3.5 Infrastructures and Common Facilities

3.5.1 Infrastructure Description (HO)

Included in the Capital Cost Estimates is additional infrastructure housing located at the Pertamina housing area some 12 km from the UP-II Refinery. The number of houses and type were developed by the Pertamina Client representative in Irvine in December, 1992. No additional schools, medical facilities or recreational facilities have been included in the estimates.

A total of 80 houses of Pertamina Type A, B and C will be built to accommodate the additional housing requirements for the Dumai base Oils Project. All utilities will be underground and tied-in into the existing systems.

The new housing area will be located at the south/west side of the existing Pertamina UP-II housing facilities or, more specifically, due south of JL. Sorong, due west of JL. Cirebon and north of the TVRI Tower. Infrastructure requirements for all four cases of the base oils project are identical.

3.5.2 Common Facilities Description

Presented herein is a general description of the common facilities as presented in the Capital Cost Estimates.

Offsite Common Facilities (CF)

- Lab equipment and furnishings will be added to the existing UP-II Laboratory. A preliminary survey was made of the UP-II laboratory and it was determined that the existing building is adequate for installing the additional lab equipment.
- Additional communications equipment (telephone, fax, etc.).
- Additional cathodic protection facilities.

- Miscellaneous steam and electrical tracing not associated with the process units.

- Miscellaneous fire and safety equipment including an additional fire truck to be located in the existing UP-II fire and safety building.

- A new 25 meter by 75 meter drum storage shelter to replace the existing shelter in the central UP-II Hydrocracker area where the new process units are to be constructed. This will not be required if the alternate plot location as described in Section 3.6 is selected.

- UP-II new jetty structural modifications to accommodate the new loading arms for product shipping.

- Additional maintenance equipment and vehicles to be added to the existing UP-II maintenance facilities to service the new facilities. A preliminary survey of the existing maintenance facilities indicated that the existing buildings are not adequate to house the additional maintenance equipment. Cost estimates for this account include an allowance.

- General civil site development work such as site preparation, paving, roads, fencing, tank dikes, drainage system, etc. Based on local available material the tank dikes will be constructed of compacted type "B" clay material available from local borrowing pits covered by a layer of bricks to prevent washout during the rainy season.

- New construction dock and laydown area to unload and receive equipment and materials. The new construction dock will require additional dredging to accommodate the dock. The construction lay-down area will be located at the fenced in panhandle on the shoreline east of the UP-II coke silo's and off-spec coke pile. The laydown area will contain:

  - Customs Bonding Area
  - Batching Plant
  - Receiving and Stockpiling of Imported Aggregate, Sand and Cement
  - Equipment Lay-down

- Bulk Material Lay-down
- Field Fabrication as required

At present, most of the site is used by the refinery as a lay-down area for surplus, drum storage and scrap material. Following removal of these items, minor site preparation work is required. In principle only, minor grading is required and some road improvement for the connector between Jalan "O" and the panhandle.

Electrical Substation/Distribution (EL)

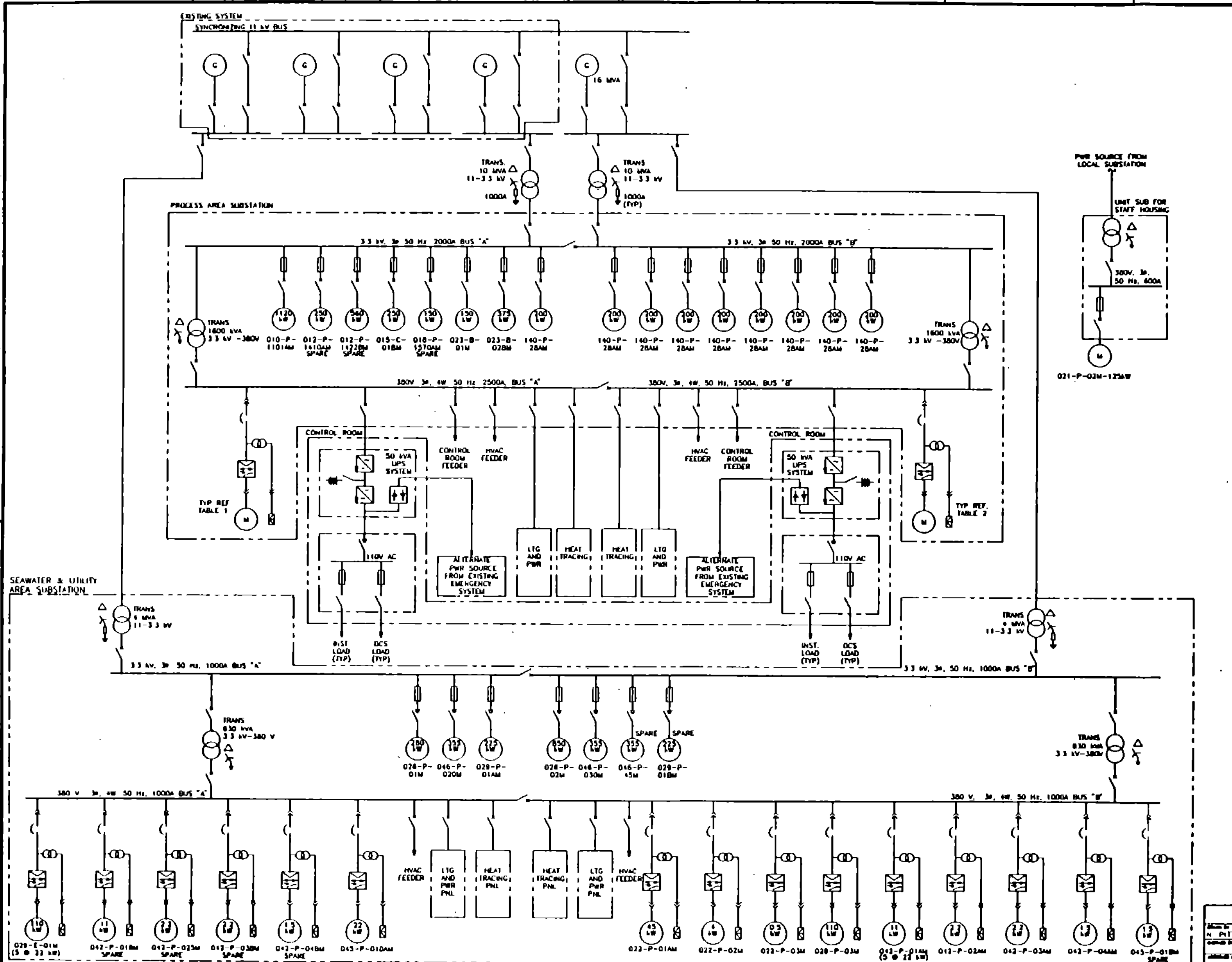
The electrical substation/distribution system includes the distribution of power from the new power generation facilities (Unit 024) up to and including the two new substations required for the new process units. Electrical distribution within the process units have been included with the costs associated for each unit. Refer to the following electrical single conceptual one line drawing #422700-A-601-SK-1 for details of the Case 1 electrical system.

Control Rooms/DCS/Analyzers (CR)

For all four cases one new 30 meter by 40 meter blast resistant main process control room and change room were added to the new lube complex as shown on the plot plans. The new control room will house the DCS hardware for the new complex. Figures 3.5.2 A, B and C on pages 3.5-4 through 3.5-6 present a pictorial view of what the new DCS Consoles may look like.

Also included in the CR estimating account was: (a) a 15 meter by 20 meter addition to the existing UP-II Utility control room to accommodate the new power generation and boiler system, (b) a 20 meter by 60 meter addition to the UP-II power generation building to house the new 14 megawatt generator, (c) a 10 meter by 20 meter building addition to the existing UP-II instrument air system building, and (d) a tank gauging system shown on Figure 3.5.2-D on page 3.5-7.

At this stage of project definition, allowances were included in the capital cost estimates for miscellaneous process analyzers, shelters, H_2S and hydrocarbon



LEGEND

REFER TO I.E.C. STANDARD PUBLICATION 617-3, GRAPHICAL SYMBOLS FOR DIAGRAMS.

REFERENCE TABLE #1

MOTOR NUMBER	kW OPER	kW SPARE
012-E-1413M	1.5	
012-E-1422M (4 @ 11kW EA)	44	
012-E-1431AM	7.5	
012-E-1432AM	8	
012-E-1436AM	18.5	
012-E-1450AM	2.2	
012-E-1455AM	30	
012-E-1465BM		7.5
015-E-01M	1.5	
017-E-1900M (3 @ 11kW EA)	33	
017-P-1900BM		37
018-P-1573BM		55
023-E-01M (3 @ 11kW EA)	375	
023-E-02M	44	
023-P-01M	75	
023-P-04BM		45
023-P-05BM		15
023-P-06A	4	
023-P-07A	4	
040-P-01AM	3	
140-P-28AM	90	
840-E-3M	15	
840-P-10M	22	
010-A-1300BM		75
010-E-1113M (5 @ 15kW EA)	75	
010-E-1120M (3 @ 15kW EA)	45	
010-E-1200E (2 @ 11kW EA)	22	
010-E-1249M	11	
010-P-1102BM		37
010-P-1103AM	4	
010-P-1200AM	15	
010-P-1205AM	45	
010-P-1208AM	15	
010-P-1235AM	11	
010-P-1248AM	11	
010-P-1250AM	8	
010-P-1255AM	37	
010-P-1258BM		30
010-P-1265BM		7.5
010-P-1275BM		11

