits or monorails shall be provided for handling equipment parts weighing in excess of 100 pounds and subject to cleaning and repair. Typical equipment parts to be handled include (1) the elements (channel, channel cover and shell cover) of elevated tubular equipment, (2) hydraulically operated slide and motor valves and relief valves, (3) housings and rotors of turbo-blowers. Pumps in general will not be provided with such facilities, however, this assumes adequate access roads for the travel of a crane-car or equal. All monorails shall have permanently mounted trolleys with plain self-aligning roller bearings except that for capacities of three tons or greater the trolleys shall be gear operated. CONTRACTOR shall provide hoists, sufficient in number and capacity, to service any lift, but not all lifts of the same magnitude simultaneously. Two basic types of hoists are required: (1) chain-operated for lifts of 10 feet for loads of two tons or less and for lifts of 3 feet for all loads exceeding two tons. (2) Air or electric hoists for all higher lifts than those specified above. One hoist and trolley shall serve in the removal of the elements from elevated horizontally-mounted exchangers. In general davits, hoists and monorails should not be designed to handle the exchanger bundle. Normal COMPANY practice is to use portable hoists and cranes for lifting and lowering bundles.

1.07 Platform Floorings and Trench Coverings

(a) CONTRACTOR shall use checkered plate for the following:

(1) Low walks over trenches
(2) Pedestrian bridges
(3) Trench coverings, where coverings are necessary
(4) Operating platforms
(5) Maintenance platforms
(6) Walkways over tanks or machinery

(b) Fabricated grating (welded or riveted) shall be used for

(1) Bridges carrying vehicular traffic over pipeways
(2) Maintenance platforms subject to heavy loads

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1.08 Services on Structures - Service air and steam connections shall be located within 25 feet of every level of structures and columns. There shall be at least four air connections at each furnace, located for ease of maintenance operations. Water connections shall be located for convenient washdown and maintenance use.

V-M-2.0 DESIGN STANDARDS

2.01 Drawings - CONTRACTOR may use the following standard drawings:

GB-M14074 - Walkways, Stiles, Short Stairs and Bents
GB-14347 - Guide Sheet No. 1 for Layout of Platforms
GB-14348 - Guide Sheet No. 2 for Layout of Platforms

V-M-3.0 INFORMATION REQUIRED FROM CONTRACTOR

3.01 Advise of any equipment which will not be provided with platforms and ladders for access.

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SECTION V - SPECIAL PROVISIONS

M - STRUCTURES

V-M-4.0 SPECIFIC REQUIREMENTS

4.01 Catalyst Storage, Makeup and Disposal - CONTRACTOR shall provide facilities for moving catalyst from trucks at base of main structure to catalyst storage bins. (See Section V-C-4.02) In addition, CONTRACTOR shall provide facilities for loading on trucks spent catalyst from fines storage for removal from plant (see Section V-C-4.02).

4.02 Catalyst Hoists - CONTRACTOR shall provide handling facilities for the unloading, storage and makeup of catalyst. CONTRACTOR shall show details of operation in his proposal.

4.03 Slide Poles - Slide poles shall be furnished for the Catalytic Cracking Unit structure per Section V-M-1.03.

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SECTION V - PLANT DESIGN REQUIREMENTS

N - INSULATION AND FIREPROOFING

V-N-1.0 GENERAL INSTRUCTIONS

1.01 Scope - This section covers the insulation and fireproofing of all equipment, vessels, piping, and structures. Insulation shall be furnished for personnel safety, stability of operation, and reduction of heat losses as amplified below; fireproofing shall be furnished to minimize structural failure of key members in event of a fire.

1.02 Insulation for Safety of Personnel - Insulation or protective shields shall be furnished and installed for hazardous surfaces. See also Basic Design Data.

1.03 Insulation for Operating Stability - Adequate insulation shall be furnished and installed for all piping and equipment wherever lack of insulation would result in unstable operations or make continued operations unduly difficult.

1.04 Insulation for Heat Savings - Piping and equipment shall be insulated against heat losses in accord with economic justification as defined elsewhere.