REFERENCE TABLE #2

MOTOR NUMBER	kW OPER	kW SPARE
012-E-1413M	1.5	
012-E-1422M (4 @ 11kW EA)	44	
012-E-1431BM		7.5
012-E-1432BM		8
012-E-1436BM		18.5
012-E-1450BM		2.2
012-E-1455BM		30
012-E-1465AM	7.5	
015-E-01M	1.5	
017-E-1900 (3 @ 11kW EA)	33	
017-P-1900AM		37
018-P-1573AM		55
023-E-01M (3 @ 11kW EA)	375	
023-E-02M	44	
023-P-01M	75	
023-P-04BM		45
023-P-05BM		15
023-P-06A	4	
023-P-07A	4	
040-P-01AM	3	
140-P-28AM	90	
840-E-3M	15	
840-P-10M	22	
010-E-111M (5 @ 15kW EA)	75	
010-E-1120M (3 @ 15kW EA)	45	
010-E-1200E (2 @ 11kW EA)	22	
010-E-1249M	11	
010-P-1102BM	37	
010-P-1103AM		4
010-P-1200AM		15
010-P-1205AM		45
010-P-1208AM		15
010-P-1235AM		11
010-P-1248AM		11
010-P-1250AM		8
010-P-1255AM		37
010-P-1258BM	30	
010-P-1265BM	7.5	
010-P-1275BM	11	

N. PITTMAN | B. GANATRA | 03 DEC 82

NONE

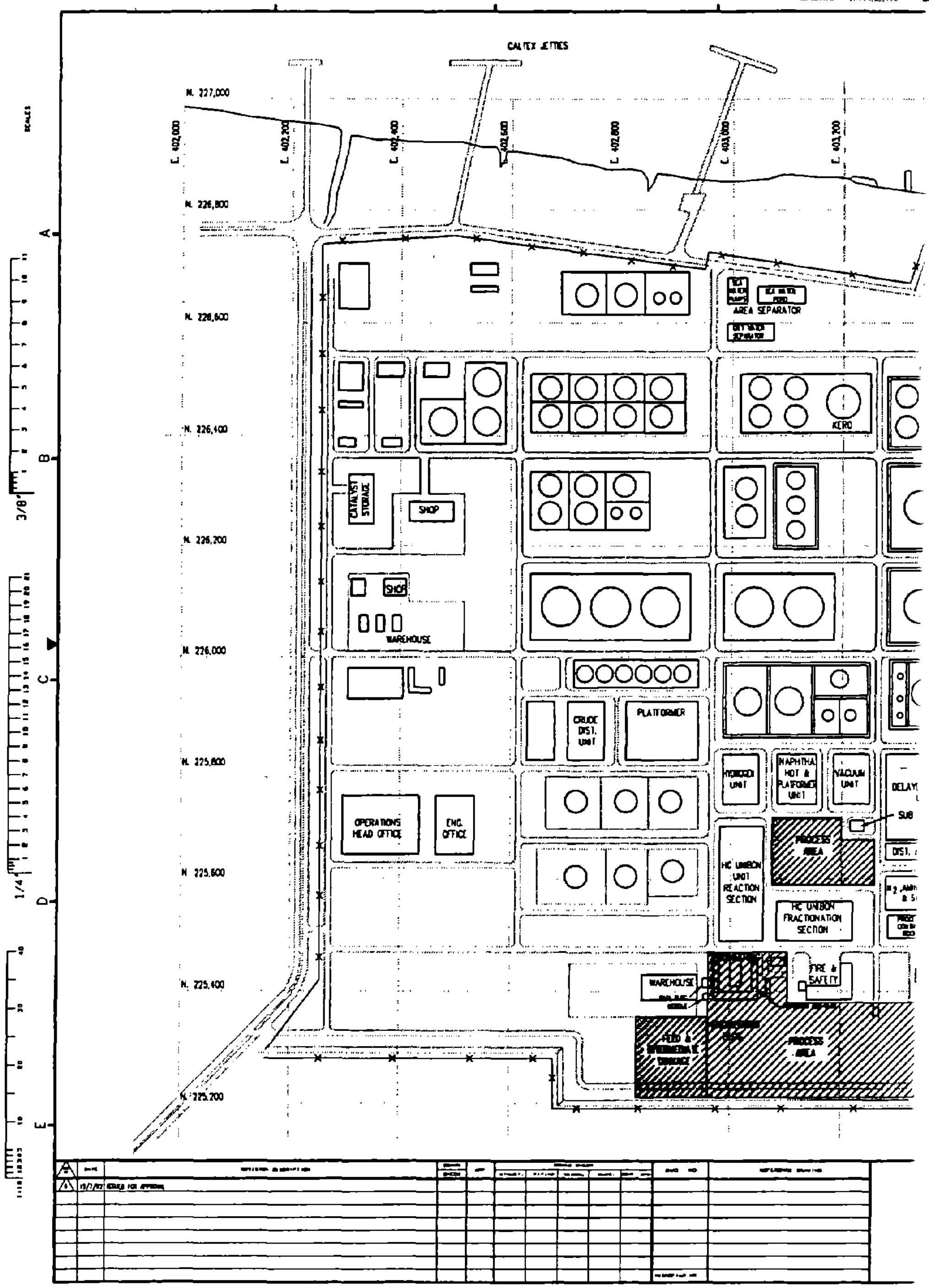
ELECTRICAL CONCEPTUAL ONE LINE

DUMAI BASE OIL PROJECT

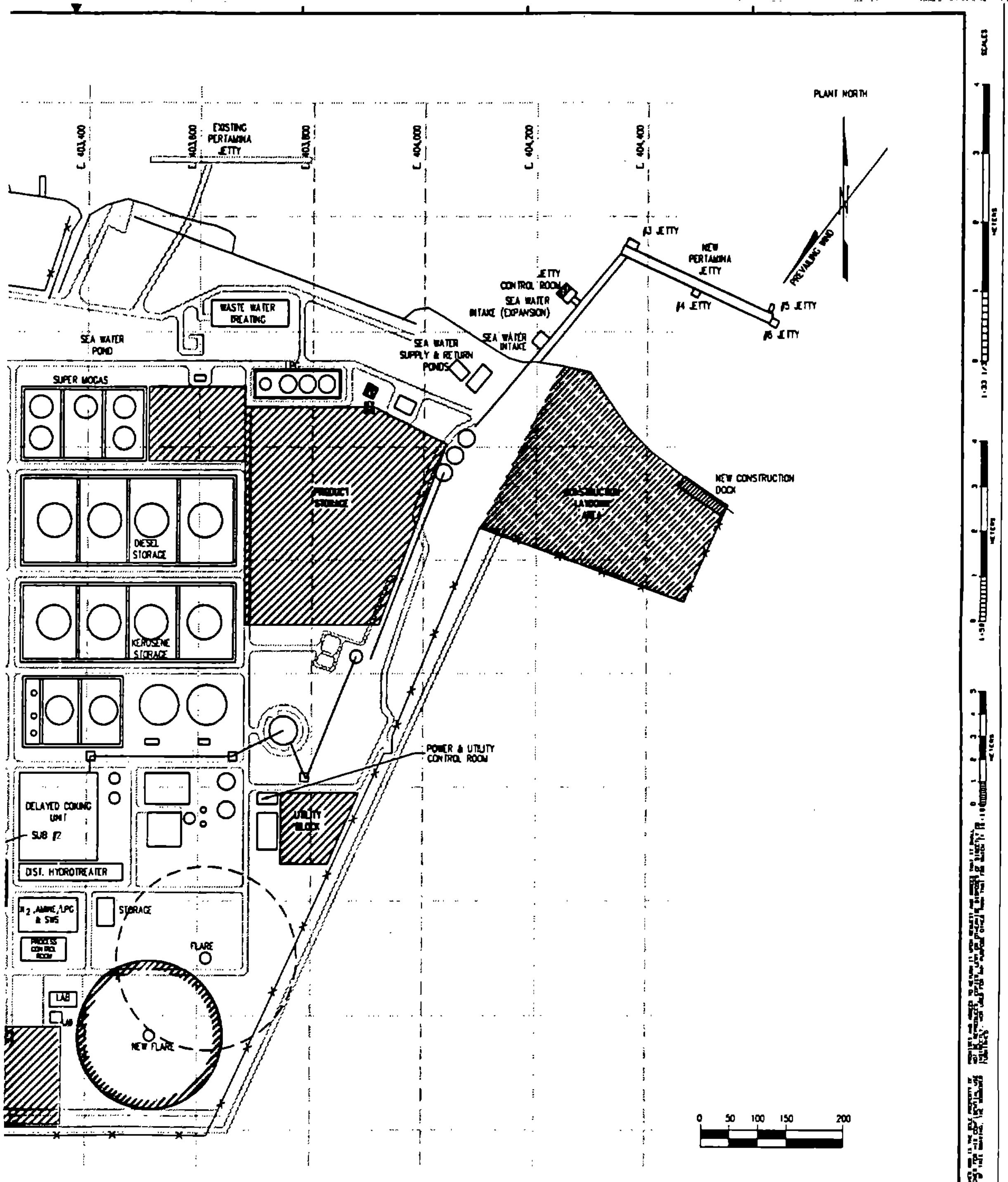
DUMAI, SUMATRA

FLUOR DANIEL

422700-A-601-SK-1



CALTEX JETTIES
N. 227,000
N. 226,800
N. 226,600
N. 226,400
N. 226,200
N. 226,000
N. 225,800
N. 225,600
N. 225,400
N. 225,200
E. 402,000
E. 402,200
E. 402,400
E. 402,600
E. 402,800
E. 403,000
E. 403,200
AREA SEPARATOR
KERO
CATALYST STORAGE
SHOP
SHOP
WAREHOUSE
CRUDE DIST. UNIT
PLATFORMER
NAPHTHA HOT & PLATFORMER UNIT
VACUUM UNIT
SUB
OPERATIONS HEAD OFFICE
ENG. OFFICE
PROCESS AREA
HC UNIBON UNIT REACTION SECTION
HC UNIBON FRACTIONATION SECTION
WAREHOUSE
FIRE & SAFETY
FEED & INTERMEDIATE STORAGE
PROCESS AREA
SCALES
3/8"
1/4"
A
B
C
D
E



PERTAMINA/CHEVRON DUMAI BASE OILS PROJECT	FLUOR DANIEL	FACILITIES LOCATION PLAN DUMAI BASE OILS PROJECT
Drawn by: R. MANNING	Supervisor: ROSENBAUM	Scale: 1:400
Drawing number: 422700-A0-506	Revision: 0	File No: PLOT-506

[The information contained in the following plot plans is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

4.0 CAPITAL COST ESTIMATES

4.0 CAPITAL COST ESTIMATES

The information presented in this section was generated before the completion of the Yield Confirmation Study. The revised capital cost estimates resulting primarily from the Yield Confirmation Study Adjustments, six months delay in the execution of the project, and updated material escalation charts, are included in Section 9.3. The estimate basis, definitions, methodology, assumptions, and qualifications stated in this section for generating the capital cost estimates are still applicable to the revised estimates in Section 9.3.