1.05 Fireproofing for Structural Protection - Structural members and skirts directly supporting hydrocarbon vessels, columns, reactors, or regenerators shall be fireproofed on all sides up to the point of load application. All other structural members shall be fireproofed at least 20 feet above-grade if their failure during a fire could be expected to cause rupture of any hydrocarbon line, vessel, etc. Secondary bracing members and supports for elevated walkways, stairs and platforms need not be fireproofed. Pipe supports included in the above description shall be fireproofed except for the top flange of the horizontal member.

V-N-2.0 DESIGN AND MATERIAL STANDARDS

2.01 Standard Details of Insulation - It is preferred that insulation material and application be in accordance with specifications and details on forms EF-222 (Insulation for Hot Lines) and EF-224 (Insulation for Hot Vessels), or equal. Insulation in exposed locations subject to physical damage shall be protected with 22-gauge sheet metal covering. Chrome nickel alloy clips and bands shall be used for all insulation.

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2.02 Standard Details of Fireproofing - All fireproofing shall be concrete, and it is preferred that fireproofing materials and application be in accordance with details on form EF-168 (for skirts of columns and vessels) and Drawing GE-33336 (for structural members), or equal. Concrete fireproofing shall be so applied (high density, surface treated, or admixed) as to minimize spalling or cracking. To save weight imposed on the supporting structures, a light weight concrete may be used.

V-N-3.0 INFORMATION REQUIRED FROM CONTRACTOR

3.01 Materials - Advise what major insulation materials (not including items such as wrappings, tie wires, etc.) will be furnished for the following:

(a) Piping insulation below 212°F
(b) Piping insulation 212°F to 600°F
(c) Piping insulation above 600°F
(d) Insulation weathercoat above 175°F
(e) Vessel insulation below 500°F
(f) Vessel insulation 500°F to 600°F
(g) Vessel insulation above 600°F
(h) Type of weatherproofing for fireproofing material

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SECTION V - PLANT DESIGN REQUIREMENTS

P - ELECTRIC POWER AND LIGHTING

V-P- 1.0 GENERAL

1.01 CONTRACTOR shall design all power and lighting facilities in conformance with the requirements of the National Electrical Code, or other applicable code and in accordance with the provisions of this specification.

1.02 CONTRACTOR shall determine the classification as to hazard of all areas within the plant limits in accordance with the designations set forth in the NEC. All areas shall be designated as Division 1 (hazardous) or Division 2 (infrequently hazardous) for Class 1, Group D atmosphere or shall be designated non-hazardous. Classification will be subject to COMPANY approval. Normal COMPANY practices beyond the provisions of the code in the designation of areas are:

(a) Spaces approximately 25-ft horizontally surrounding, 10 ft above, and to grade below any point where leakage of volatile hydrocarbons (flashpoint less than 100°F) is likely to occur at any time without definite failure of any part such as leakage in pump packing shall be considered as if they were Division 1.

(b) Spaces in the immediate vicinity of a point where spillage of a volatile hydrocarbon would result only after failure of some part such as a flange gasket shall be considered as if they were Division 2.

(c) In addition to the normal practices included in (a) and (b) above, COMPANY'S Recommended Practice No. 1, Selection of Electrical Equipment for Hazardous Locations, is included in the Appendix as a guide for CONTRACTOR.

1.03 CONTRACTOR shall furnish electrical facilities suitable for use in areas as designated and in conformance with the provisions outlined herein.

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V-P-2.0 ELECTRICAL MATERIAL AND EQUIPMENT

2.01 All electrical material shall have Underwriter's Laboratories approval for the services in which it is used and shall bear the label or shall be listed in the Underwriter's Laboratories List of Electrical Equipment. If the material is of such size or rating that the Underwriter's Laboratories is unable to test it, it shall be built in accordance with their standards. In addition all electrical material shall be furnished in accordance with Basic Design Data GT-E-4546.

2.02 All above-ground conduits shall be rigid steel, either galvanized or "Sherardized". Underground conduits shall be hot-dipped galvanized steel or fiber. Fiber underground conduits shall be encased in red colored concrete envelopes providing a minimum coverage of three inches. Underground hot-dipped galvanized steel conduit shall either be encased in red colored concrete or laid bare per Basic Design Data. Where conduits cross roads or are otherwise subject to loads, they shall be adequately protected to minimize the effect of uneven settlement.

2.03 Wire for underground 440-volt motor and control circuits, lighting circuits, and other low voltage circuits shall be of the 600-volt classification and shall be TW or better. If the underground installation is in a refinery where the wire is subject to contact with hydrocarbons, machine tool wire, type TW, good for 80°C in air shall be used. Rubber insulated wire may be used aboveground for dry locations where it is appreciably cheaper than TW or where the size is greater than permitted by the NEC for TW wire. Lead covered wire may be required in some installations. Refer to Basic Design Data GT-E-4546.

2.04 Explosion-proof conduit fittings shall be used in Class 1, Division 1 areas. Condulet type fittings shall be used in Class 1 Division 2 areas unless corrosive liquids or gases may be present, in which case explosion-proof fittings shall be used.

2.05 Underground conduit runs shall be adequately designated by markers similar to details on Drawing GB-P-87601. Conduits located below pavements or below the floor of a building shall be marked per details "D" and "E" of above drawing by impressing arrows in the concrete or by installing concrete inserts in the pavement.

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2.06 Underground conduits shall be sealed with a Crouse-Hinds type EYS condulet or equal at the point where they enter or leave the ground. If fiber conduit is used, transfer should be made to steel in a horizontal run before the conduit leaves the ground.

2.07 Nameplates similar to those shown on Drawing CC-J88609 shall be supplied on all push button stations, circuit breakers, motor starters, transformers, lighting panels, welding outlets, and other control devices. All panel boards and switchboards shall have nameplates giving appropriate designation and voltage, phases, and frequency.

V-P-3.0 ELECTRIC POWER AND MOTORS

3.01 All motors shall be designed and built in accordance with the latest NEMA standards and shall conform to Basic Engineering Design Data. Motors are preferred with built-in thermal protection.

3.02 COMPANY prefers that motor starters be installed indoors in standard NEMA Type 1 enclosures and in control centers similar to Cutler-Hammer "Unitrol" or equivalent. Control centers shall be used where the group of starters and circuit breakers require two or more vertical sections. Provide spare spaces in the control center for additional control equipment, if it does not require an additional vertical section. If it is not practicable to locate the control center indoors, and installation shall be in a non-hazardous area, a weatherproof, NEMA Type 3, control center may be installed. For smaller groups standard combination type enclosures with circuit breaker disconnects may be used. If CONTRACTOR finds it necessary to mount motor starters (in individual enclosures) outdoors, NEMA Type 4 shall be used for nonhazardous areas and NEMA Type 7 for hazardous ares. At COMPANY's option NEMA Type 8 (oil-filled) starters may be required in some locations if specified in the Basic Design Data. Induction type or temperature compensated overload relays are preferred for outdoor installations. All panels shall be designed and located so that additions can be easily made. If reliability of operation warrants, two motors on the same service (driver and its spare) may be supplied from separate power sources and inter-connections provided so that either motor may operate from either source of power.

3.03 All 2300 or higher voltage control shall be located in non-hazardous areas. CONTRACTOR shall base his estimate on 50 MVA "Metal-clad" equipment. It will be necessary to have the tripping relays coordinated with system equipment throughout the plant. Provisions of this section may be modified in the Basic Design Data, or at a later date.

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4.06 Control Board Lighting - Fixtures used for lighting the vertical surface of control boards shall provide even illumination over the surface of the board without glare. The fixture should be located to prevent reflection of the bright light source from the glass face of the instrument. Mounting direct fluorescent or incandescent fixtures in a row about two feet from the face of the board and about two feet above the top of the board has proven to be a satisfactory method of illumination. Fixtures with directional reflectors or lenses can be used to advantage to direct most of the light on to the surface of the control board. Supplementary lighting should be provided for desks in the same room.

4.07 Clearance Lights

Structures, towers, and other equipment shall be equipped with airplane clearance lights in accordance with existing government regulations.