4.1 Overview

Presented in this Section are the Capital Cost Estimates for the Feasibility Study. Feasibility grade Capital Cost Estimates were prepared in two parts:

EPC Contract Costs represent an EPC Contractor's traditional role in the engineering, procurement, construction, and start-up of a project consisting of process plants, offsites and utility systems, infrastructure, and other common facilities as defined in Section 3.0 of this report. The EPC Contract Costs include costs from project definition through mechanical completion, turnover, and start-up of the facilities.

Owner's Costs represent the Owner's traditional role in developing a project including providing project management and technical services; process licensor support and technology; supply of initial charge of catalysts and chemicals; developer's fees; operations and maintenance training; land acquisition; governmental fees, import duties, and permits; and start-up of the facilities. Further definition of these items may be found in Section 4.2.2.

It was the intent of the study team to include all components of the project in developing the Capital Cost Estimates so that the estimates reflect a complete picture of all anticipated costs that may be incurred. The actual final split of work between an EPC Contractor and the Owner, however, will probably be somewhat different.

The Capital Cost Estimates are based on Fluor Daniel process engineering design work, licensor information, vendor pricing information, and on the execution plan and schedule outlined in Section 5.0. Chevron and Pertamina provided most of the Owner's Cost information. In developing the Capital Cost Estimates, emphasis was placed on Cases 1 and 2 as directed by the Consortium. As Case 3 and Case 4 were somewhat less defined, a higher level of contingency was applied. It must be recognized that these estimates are subject to change if any of the assumptions or qualifications require modification or become invalid.

4.2 Estimate Basis

4.2.1 General

a. ***Introduction***

The Estimate Basis sets forth the foundation of all cost estimating data, definitions, assumptions, and methods used to prepare the Capital Cost Estimates for the Dumai Base Oils Project located at Dumai, Indonesia. This basis was reviewed and agreed to in principle with Chevron prior to beginning the actual estimating effort.

b. ***Objectives of Estimate Basis***

The primary objectives of the Estimate Basis are to:

1. Establish the estimating guidelines for the development of capital cost estimates

2. Ensure that all project discipline approaches are consistent and compatible to the derivation of basic cost data

3. Ensure that all methods, data, and formats of presentation are acceptable to the Consortium

4. Serve as the basis for future cost estimating efforts beyond Feasibility Study completion.

The detail to which engineering information was developed to support the estimating effort is summarized in the following sections. Also included are the estimate methodology and presentation format used to complete an understanding of the effort that went into the estimating work.

c. *Estimate Type*

Two main types of cost estimates were prepared for the various facilities as follows:

1. Costs for all process areas, utility units, and offsites areas were developed by either equipment-factored or capacity-factored estimating techniques and are summarized by individual units.

2. Costs for common facilities, infrastructure, interconnecting pipeways and some utility systems were estimated by using a rough quantity material take-off unit pricing method (semi-detailed) and summarized by a logical unit grouping.

d. *Estimate Baseline*

The cost estimates were initially prepared on an instantaneous 1st Quarter 1993 time frame with escalation excluded to allow for Chevron reconciliation with their own conceptual estimates. An escalation factor of 6% per annum was then applied to the EPC contract cost estimates and 3% per annum to the Owner's Cost estimates that formed the basis for Financial Evaluations contained in Section 6.0.

e. *Estimate Organization*

Presented below is a list of units, systems, or groupings as defined previously in Section 3.0 into which the cost estimates for each of the four cases were summarized:

New Process Units

010 Lube Isocracker

011 Lube Vacuum Column

012 Lube Isodewaxer/Hydrofinisher

013 Distillate Hydrotreater

014 DAO Hydrocracker

015 Make up H2 Booster Compression

016 Solvent Deasphalting (SDA)

017 Tempered Water System

018 Wash Water Injection System

Evaluated or Modified Process Units

212 Converted HC Unibon Train 2

140 Delayed Coker

110 High Vacuum (HVU)

840 Sour Water Treating

410 Amine Treating & LPG Recovery

Utility Systems

020 River Water Intake & Pipeline

021 Water Treatment (Off-plot)

022 Raw/Plant/Potable Water

023 Demin. Water, BFW, Condensate, Steam Generation

024 Power Generation

025 Instrument/Plant Air

026 Sea Cooling Water

027 Fire Water (Sea Water)

028 Fuel Oil

029 Jacket Water

030 Fuel Gas

Offsite Systems

040 Flare System

041 Nitrogen Storage/Vaporizer

042 Oily Water Treatment

043 Sanitary System

Tankage & Shipping Systems

045 Intermediate Storage

046 Product Lube Storage

050 Product Shipping

Infrastructure

HO Offsite Housing

Common Facilities

CF Miscellaneous Common Facilities

EL Electrical Substations/Distribution

CR Control Rooms/DCS/Analyzers

IP Interconnecting Pipeways

4.2.2 Components, Definitions, and Methodology

a. ***Introduction***

The accuracy of any estimate is a function of two things: (1) the completeness of the definition and (2) the estimating method. Sufficient project definition must be accomplished to adequately satisfy the estimating requirements for the project. Three types of estimating techniques were used in preparing the cost estimates for the Dumai Lube Base Oils Project Feasibility Study. These techniques included equipment-factored method, capacity-factored method, and a semi-detailed method. The particular application depended on the information available.

The cost estimates were generally based on preliminary Fluor Daniel process or licensor engineering design information that included sizes of major equipment, metallurgy, design conditions and process flow sketches. Overall facility location plans were also prepared with unit plot plans for the new process units. Other major engineering included (a) a site development plan, (b) electrical distribution system, (c) process control philosophy and (d) major interconnecting piping routing. Table 4.1 on page 4-7 presents a summary of the Fluor Daniel engineering support that went into preparing the cost estimates.

b. ***Methodology***

The following presents the estimating techniques used in the development of the capital cost estimates.

- <u>Equipment Factor Method</u>

  The equipment-factored technique was used for essentially all of the onplot process units, utilities, and offsites with the exception of two process units: Distillate Hydrotreater (014) and Lube Vacuum Column (011) for Case 4. Fluor Daniel's proprietary computerized estimating program (EXPONE) was used to produce factored estimates from equipment sizes, metallurgy, and equipment design parameters. The results were obtained as a printout of required U.S. Gulf Coast craft manhours equipment and material costs, labor costs, subcontract costs, etc. by prime account. The estimated manhours and materials costs were then adjusted to provide productivity or location adjustments to incorporate changes due to geographic pricing adjustments. Equipment costs were developed primarily using vendor pricing information or recent Fluor Daniel experience from other major projects.

Table 4.1

Summary of Engineering Support Used in Preparing Cost Estimates

Process Engineering
- Equipment Lists and Descriptions
- Process Flow Sketches/Diagrams
- Equipment Data Sheets
- Utilities & Offsite Flow Schemes
- Licensor Data (Chevron, UOP, Kerr-McGee)

Civil/Structural/Architectural Engineering
- General Site Development Plan
- Review of Existing Geotechnical Data
- Drainage Plan
- Major Foundation Requirements (Piling, etc.)
- Surcharge Requirements
- Conceptual Design of Major Concrete & Steel Structures
- Building Requirements
- Fireproofing Requirements
- Seawater Intake Structure Sketch
- Jetty Extension Design
- Construction Dock Design

Machinery and Equipment Engineering
- Machinery/Equipment Specifications
- Review of UP-II Maintenance Facilities

Piping Engineering
- Plot Plans (Overall & New Process Units)
- Interconnecting Piping Design (Process, Utilities & Offsites)
- Major Underground Piping Systems
- Steam Tracing Requirements
- Sanitary System
- Cathodic Protection Requirements

Electrical Engineering
- Major Electrical Equipment Specification
- Electrical or Line Diagram (Case I)
- Electric Heat Tracing Requirements
- Area Classifications
- Communication Systems Requirements

Control Systems Engineering
- Controls Philosophy
- Distributed Control System Specification
- Analyzers & Other Critical Instrumentation
- Tank Gauging System Specification
- Fire and Safety Monitoring System
- Meter Proving Facility Design

- <u>Capacity-Factor Method</u>

  For the Case 4 Distillate Hydrotreater Unit (014) and the Lube Vacuum Column (011) the capacity-factored method was used. Equipment-factored cost data obtained for Case 2 facilities similar in process configuration to the proposed facilities was used as the basis. Direct field costs of those facilities were then adjusted for jobsite conditions, and ratioed for the Case 4 capacity required.