V-P-5.0 LIGHTNING PROTECTION

5.01 Adequate means shall be provided for lightning protection of power lines and equipment.

V-P-6.0 INFORMATION REQUIRED FROM CONTRACTOR

6.01 The following information is required with proposal:

(a) Type of conduit for underground service
(b) Type of wire
(c) Approximate location and type of motor controls
(d) What equipment will operate at 2300 or higher voltage
(e) Indicate general plan of conduit runs regarding underground and aboveground installation
(f) Simplified one-line diagram of power supply to drivers and lighting transformers.

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SECTION V - PLANT DESIGN REQUIREMENTS

Q - FOUNDATIONS

V-Q-1.0 GENERAL

1.01 Scope - This section applies to all foundations including building foundations.

1.02 General Conditions - Allowable soil bearing pressures are given in the Basic Design Data.

1.03 Spread Footings - Spread footings shall be used for all foundations.

V-Q-2.0 DESIGN STANDARDS

2.01 CONTRACTOR may use the following standard drawings and forms:

GE-88167 - Design Guide Sheet for Pump Slabs
E-516 - Fabrication of Reinforcing Steel
E-850 - Placing and Curing Concrete
E-851 - Concrete Proportioning and Mixing

2.02 Top of foundations and pump slabs shall be no less than 6 inches above grade and at minimum height to give good piping layout both with respect to economy and appearance.

V-Q-3.0 MATERIAL STANDARDS

3.01 Concrete - If ready-mixed concrete is used, it shall conform to ASTM Specification C-94, latest edition. Design strength shall be 2500 psi at 28 days and 1-1/2 inch maximum aggregate size, 4-inch maximum slump.

3.02 Reinforcing Steel - Shall conform to ASTM Specification A-305-49, Structural Grade, Deformed Bars.

V-Q-4.0 INFORMATION REQUIRED FROM CONTRACTOR

4.01 Strength Control - What procedure of inspection and testing will be followed to insure that concrete as placed meets the design strength.

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SECTION V - PLANT DESIGN REQUIREMENTS

R - BUILDINGS

V-R-1.0 GENERAL INSTRUCTIONS

1.01 Instrument Control House - Provision for mounting control instruments for the Catalytic Cracking Plant will be made in the Gas Recovery Section Control House. This control house will be furnished by others.

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SECTION V - PLANT DESIGN REQUIREMENTS

S - MISCELLANEOUS ITEMS

V-S-1.0 GENERAL

This section applies to miscellaneous items which because of their nature are not included in other classifications.

V-S-2.0 SANITARY SEWERS AND OILY DRAINS

2.01 General Instructions

(a) CONTRACTOR shall provide separate sanitary sewer and oily water drain systems within the plant area and shall provide for storm water or area drainage to pipe trenches. The drain and sewer systems shall be connected to Refinery system at line L-L by CONTRACTOR. Gas seal catch basins per Drawing GB-S13870, or equal, shall be used at plant limits for connection to the Refinery system.

The sanitary sewer shall be connected to the sewer line downstream of any gas seal catch basin.

(b) No sewer or drain shall be less than 4-inch diameter although 6-inch minimum diameter is preferred. Drain inlets shall be of the type shown in Detail J, Drawing GB-13990, or equal. Drains shall be adequately vented to protect the seal with due regard to vapor hazards from the vents. Sewers and drains shall be sufficiently deep to protect pipe from crushing.

(c) At junctions of main drain headers within the Plant, a gas seal type catch basin equal to Drawing GB-13870 shall be provided.

(d) Plugged cleanout connections which can be reached without excavation shall be installed to permit cleaning any sewer or drain which cannot be otherwise reached by rod type cleaning equipment.

(e) Design of piping shall take into consideration the character of the soils at the site and the possibility of settlement of the lines. Rafts and saddles, if required to support bell and spigot pipe, shall conform to COMPANY Drawing GB-S99617.

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(f) Drains shall be sized to allow for a maximum of 1200 gpm of fire-fighting water drain-off from any drainage area within the plant, or for a maximum rain water run-off from the plant area based on the greatest storm intensity expected in a 10-year period (1-1/2 inches per hour - see Basic Design Data), whichever is the greater.

(g) Backfill over buried lines shall be constructed so that the backfill will not serve as a passageway for gases. Pulverized clay will be acceptable in place of quarry screenings.

2.02 Material Standards

(a) All material shall be new and of a type suitable to resist corrosive action of sewage.