- <u>Semi-Detailed Method</u>

  The semi-detailed method was used for infrastructure and common facilities where the equipment-factored and capacity-factored methods were not applicable. Typical applications included site development, piling, interconnecting piping, buildings, major structures, and housing costs. Quantities or sizes were taken off or developed using preliminary routing diagrams, plot plans, and engineering judgements. Material unit costs and labor rates were then applied to the quantities to establish the costs.

c. ***Definition of Cost Terms***

1. *<u>Total Project Costs</u>*

Total Project Costs represent the total of all EPC Contract and Owner's Costs to develop and execute the Dumai Base Oils Project.

2. *<u>Total Installed Costs (TIC)</u>*

Total Installed Costs represent the total of all EPC Contract-related Direct Field Costs, Indirect Field Costs, Home Office Costs, other Costs and Contingency required to engineer, procure, and construct the facility.

3. *Direct Field Costs (DFC)*

Direct Field Costs represent the EPC contract costs of all tagged equipment and materials for the permanent plant as well as the direct labor required for their installation. Direct Field Costs also include field subcontracts, equipment inspection, freight, vendor support during construction, and spare parts for two years of operation. Freight was estimated at 17% of FOB equipment prices for all items purchased offshore. A spare parts allowance of 2% of the equipment price was used for the estimates.

4. *Indirect Field Costs*

Indirect Field Costs include all EPC contract material, labor, and expenses related to the construction and start-up of the permanent facilities, which do not become a permanent part of the plant. Field staff, construction management, craft training, construction equipment, all-risk insurance, small tools, and temporary construction facilities are included in this item. Camp costs were broken out separately on the estimate summary, as there is some question as to whether a camp will eventually be needed. The alternative is to increase the craft labor wage rate and allow the "local economy" to support the construction force.

5. *Home Office Costs*

This cost element includes EPC contract home office labor, expenses and fees associated with overall project management, engineering, procurement, construction advisory services, and start-up assistance for the project. Plastic model costs have also been included in Home Office expenses.

6. *Other Costs*

These costs include initial capital spare parts, vendor representative cost, all-risk insurance, and startup assistance cost.

7. *Contingency*

Contingency is a special monetary provision included to cover estimating uncertainties. A contingency percentage of 22-25% depending on the case was applied to the cost estimates based on the confidence level assigned to the estimates. This same contingency level was directed by Chevron to be applied to the Owner's Costs.

8. *Owner's Costs*

Owner's Costs include all labor and expenses, which traditionally are the Owner's responsibilities in executing a project such as development fees, process licensor technology and support, initial supply of catalysts and chemicals, operations and maintenance training, land acquisition, governmental fees, permits and taxes, etc. This information was developed primarily by Chevron and Pertamina and supplemented as required by Fluor Daniel in-house data.

4.2.3 Qualifications and Assumptions

a. ***Workweek***

The standard work week for construction was assumed to be normally 60 hours, 10 hours a day, six days a week, which is typical of a project this size in Indonesia. Early field activities such as construction of infrastructure housing would normally be based on a 50-hour work week.

b. ***Direct Labor Efficiency***

The labor efficiency used in the cost estimates was adjusted for Indonesian labor as compared to U.S. Gulf Coast productivity. The composite productivity adjustment used in the development of the craft jobsite labor hours was 2.30 times U.S. Gulf Coast manhours. This factor reflects the overall composite productivity anticipated for field construction for both the grass roots and revamp portions of the project. In reality, the actual productivity for the revamp work would probably be somewhat lower than the construction of grass roots facilities.

c. ***Wage Rates***

The all-in construction wage rate used for the cost estimates was $5.60 per manhour. This rate covers all craft benefits such as travel time, payroll burdens (vacation, sick, and holiday pay), benefits, medical costs, and all insurance in conformance with current Indonesian laws and regulations.

d. ***Material and Equipment Pricing Basis***

Project specific vendor budget pricing data in U.S. $ was obtained for about 35-40% of the major equipment costs, and the rest was based on in-house or other recent Fluor Daniel project experience. Indonesian bulk material pricing information was also obtained through the help of a local engineering firm, P. T. Indhasana Gemareksa. This information is included in Section D of the Appendix for reference.

The cost estimates reflect a reasonably stable "world market" and an anticipated "on-shore" versus "off-shore" split of material. "On-shore" refers to all equipment and materials that would normally be furnished within Indonesia. "Off-shore" refers to all equipment and materials furnished outside of Indonesia. Approximately 35 percent of materials is estimated to be purchased within Indonesia and 65 percent "off-shore". Section 5.5 provides a listing of the probable materials which would be purchased within Indonesia for the EPC contract.

e. ***Exclusions***

The Capital Cost Estimates as presented in the summaries do not include the following costs:

- Financing costs

- Interest during construction

- Owner's permanent facilities for continued product development, technical services, marketing, etc.

- Additional fire and safety requirements above the normal which may be required by the selected insurance carrier for the facilities

- Special requirements above the norm which may be imposed by lending institutions such as performance bonds, additional performance or equipment warranties, source-country requirements, etc.

- Special requirements above the norm which may be imposed by the prospective joint venture participants

- Expenditures incurred prior to Phase II for this Feasibility Study (Fluor Daniel costs, Licensor costs, Chevron and Pertamina costs)

- Cost of any subsequent studies required in developing the project prior to Phase II.

f. ***Escalation Factor***

The estimated cost baseline reflects 1st Quarter 1993 pricing basis for labor, material, subcontracts, and expenses. Estimated costs are escalated based on the timeframe of their expenditure as indicated on the project master schedule. Each major cost category is spread reflecting the centroid of the expenditures timeframe. Various escalation percentages are applied to each cost category value based on the centroid timeframe. The labor-escalation factor is based on a recent survey and experience. The material-escalation factor is evaluated by using the in-house material indexes on a worldwide basis and an average for all material. The subcontract escalation factor is based on an average combination of labor and material factors. This composite factor of 6% was developed using Fluor Daniel in-house data and experience in executing recent projects in Indonesia.

An escalation factor of 3% was applied to Owner's Costs except that process licensor royalties, land, and developer's fees were not escalated.

4.3 Capital Cost Estimates

4.3.1 Total Project Costs

The Total Project Costs presented in Table 4.2 on the following page are the sum totals of EPC Contract and Owner's Costs escalated for the life of the project.

4.3.2 EPC Contract Costs

The EPC Contract Costs presented in Table 4.3 on page 4-15 are defined by the information contained in Section 3.0 of this report and include all costs to engineer, procure and construct the facilities in accordance with the Estimate Basis.

4.3.3 Owner's Costs

The Owner's Costs presented in Table 4.4 on page 4-16 were based on information developed by Chevron and Pertamina supplemented by Fluor Daniel in-house data, and include all costs identified typically with an Owner in developing a project of this type.

[The information contained on pages 4-14 through 4-16 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

4.3.4 Alternates Considered

During the course of the Feasibility Study, Fluor Daniel was requested by Chevron to provide rough-order of magnitude cost estimates for two alternates being considered. These cost estimates are presented in the following Table 4.5 and are for:

- Alternate Lube Base Oils Complex facility site location as defined in Section 3.5

- New 10" diameter, river water pipeline system in lieu of providing additional raw water storage and tube wells in the Pertamina housing area as defined in Section 4.3.2.

[The information contained on page 4-18 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

4.4 Contingency and Risk Analysis

Fluor Daniel developed contingency levels for all four cases based solely on the estimating method applied and available design data. Status of technology development was not considered. Contingency percentages were determined and applied against each of the major cost categories. The actual percentages were dependent on the confidence level of the particular cost category and pricing basis. A Monte Carlo risk analysis using a risk simulation program was also performed for Case 1 on a 90% probability. The risk analysis graph (Figure 4-A on the following page) for Case 1 is included. *[This deleted information is considered confidential and proprietary.]*

As Fluor Daniel was completing their cost estimates, Chevron engaged Independent Project Analysis, Inc. (IPA) to provide an independent assessment of cost risks associated with the Dumai Base Oils Project. IPA used their proprietary technology and a data base of over 125 projects completed by 44 companies to compare a project at any stage of development against similar actual project outcomes. The mechanism of comparison is a set of statistical models that is used to determine IPA's recommended contingencies. This type of assessment is routinely made on all large Chevron projects.

IPA interviewed Chevron and Fluor Daniel project personnel on November 30th and December 1, 1992 in Irvine, California. The Pertamina client representative in Irvine at the time participated in the December 1st interview. At that time, Chevron's Yield Confirmation Study using typical Dumai feedstock had not progressed far enough to suggest more than an indication that lube base oils of sufficient quality could be produced. Demonstrated yield information was lacking and therefore IPA's assessment of cost risks was somewhat premature.
[This deleted information is considered confidential and proprietary.]

[This deleted information is considered confidential and proprietary.]

[The information contained on pages 4-21 through 4-25 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

5.0 EXECUTION PLAN

5.0 EXECUTION PLAN

5.1 Overview

This section of the final report presents an overview of a probable execution plan for the Dumai Base Oils Project as suggested by Chevron and Fluor Daniel. This plan assumes that the project will continue to be economically attractive in its present configuration and the financial structure will require primarily U.S. goods and services.

As it is currently envisioned, the Dumai Base Oils Project is expected to be implemented in four distinct phases with appropriate reviews and decision points included before proceeding to the next phase. Summary level schedules listing major activities for each phase are included in Section 5.2 and were the basis for the Capital Cost Estimates and Financial Evaluations.

Phase I - Feasibility Study

The primary objective of the Phase I Feasibility Study was to evaluate the technical, commercial, and legal feasibility of the project as defined by the Consortium in the Terms of Reference. This work was completed in July 1993 and analysis of the results is currently underway by Consortium members.

Phase I-B - Optimization Study

After the Feasibility Phase is complete, Chevron will use their Yield Confirmation Study pilot plant work and the Fluor Daniel Feasibility Study to develop derivative cases based on the work done on Case 2. The objective of this phase is to optimize the process configuration to improve the project's economics. The expectation is that most of this work will be done in-house at Chevron with some assistance from Fluor Daniel. At the completion of the study effort, check estimates will be prepared and the economics reevaluated. Upon completion of this evaluation, a decision to proceed or not proceed with Phase II (Project Definition) will be made based on the schedule presented in Section 5.2. Phase II will then proceed based on one Case only.

<u>Phase II - Project Definition</u>

The primary objective of Phase II will be to define the Dumai Base Oils Project in sufficient technical detail so that the project may proceed into detailed engineering, procurement, and construction under a lump sum "EPC" Contract. Obtaining outside financing to fund all or a portion of Phase II will be required. Additional project participants are expected to join the Consortium in developing the project. A summary level schedule and execution plan for this phase are included in Section 5.2 and 5.3. Phase II start is expected to begin in the ____________. At the completion of this phase, project viability will again be reconfirmed and financing for Phase III (EPC Contract Period) secured. Approximately one year will be required to secure Phase III project financing. Agreements such as feed supply, product offtake, transfer pricing, operating and maintenance services, technical advisory, joint venture partnerships, technology, etc. will be finalized during Phase II.

<u>Phase III - EPC Contract Period</u>

As noted previously, a lump sum "EPC Contract" for execution of detailed engineering, procurement, and construction is expected. The "EPC Contract" is expected to be awarded during ____________ after allowing for sufficient time for bid preparation, contract negotiations, etc. Based on this "EPC Contract" award date, mechanical completion of the Dumai Base Oils Project should be in the ____________ with partial production following immediately in the ____________. A summary level execution plan for this phase of the Dumai Base Oils Project is included in Section 5.3.

To maximize the probability that the Dumai Base Oils Project will prove to be a viable, long-term project, Consortium participants are expected to provide appropriate levels of assistance during development, engineering, construction, and start-up.

5.2 Master Project Schedule

Figure 5-A on the following page presents a reasonable Master Project Schedule of approximately ____________ (from completion of the Feasibility Study to initial production)

[The information contained on page 5-3 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

for implementing the Dumai Base Oils Project. This schedule has been prepared recognizing that the smooth execution of the project and the attainment of completion within the shortest reasonable period are most important for the Consortium. Emphasis in developing this schedule was placed on Cases 1 and 2 as directed by the Consortium. An Overall Master Schedule for Cases 3 and 4 probably would be somewhat longer due to the added complexity, but for the purposes of this are assumed to be within this range.

Phase II - Project Definition Schedule

The Phase II schedules presented in Figures 5-B & 5-C on the following pages were developed from discussions with Chevron and from Fluor Daniel's experience in executing similar front-end engineering work for the EXOR-IV Project. Chevron provided Phase I-B and Phase II schedule information regarding project development, funding, and process licensor engineering durations. The EXOR IV Project was a grass roots refinery complex to be located physically adjacent to the existing UP-II Refinery at Dumai. Although the EXOR IV Project was much larger in size and scope, many technical activities performed during the EXOR IV Project Definition Phase are similar to what is required to define the Dumai Lube Base Oils Project. A suggested contents listing of the Project Definition Document is provided in Table 5.1 on page 5-7.

Phase III - EPC Contract Period

The ____________ duration suggested for the Phase III schedule presented in Figure 5-D on page 5-8 is based on Fluor Daniel's experience in executing similar-sized projects in Indonesia, and assumes that the Phase II Engineering Contractor is the same as the Phase III EPC Contractor. The schedule also assumes that for the most part, plot plans, piping and instrumentation diagrams, and equipment vendors have been reviewed and approved during Phase II.

[This deleted information is considered confidential and proprietary.]

[The information contained on pages 5-5 through 5-6 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

Table 5.1
Project Definition Document Contents

1. Project Definition and Description
2. Process and Facility Description
3. Infrastructure and Common Facilities Definition
4. Owner's and EPC Contractor's Scope of Work
5. Project Execution Plan (Engineering, Procurement & Construction)
6. Constructability Program Manual
7. Licensor Data
8. Process Flow Diagrams
9 Piping & Instrumentation Diagrams
10. Utility Flow Diagrams
11. Site Development Plan
12. Overall and Unit Plot Plans
13. Appropriate Electrical One Line Diagrams
14. Area Classification Drawings
15. Control System Design Philosophy
16. Detailed Engineering Design Basis
17. Equipment Lists
18. Specifications for Major Equipment
19. Acceptable Vendor and Subcontractor Lists
20. Project Specifications (Engineering Standards and Drawings)
21. Site Survey Information (Geotechnical, Bathymetric, Topographic, Marine, etc.)
22. Environmental Requirements
23. Training Program Outline
24. Objectives/Priorities of Owners
25. Safety/Hygiene Objectives
26. Regulatory Requirements
27. Permitting Strategy Outline
28. Financial Objectives, Priorities, and Strategies
29. Operational Requirements
30. Project Quality Requirements Definition
31. Criteria Established for Making Cost/Schedule/Quality Tradeoffs
32. Project Safety Process Outline

[The information contained on page 5-8 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

[This deleted information is considered confidential and proprietary.]

5.3 Phase I-B and Phase II Project Execution Plan

Once Phase I is completed and the decision is made to proceed to Phase I-B and Phase II (the PDD phase), Chevron must accomplish several major activities by as part of Phase IB:

- Additional pilot plant work must be done. The original pilot plant work was intended to confirm the yield and product quality assumptions made at the start of Phase I. Depending on the outcome of these original pilot studies, the derivative case studies, and the desired product qualities, additional pilot work will be required to explore the feed quality options and to define process conditions.

- While this additional pilot plant work goes on, Chevron will review the proposed project as it emerges from the derivative case studies with other participants, with the objective of securing Letters of Intent (LOI) to support Phase II.

- Simultaneously, Chevron will enter into negotiations with Pertamina on behalf of LOI participants, with the intent of establishing a Memorandum of Understanding (MOU) covering feedstock supply and pricing, operating agreements, etc., at the Dumai Refinery.

- At the same time, financing for Phase II will be secured.

- All LOI participants will review the pilot plant results and their own marketing strategies, etc. to finalize a Design Basis for the project process designs.

- Chevron will complete the Process Design for Construction work. When it is available, Fluor Daniel will be given sufficient information to start their PDD activities, which will include engaging other process licensors as required for their proprietary input.

- Permit applications will be made. It is anticipated this will involve BKPM and/or Kepres 39 activities.

- A financial adviser will be retained, if appropriate, to assist in structuring project agreements to enhance prospects of final project financing.

- During the PDD preparation, negotiations will take place to finalize the joint venture agreements, all matters with Pertamina, and other permits and/or agreements necessary to proceed with the project once the final decision to proceed is reached by the joint venture partners. Following this decision, financing will be finalized.

Other key items that are critical to the success of the Phase II (Project Definition) are as follows:

- Perform a thorough survey of the existing UP-II Refinery maintenance and other facilities, laboratory, and fire and safety provisions to firmly establish any additional facilities needed for the Dumai Lube Base Oils Project.

- Preparation of a comprehensive financing plan to secure project financing for Phase III. Financing is expected to take approximately one year to complete.

- The technology licensor must verify with the United States Department of Commerce, Bureau of Export Administration, Office of Technical Policy Administration, the need for individual validated export licenses for the specific technologies to be exported. A response to whether or not individual validated export licenses are required is expected in approximately 15 days.

  If individual validated export licenses are required, it takes approximately 2 months after a complete application is submitted. While requirements vary, it is expected that the application requires process designs, P&IDs, plot plans and critical process drawings, as required. Other documents required will be determined on a case-by-case basis.

  Alternately, a Letter of Assurance from the license that he will abide by the U.S. Export Laws may be all that is required.

  Supply of catalysts are also subject to the same export restrictions as technology, even if they are supplied from a third country.

- Obtain all required Indonesian governmental permits. Tables 5.3 and 5.4 on the following pages present an initial listing of Indonesian decrees or permits that are pertinent to the development and execution of the Dumai Base Oils Project.

5.4 Phase III Project Execution Plan

EPC Contract Period (Project Execution Plan)

The Phase III schedule is presented in the previously illustrated Figure D on Page 5-8.

Key points to be noted during the EPC Contract Period are as follows:

- Project funding or project participant arrangements may place specific execution requirements on the EPC Contractor, which may affect the final negotiated price of the EPC Contract.

- Involvement and strong participation by UP-II Refinery personnel in constructability and shutdown planning, logistics, etc. is critical to the success of the project.

- The Owner's Project Management Team must be in place at the start of the EPC Contractor's work to effectively manage and provide assistance to the EPC Contractor.

- All permits and licenses to be obtained by the Owner must be secured prior to the EPC Contract Effective Date.

- Land acquisition must be complete or arranged for prior to the work commencing.

- All Owner's Scope of Work items and responsibilities must be incorporated into detailed overall EPC Contract Period schedule and the dates adhered to.

- Planning and coordination with UP-II Refinery Operations and Maintenance personnel are paramount to success at the job site to facilitate tie-in work and to ensure that the work proceeds safely with a minimum impact on refinery operations.