(b) Pipe shall conform to the latest ASTM specification for the type used.

(c) Pipe under buildings, structures, or where otherwise inaccessible shall be extra heavy cast iron or standard weight steel pipe if suitable for the intended service. Where steel pipe is used it shall be protected from soil corrosion. (See Section V-L-3.06) Connections to structures which may be expected to settle more or less than the surrounding area shall be flexible enough to prevent breakage.

V-S-3.0 PAVING AND BRIDGES

3.01 General Instructions

(a) Concrete paving shall be installed on surfaces subject to spillage of hydrocarbons and in areas subject to heavy load concentrations during maintenance operations. Asphaltic paving may be used elsewhere. Minimum acceptable paving thickness shall be 3" of asphaltic concrete on plant roadways and two inches for other areas. Minimum concrete paving thickness shall be four inches with 6" x 6" by 10 gage welded steel mesh reinforcing. Bottom and sides of pipe trenches shall be concrete.

(b) Prior to paving entire area with concrete and asphalt as specified in paragraph V-S-3.01(a), the entire area, after filling, shall be graded and low spots eliminated to permit run-off of water.

(c) Subgrade under paved areas shall be well-compacted. Three inches of base rock shall be placed over subgrade for plant access roads and two inches of base rock shall be placed for areas in which paving is to be provided.

3.02 Design Standards

(a) Asphaltic paving shall conform to the applicable construction specification of the Asphalt Institute.

(b) Vehicular bridges over pipeways shall have welded or riveted steel grating decks.

(c) Bridges shall be designed for H-20 highway loading plus 10% impact, or 75 tons deadweight (plus 10% impact) of 50-ton capacity Manitowoc Crawler Crane. COMPANY Drawing GA-99549 may be used as applicable.

V-S-4.0 PIPE TRENCHES

4.01 Pipe trenches shall be of concrete construction.

4.02 The design of the trench shall provide adequate clearance for removal of piping.

4.03 Spacing of lines in trenches shall not be less than shown on Drawing 31323. The bottom elevation of lines shall be at least ten inches above the high point of the trench bottom.

4.04 Trench bottom shall slope to drain gutters which in turn drain to sealed catch basins. This slope shall be 2% except in cases where this would cause excessive elevation changes. In these cases it shall be 1-1/2%.

4.05 Concrete firestops shall be built across all trenches at intervals of approximately fifty feet, and shall serve in those locations as pipe sleepers. In locating firestops consideration shall be given to segregation of individual plant areas as operating areas.

4.06 Trench covers, where used, shall be in accordance with Section V-M.

4.07 Approximately twenty-five percent of total pipe trench width shall be left unoccupied in each trench for future lines.

V-S-5.0 PAINTING

5.01 General Instructions

(a) All equipment, except insulated equipment, insulation, and concrete or stucco buildings, shall be painted with two prime coats and two finish coats. Insulation shall be painted with one coat. Concrete or stucco buildings shall be painted with two coats. Insulated equipment if sheet steel covered, shall be painted with a primer and two coats.

(b) Exterior and interior paint color shall conform to color scheme to be furnished at a later date.

5.02 Material Standards

(a) Paint materials and surface preparation shall conform to COMPANY Specification Form EF-68, or equal, and shall be compounded by the manufacturer specifically for the type of surface to which they are to be applied. Zinc chromate meeting COMPANY Specification No. 809 shall be used as a primer.

(b) Application and reduction of paints shall be in accordance with manufacturer's recommendations.

(c) Identification of pipe lines, pumps, turbines, motors, vessels, columns and other equipment shall be clear and legible and shall be painted using stencils with letters as large as is practicable. Lines are normally identified where they connect to equipment, at cross-walks, and at plot limits.