- The Owner's operations and maintenance training program should be developed and implemented well in advance of EPC Contract Mechanical Completion to allow start-up and operations to proceed smoothly and safely.

Table 5.3
Current Indonesia Regulations Regarding Planning and Execution

1.0 EKUIN Directive No. SE-10/M.EKUIN/1992

"Utilization of the National Ability for the Development Planning and Arrangements"

[Specifies Indonesian Content]

2.0 The Use of Domestic Products in the Sector of Oil and Gas Operations

No. SE-14/M.EKUIN/1989, September 20, 1989

[Specifies Indonesian Content]

3.0 Decree No. KPTS-184/C0000/86-B1

"Implementation Directives of Presidential Decrees No. 29 & 30, 1984

[Specifies Indonesian Content]

4.0 Guidelines for Importers as per

"Joint Decree of Minster of Trade, the Minster of Finance and the Govemor of Bank Indonesia No. 656/KPB/IV/85, 329/KMK 05/85 and 18/Z/KEP/GBI of April 1985

and

Circular Letter of Bank of Indonesia No. 18/1/ULN of April 1985

[Both Identify Import Restrictions, Migas Inspection, etc.]

5.0 Decree of the State Minister for Population and Environment

"Decree of the State Minister KLH Nomor: KEP-03/MENKLH/II/1991 regarding Quality Standards for Existing Operations"

[Specifies Environmental Requirements]

Table 5.4
Project Permitting in Indonesia

The following summarizes the sequence and type of submissions carried out in the application for the various permits:

All information listed below is typical and can vary depending on location of plant.

Type of Application	Type of Documents Required	To Department	Approximate Time For Approval
1. Application for planning approval	• Overall plot plan • Land title • EIA report	BkPM (Investment Coordinating Board)	~ 1.5 Months
2. Application for permission to install temporary structures	a. Temp. construction site office drawings b. Temp. water supply for construction use c. Telephone connection to site office d. Electricity for construction use	After building plans submission a,b,c permit is not required d. PLN (elect. state owned comp.) If using own gener. permit not required	~ 1 Month
3. Application for special permit to commence piling work	• Location plan • Documentation Re: to land title, transfer of land title, etc. • Piling equipment to be used	PEMDA (district council)	No special permit, only notification to commence work
4. Application for approval of pressure vessels	• Third party certificates • Equipment drawings • Design calculations	Department of Industry Migas	~ 1.5 Months

Table 5.4 (continued)

Type of Application	Type of Documents Required	To Department	Approximate Time For Approval
5. Application for approval of building/architectural plans	• Building/architectural plans • Standard form for submission of building plans by registered engineer • Location plan	PEMDA (district council)	~ 3 Months
6. Application for approval of fire protection system design	• Building and/or plant layout drawings • Fire protection system drawings • Location plan	Fire service department (Pemadam Kebakaran) Jakarta and various districts	3 Weeks
7. Application for approval to install machinery and equipment	• Plot plan and standard forms • List of equipment to be installed	Department of Manpower only requires for boilers and pressure vessels	1 Month
8. Application for approval of sewerage treatment	• Location plan • Design drawings	PEMDA (district council) Ministry of Environment	3 Months
9. Application for approval of drainage system	• Location plan • Design drawings	PEMDA (district council) Ministry of Environment	3 Months
10. Application for approval of telephone system	• Cable routing drawings • Overall layout	P.T. Telkom (state owned telecomm. company)	3 months
11. Application for approval of waste water treatment system	• Design calculations and drawings • Effluent discharge inform.	Department of Environment and Population	2 Months
12. Application for the Operating Permit (Certificate of Fitness)		PEMDA (district council)	1 Month

- Early construction of additional housing at the UP-II Refinery Housing Complex for expatriate construction and Owner's personnel is critical.

Described below is a proposed general execution philosophy and strategy for executing the EPC Contract phase of the project. For this exercise, it is assumed that the EPC Contractor is U.S. based and project funding requirements dictate mostly U.S. goods and services be used. The starting point for the EPC Contract will be a well defined technical basis as developed during Phase II. Understanding the Owner's objectives, and the general execution approach will be the key for managers at all levels to contribute to the successful execution of the project.

Engineering and Design Approach

A project of this type will be undoubtedly construction driven, and the engineering and design plan will need to support this. Fluor Daniel believes that detailed engineering execution of the Dumai Base Oils Project will involve design in at least two office locations, one based at the EPC Contractor's Home Office and the other at an engineering office in Jakarta or at the UP-II jobsite. This approach is suggested because:

- Detailed engineering for the "grass roots" portion of the project is probably best carried out in the EPC Contractor's Home Office where adequately trained resources, systems, procedures, and tools are in place.

- Detailed engineering for the revamp portions of the project is best carried out where easy access to the site relative to modifications, tie-ins, and integration of the new units is possible. This approach satisfies the intent of recent Indonesian legislation designed to improve the skills of Indonesian citizens and to protect the commercial economy of Indonesia.

Technology Transfer

Based on previous project experience in performing work in Indonesia, Indonesian personnel will be asked to observe and participate in all phases of the work at all locations. The intent of this provision is to help train Indonesian technical and management personnel in the details of the work and the management of the design and construction process.

Procurement Plan

Due to the assumption of U.S. based funding for the project, there will be a concerted effort to maximize U.S. goods and services on the project. This will limit the number of items the Contractor may procure on a worldwide basis, which will require the process licensors to specify U.S. manufactured equipment rather than European or Japanese equipment. Monitoring of local Indonesian agents, vendors, and subcontractors for U.S. goods and services contract also will be required.

Indonesian decrees and regulations also will require that the EPC Contractor maximize the procurement of Indonesian equipment and materials, consistent with other procurement constraints. To accomplish this, the EPC Contractor will develop a specific list of equipment and materials that must be purchased in Indonesia with a list of items that are available in Indonesia. Table 5.5 on the following pages contains a preliminary listing of this information.

To balance the requirements to procure both Indonesian and U.S. goods and services, the EPC Contractor will endeavor to procure U.S. goods and services unless one of the following conditions exists:

a. Specific material or equipment must be procured from an Indonesian source;
b. Specific material or equipment cannot be procured from a U.S. or Indonesian source; or,
c. The process licensors or Owners require a specific non-U.S. and non-Indonesian supplier for equipment they specify.

Table 5.5
Material and Equipment Available in Indonesia

Description	Material Available in Indonesia	Import
Civil and Structural		
EXCAVATION AND CIVIL	x	
Backfill	x	
Sumps, Rockfill	x	
Piles	x	
Road/Area bedding materials	x	
Road/Area top course materials	x	
Curbs, guard posts, etc.	x	
Fencing	x	
CONCRETE MATERIALS		
Additives, grout, curing compounds	x	x Note 1
Cement and aggregates	x	
Ready Mix Cement	x	
FORMING MATERIALS		
Lumber, nails	x	
Permanent forms	x	
Clamps and shoring	x	
REINFORCING MATERIALS		
Rebars, straight	x	
Rebars, fabricated	x	
Welded wire fabric	x	
Tie wire	x	
CONCRETE ACCESSORIES		
Anchor bolt stock	x	x Note 1
Anchor bolts fabricated	x	x Note 1
Nuts and washers	x	x Note 1
Water stop	x	
Curb angle	x	
Teflon slide plates		x
Sleeves		x
Polyethylene sheets	x	

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Description	Material Available in Indonesia	Import
MISCELLANEOUS		
Acid brick	x	x Note 1
Trench cover	x	
Manhole frames and cover	x	
Precast catch basins	x	
Bittumastic joint compound	x	x Note 1
Expansion joint compound	x	x Note 1
Expansion bolts	x	x Note 1
Survey monuments	x	
Incorts and ladder steps	x	
Leveling plates	x	
FABRICATED STEEL		
Structural members	x	
Grating	x	
Checkered plate	x	
Ladders and platforms	x	
Pipe supports and pipe racks	x	
Monorails	x	
Stair and handrails	x	
Unistrut for pipe supports	x	
Embeds	x	x Note 1
MISCELLANEOUS STOCK		
Shapes, plate, and bar	x	
MASONRY		
Concrete blocks	x	
Common brick	x	
Acid resistant brick	x	x Note 1
Mortar	x	
Acid resistant mortar	x	x Note 1
Acid resistant coatings	x	x Note 1
FRAMING (WOOD OR METAL)		
Walls		
Partitions	x	
Ceilings	x	
Floors	x	
Roofs	x	
	x	

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Description	Material Available in Indonesia	Import
HVAC		
Heating equipment	x	
Radiators	x	
Ventilators	x	
Fans	x	
Filters	x	x Note 1
Refrigeration units		x
AC ductwork	x	x
Louvers	x	
Instrumentation and controls		x
PLUMBING		
Fixtures	x	
Piping	x	
Hot water heater	x	
Water cooler	x	
Kitchen unit	x	
Fire sprinkler system	x	
Machinery and Equipment		
FIELD FABRICATED VESSELS		
Tankage		
Spheres	x Note 3	Materials
SHOP FABRICATED VESSELS		
Columns	x Note 2	
Vessels	x Note 2	
Reactors		x
Ladders and platforms	x	
Davits	x	
Tanks	x Note 2	
Drums	x Note 2	