V-S-6.0 FIRST AID STATIONS, SHOWERS, AND EYEWASH

6.01 First aid stations, fire blankets, and similar equipment will be provided by COMPANY and installed by CONTRACTOR.

6.02 CONTRACTOR shall provide safety showers and eye baths as necessary.

V-S-7.0 DRINKING FACILITIES

7.01 General Instructions - Adequate drinking fountains shall be installed.

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V-S-8.0 MAINTENANCE TOOLS

8.01 All special tools and equipment required for maintenance of the plant shall be furnished by CONTRACTOR. This will not apply to standard tools and equipment which COMPANY will furnish. Items to be furnished by CONTRACTOR shall include:

(a) Special tube rolling tools.
(b) Special tools for furnace, if any.
(c) Hoists required for maintenance (see Section V-M-1.06)
(d) One set of all special tools to service pumps, compressors, or other mechanical equipment. CONTRACTOR will provide COMPANY with list of special tools he proposed to furnish. COMPANY will review list and advise which tools are available in Refinery. CONTRACTOR shall delete such tools and credit cost of job.

V-S-9.0 HYDROSTATIC TESTING

9.01 Scope - All refinery equipment and lines, except sewers and drains, which are to be subjected in service to internal or external pressure, shall be hydrostatically tested except items specifically excluded per paragraph 9.08. Hydrostatic testing shall be witnessed by COMPANY representative.

9.02 Time of Test - Tests shall be applied after erection and before equipment is insulated or initially placed in service. Welded joints shall be exposed during test.

9.03 Test Pressures - The following general specifications for test pressures shall apply.

(a) Lines - The normal test pressure for piping is 1-1/2 times the adjusted cold pressure rating of the valves, fittings, expansion joints, or other limiting elements on the line, such ratings being defined in Section V-L.

(b) Other Equipment - The normal test pressure for refinery equipment shall be 1-1/2 times the equivalent cold maximum allowable pressure based on total thickness including corrosion allowance.

(c) In general, EF-121 outlines hydrostatic test pressures and procedures that shall be followed.

9.04 Test Media - All lines and other equipment shall be hydrostatically tested with fresh water furnished by COMPANY except air, water, and steam lines operating at pressures below 150 psig which may be tested with their respective fluids at their operating pressures only.

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9.05 Inspection and Hammer Test - During testing, the pressure shall be built up slowly and held for a sufficient length of time to permit a thorough examination for leaks. Lines shall be hammer tested while under pressure in accordance with procedure outlined in paragraph 630 (c) of the Code for Pressure Piping, ASA, B-31.1-1942.

9.06 Correction of Defects - All defects, as found, shall be corrected to the satisfaction of COMPANY representative. The tests shall be repeated after each repair.

9.07 Testing of Associated Equipment - All small connections (drains and bleeders, material and sample connections, level and gauge glass connections, and thermometer and pyrometer wells) shall be in place during testing and shall be subjected to the test pressures out to the first valve of the connection. When testing level control connections the float chamber shall also be subjected to the test pressure.

9.08 Equipment to be Excluded from Field Test - Pumps, turbines, relief valves, displacement meters, and gauges, shall not be subjected to field hydrostatic tests, but should be blinded off during test. Control valves shall be field tested only to their allowable pressure rating and shall be blinded off during test of the line. Air motors need not be field tested.

9.09 General Procedure - All high points in equipment tested shall be vented so that all air will be displaced from the system while it is being filled with the testing medium. All hot lines shall be tested before applying insulation. Buried lines shall be tested before backfilling. All coated lines shall be tested before covering joints.

9.10 Completion of Tests - At the completion of a test, the equipment shall be drained promptly and thoroughly. Expansion joints of 18-8 Cr-Ni shall be removed from the line, and thoroughly dried to prevent stress corrosion cracking. They shall not be reinstalled until shortly before starting the unit. Alloy steel furnace tubes shall be washed with fresh water after testing, and be blown dry with air.

9.11 Special Tests and Exceptions - With the approval of COMPANY representative special tests and exceptions (such as air tests to avoid water in the system, reduced pressures, proof tests, etc.) may be applied in lieu of tests in accordance with this Section V-S-9.

9.12 Disposal of Test Water - CONTRACTOR shall provide all facilities for disposal of test water.

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SECTION V - PLANT DESIGN REQUIREMENTS

T - CHEMICALS

V-T-1.0 CHEMICALS

1.01 Chemicals Required - CONTRACTOR shall specify in his proposal all chemicals required for starting operation of the plant and for a period of 60 days following the completion of initial startup period. COMPANY will furnish required chemicals and catalyst.