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Description	Material Available in Indonesia	Import
COMPRESSORS AND GENERATORS		
Compressors (process)		x
Compressors (inst. air)		x
Compressor drivers and turbines		x
Compressor gear sets		x
Compressor intercoolers		x
Compressor pulsation system		x
Analog study		x
Instrument piping		x
Blowers and fans		x
Diesel engine general package		x
Sheet and tube exchangers	x Note 2	x
Air cool exchanger	x Note 2	x
Double pipe exchanger	x Note 2	x
Waste heat boiler		x
Cooling towers	x Note 3	Material
FIRED HEATERS AND BOILERS		
Fired heaters	x Note 3	Material
Stacks	x Note 3	Material
Ducts/Stacks	x Note 3	Material
Refractories	x Note 3	Material
PUMPS		
Centrifugal pumps		x
Sump pumps	x Note 2	x
Positive displacement pumps		x
Metering pumps	x Note 2	x
Rotary pumps		x
Diaphragm pumps		x
Electric pump		x
Turbines		x
Gear boxes		x
MATERIAL PROCESSING EQUIPMENT		
Coalescers		x
Ejectors systems		x
Filter and separators	x Note 2	x
Flare systems		x
Mixer/agitators		x
Chemical injection systems		x
Vacuum systems		x
Special package units		x
Misc. refrigeration equipment		x
Misc. water treatment equipment		x
Lubrication systems		x

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Description	Material Available in Indonesia	Import
SOLIDS AND MATERIAL HANDLING EQUIPMENT		
Cranes and hoists		
Elevators	x	
Feeders, slides, gates		x
Bulk storage	x Note 2	x
		x
MISCELLANEOUS EQUIPMENT		
Fire protection	x	
Catalysts		x
Lubricant and fuels	x	x Note 1
Spare parts	x	x
<u>Piping</u>		
UNDERGROUND PIPING		
C.S. pipe, fittings, flanges (shop fab)	x	x Note 1
C.S. pipe, fittings, flanges (field fab)	x	x Note 1
FRP or PVC piping	x	
Bolts gaskets	x	x Note 1
ABOVEGROUND (FIELD FAB)		
C.S. pipe, ftg, flgs. (2" and smaller)	x Note 2	x
Alloy pipe, ftg, flgs. (2" and smaller)		x
C.S. pipe, ftg, flgs. (2 1/2" and larger)	x Note 2	x
Alloy pipe, ftg, flgs. (2 1/2" and larger)		x
ABOVEGROUND ASSEMBLY MATERIAL		
Flanged valves	x Note 2	x
Butt weld valves	x Note 2	x
Bolts and gasket	x	x Note 1
Blinds and spacers	x Note 2	x
Strainers	x	x Note 1
Expansion joints		x
Springs hangers, hangers rod		x
Shoes, guides, clamps	x	x Note 1
Fire hydrant/monitors	x	
Insulation sets	x	x Note 1
Shock arresters/struts	x	x
ABOVEGROUND SCRD/SW PIPING		
SW valves	x Note 2	x

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Description	Material Available in indonesia	Import
Insulation and Coating		
PIPING		
Paint	x	x Note 1
Insulation	x	x Note 1
Coating	x	x Note 1
Wrapping	x	x Note 1
Cathodic protection	x	
EQUIPMENT/VESSELS/TANKS		
Paint	x	x Note 1
Insulation	x	x Note 1
Fireproofing	x	x Note 1
Electrical Equipment and Materials		
MAJOR ELECTRICAL EQUIPMENT		
Incoming power distribution system		x
Power transformer		x
Switchgear 415v and over		x
Motor control centers 415v and over		x
Uninterruptible power supply		x
Power circuit breaker	x	
Switch racks	x	
Lighting panels and transformer	x	
Communication systems (infra plant)		x
Power metering system	x	
Batteries and charger	x	
Power rectifiers		x
Variable speed drives		x

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Description	Material Available in Indonesia	Import
ELECTRICAL BULK MATERIAL		
Conduit	x	x Note 1
Conduit fittings	x	x Note 1
Cable tray	x	x Note 1
Cable tray fittings	x	x Note 1
Power cable	x	x Note 1
Control cable	x	x Note 1
Thermocouple cable	x	x Note 1
Wire	x	x Note 1
Termination kits	x	x Note 1
Splice kits	x	x Note 1
Lighting fixtures	x	
Lamps	x	
Control stations, pushbutton	x	x Note 1
Welding outlets	x	x Note 1
Electrical heat treating	x	
Strut materials	x	
Support materials	x	
Misc. assembly materials		x
Grounding materials	x	
Electronic instrument cable	x	x Note 1
Poles	x	
Control Systems		
CONTROL SYSTEM ENGINEERED ITEMS		
Control valves		x
Safety and relief valves		x
Level instruments and gauges		x
Pressure instruments and gauges		x
Temperature instruments and gauges		x
Flow instruments and elements		x
Control panels		x
Transmitter		x
Annunciators and switches		x
Analyzer		x
Distribution control systems		x
		x
		x
CONTROL SYSTEM BULK MATERIALS		
Tubing	x	x Note 1
Tube Fitting	x	x Note 1
Valves	x	x Note 1
Prefab instrument supports	x	
Raceway		x
Tubing Bundles		x
Pipe fittings	x	

Note 1: Most items available in Indonesia. Items requiring special materials or unusual requirements will probably be purchased offshore.
Note 2: Low pressure, CS, small sizes may be purchased in Indonesia.
Note 3: Materials and some prefabrication may be from offshore. Assembly and final fabrication may be in Indonesia. When placing order on a case by case basis, it may be required to split order into onshore/offshore.

Consolidation Shipment and Customs Clearance

The U.S. based EPC Contractor will probably establish a consolidation yard for shipment of U.S. equipment and materials located on either the U.S. gulf or west coasts. At this location, materials will be packed for export, inspected, and shipped to a trans-shipment point (probably in Singapore) for consolidation into complete barge loads for final shipment to the UP-II jobsite. The EPC Contractor will containerize shipments to the maximum extent possible and use air-freighting sparingly.

All equipment and materials imported into Indonesia typically name the Owner as consignee and transfer title to the Owner at the port of exportation. Customs inspection of shipments from the U.S. will take place at the U.S. consolidation yard prior to shipment, as well as at the jobsite. Typically an EPC contractor would establish a bonded customs clearance area at the jobsite to facilitate customs clearing.

Materials Management

To execute a project of this magnitude, the EPC Contractor will need to use a proven Materials Management System (MMS) to track and control materials for the Project. This system will be used to track materials information from the placement of purchase order, through expediting, inspecting, and shipment to the site. Upon arrival, the job-site MMS systems will be used to control materials.

Early Materials Purchases

To maintain the project schedule, the EPC Contractor will need to place purchase orders for all major equipment as soon as possible after EPC Contract Effective Date. Inquiries for all major equipment will be issued during the PDD Phase to establish equipment pricing for the lump sum EPC contract bid and will form the basis for selecting equipment vendors.

As soon as engineering permits, the EPC Contractor will also need to place blanket purchase orders for bulk materials to meet the construction schedule. These blanket purchase orders will be based on "conceptual" take offs for all materials using the best available information to develop an estimate of the total project needs. Actual purchases will be "drawn down" against these blanket orders.

Subsequently, the EPC Contractor will compare these materials takeoffs against actual requirements, using his Materials Management System.

Approved Vendors and Sub-Contractors

The EPC Contractor will be required to procure equipment and materials and issue subcontracts to pre-approved vendors and subcontractors. During the PDD phase, a list of approved vendors and subcontractors for both onshore and offshore procurement of all equipment and materials will be developed and submitted for review. This will be an extensive list and will largely consist of U.S. and Indonesian vendors and subcontractors. Approved subcontractors will also be requested to submit their vendor or subcontractor selections for approval.

Subcontracting Plan

This section describes typical work that the EPC Contractor will probably subcontract. The majority of subcontracts if not all subcontracts on this project will be with Indonesian firms and will be prepared and administered from the EPC Contractor's Indonesian project offices.

As indicated previously, the EPC Contractor will need to subcontract detail engineering services to local Indonesian engineering companies. The selected Indonesian firms typically would provide engineers and supervisors to work under the supervision of the EPC Contractor to perform detail engineering and construction assistance as required.

In addition to engineering services, typical construction subcontracts in Indonesia would include:

- Freight Forwarding
- Customs Clearance
- Geotechnical and Site Surveys
- Soils Engineering
- Site Preparation
- Piling
- Roads and Paving
- Housing and Other Infrastructure
- Batch Plant
- Dredging
- Inspection Services
- Marine Surveys
- Fencing
- Tank Fabrication
- Construction Dock
- Insulation
- Chemical Cleaning
- Cathodic Protection
- Construction Equipment
- Tug and Barge Service
- Radiography
- Temporary Facilities
- Personnel and Labor Brokering Services

Construction Plan

Construction will be accomplished by a combination of direct-hire and subcontracted labor, with preference given to Indonesian labor for both skilled and unskilled tasks. Maximum use must be made of experienced, local trained craftsmen who are available in Indonesia from other related projects. An EPC Contractor would typically rent or lease imported construction equipment and re-export it after construction.

Expatriates and third country nationals (TCN) typically fill key managerial and supervisory positions in the project organization. Indonesian government approval of all expatriates assigned to the project is mandatory.

Shutdown Plan

At least two major UP-II shutdowns will be required to complete the revamp work. The EPC Contractor should be well prepared in advance to complete miscellaneous tie-ins during unscheduled plant shutdowns. These shutdowns must be planned for and agreed to with Pertamina before the work begins.

Manpower Plan

Based on the estimated man-hours for construction of the Dumai Base Oils Project, it is anticipated that the manpower requirements for the EPC Contractor will be as follows:

EPC Contractor's Expat Staffing	_____
Indonesian Personnel	
Average	_____
Peak	_____

This expatriate staff does not include the Owner's staff, which may number another five to ten people. All efforts will be made to hire workforce from the Dumai area. However, a portion of required Indonesian workforce probably will come from outside Dumai. Hence, Indonesian-type camp facilities will be provided for labor and skilled personnel who cannot be absorbed by the local infrastructure. A camp for _____ people was included in the Capital Cost Estimates. As the project progresses, this will need to be further evaluated.

5.5 Training Programs

Presented herein is an outline of the various training programs that will need to be developed during the execution of the Dumai Base Oils Project.

Training will commence with Pertamina's Indonesian personnel in the EPC Contractor's Home Office, and continue through field construction, precommissioning, commissioning, and start-up. Pertamina, in consultation with the Owner and the EPC Contractor, will select the trainees for each phase of training and will maintain at least one supervisor conversant with the subject, and with a sufficient working knowledge of the English language to assist in the translation of instructions for on-the-job and classroom training. When considered necessary by the Owner or Pertamina, the EPC Contractor will be asked to provide appropriate temporary facilities in order to conduct the training.

Construction Training

The Contractor's training of Indonesian skilled labor for construction employment will need to consist of three basic levels or phases:

- Basic Skills Training
- Apprenticeship Training
- Journeyman Upgrade Training

All phases will include a suitable combination of classroom and technical practice. On-the-job training will be included in all phases as and where appropriate.

Training will include safety, basic craft principles and fundamentals, techniques, procedures, and practical training and certification. The Indonesian language will be used for the construction craft labor training.

Craft training shall be conducted onsite and shall include all disciplines expected to be employed for the duration of the contract including, but not limited to:

- Boilermakers
- Electricians
- Instrument Fitters
- Pipe Fitters
- Welders
- Millwrights
- Carpenters
- Ironworkers
- Insulators
- Painters

Basic Skills Training

All construction laborers who are not qualified journeymen will participate in a Basic Skills Training course for their specific craft. These programs will provide introductory instruction on tools, safety, mathematics, and fundamental work duties of the craft. Participants shall attend classes during normal working hours, and would receive entry-level pay while attending.

Apprenticeship Training

All apprentices shall participate in craft-specific training processes that combine classroom laboratory/shops, and on-the-job training. The duration of each program shall be dependent upon the complexity of the craft.

Journeymen Upgrade Training

Journeymen Upgrade programs shall be provided for project-specific procedures or skills as may be identified throughout the duration of the project. The training shall consist of the appropriate mixture of classroom instruction, technical practice, and on-the-job training.

Safety Training

Safety training programs shall be developed by the EPC Contractor for all craft construction personnel, Pertamina and Owner's field personnel, and should cover the following topics:

- New employee orientation
- General safety awareness
- Tool box safety meetings
- First aid and medical treatment
- Proper use of hand tools
- Construction equipment operation and maintenance

- Fire procedures
- Working in operating facilities
- Emergency evacuation procedures
- Tag and log out procedures

Training of Operations and Technical Personnel

The training of operations and technical personnel will include class room sessions relating to basic process knowledge, equipment descriptions, plant and refinery wide systems, and hands-on process plant control on a process simulator. A DCS training simulator has been included in the start-up costs of the Owner's Cost estimates. This training will be based on process manuals supplied by the process licensors and equipment provided by vendors. The training will be supplemented by operating manuals prepared by the Owner containing details of operating procedures. Trainers will be drawn from Pertamina, the process licensors, the EPC contractor, and appropriate vendors.

In-Plant Training will include:

- Pre-mechanical completion inspections
- Pre-start-up inspections, adjustments, and checks of all equipment and systems
- Normal start-up of equipment and systems.

Training of Maintenance Personnel

Maintenance personnel training will consist of programs covering basic skills, equipment-specific maintenance, and preventive maintenance. Course materials will cover mechanical, electrical, and instrumentation requirements including:

- Supplier's recommended maintenance, lubrication and inspection
- Routine cleaning, lubrication, adjustment, and calibration
- Special tools, equipment, and repair procedures
- Coordination with operating procedures for safety and reliability of operation
- Keeping of logs and records, and preparation of routine reports on work completed.

5.6 **Constructability Program**

Fluor Daniel, Pertamina, and Chevron agree that the development of an overall Constructability Program early in the project is paramount to achieving a successful project. The first meeting to discuss the constructability process was held in Irvine on November 17, 1992. Many topics discussed will be addressed in detail during the PDD phase.

The implementation of the constructability process will develop innovative field erection techniques and yield significant cost and schedule benefits for the Dumai Base Oils Project. Such construction methods may involve innovation related to sequencing field tasks, construction equipment, preassembly and modularization, and temporary construction materials and systems. Maximum benefits are achieved through the best combination of these methods suited to the specific facility being constructed along with stated schedule and cost objectives. The opportunity to implement the optimal level of construction innovation is significantly enhanced when plant design and material procurement are developed around a detailed construction execution strategy. Using the approach of early and ongoing constructability assessment will support a combination of innovative and efficient construction strategies. Equipment and materials will need to be purchased according to these planned construction approaches to support the optimized construction program.

The EPC Contractor's constructability process should be a forward-looking rather than a backward-looking review of completed designs. It should be an integral part of the execution of the project, and will further serve as one vehicle to assist in the EPC Contractors obligation to train and transfer technology to the Owner's organization.

Table 5.6 presents a preliminary contents listing of a Constructability Program. This Constructability Program Manual is not intended as an all inclusive cast-in-concrete document, but will evolve as the project progresses.

Table 5.6
Constructability Program

Table of Contents

6.0 FINANCIAL EVALUATION

6.0 FINANCIAL EVALUATION

This section of the report has been updated to reflect the changes resulting from the Yield Confirmation Study adjustments. However, a small portion of the section, specifically the schematics and tables associated with the "Lube Base Oils Complex Financial Model" (pages 6-7 through 6-12 and Tables 6.2, 6.3 and 6.5) were not revised since the data generated for the "UP-II Financial Model" was used in the feasibility study economic evaluations. A discussion of the two financial models is included in Section 6.2.1. Even though the data associated with the "Lube Base Oils Complex" has not been updated, it provides a basis for future work should the study participants decide to further evaluate a case based on this financial model.

6.1 Overview

Technical evaluation of the Dumai Base Oils Project has included four study cases as described elsewhere in this report. Cash flows associated with each of these cases have been forecast using conservative assumptions of capital costs, operating expenses, and other variables. This financial evaluation includes rates of return calculated on a 100% equity basis and on a leveraged, 25% equity basis for each case, plus sensitivity analyses for selected cases. The financial evaluation used data developed in current US Dollars and forecasted cash flows over an initial construction phase followed by the first 20 years of operation.

Construction funds and other capital costs are spent according to a drawdown schedule ("S-curve") which Fluor Daniel believes appropriate for the project. Capital costs and operating expense estimates and certain product prices and feedstock costs are valid as of the base year, 1993. For this evaluation, these costs and prices have been escalated with appropriate factors to represent inflationary trends during the construction and operating periods.

The financial evaluation for all four cases uses the UP-II Financial Model (see Figure 6.2.1-A), which assumes the new lube base oils complex and support facilities are additions to the existing UP-II Refinery as opposed to a stand-alone project as discussed under the Lube Base Oils Complex Financial Model. When the UP-II financial model is used, the only components considered are those which enter or leave the UP-II refinery. The streams which enter or leave the lube base oils processing units have no bearing on the financial evaluation.

The major operating expense components include increases in operating and maintenance labor, maintenance material, management and services, insurance, plant general expense, utilities, catalysts and chemicals. Incremental capital costs for the construction of the lube base oils include EPC costs, land, other owners costs, start up costs and working capital. The incremental feed for all four cases is LSWR, while the products include lube base oils plus incremental coke.

[This deleted information is considered confidential and proprietary.]

Each case was also tested for its sensitivity to product prices, operating expenses, capital cost, feedstock prices, operating days per year and project schedule. The cases proved to be most sensitive to product prices and operating days and moderately sensitive to capital costs and relatively less sensitive to feedstock prices and operating expenses.

6.2 Basis and Definitions

This financial evaluation has been performed based on an assumed financial structure and on estimates of capital costs and operating expenses as well as estimates and projections of product sales prices and other factors. Returns on investment based on 100% equity and on a leveraged financed basis with 25% equity have been calculated for each case. This analysis includes sensitivity analyses which measure the impact on profitability of changes in a number of key inputs and assumptions. A total of four different financial cases plus sensitivities has been evaluated.

A summary description of the methodology, assumptions, and basis for financial evaluation of this proposed project is presented in the following text.

6.2.1 Financial Model

The Dumai Base Oils Project (DBOP) is currently planned to be a stand-alone, private investment. To capitalize on its proximity to Pertamina's existing UP-II Refinery, DBOP will acquire feedstock, hydrogen, and certain utilities from Pertamina. It will return light products (mostly transportation fuels) generated in the base oil manufacturing process for integration into existing UP-II production. Produced base oils will be lifted for export by the owners of DBOP or its Offtakers.

Neither the identity of the initial DBOP owners nor the commercial structure of their venture can be confirmed at this time. Therefore, the precise terms and conditions applicable to the acquisition of feedstock, hydrogen, and utilities from Pertamina are not known. The same circumstance is true regarding the return of light products from the Lube Base Oils Complex to the UP-II Refinery.

During the course of the study two distinct approaches were identified for generating the financial evaluation model. For the purpose of discussion these two models are identified as follows:

- UP-II Financial Model
- Lube Base Oils Complex Financial Model

A very simplified schematic of the two financial models is presented in Figures 6-A and 6-B on the following pages. The UP-II Financial Model uses an incremental approach to economic analysis. Incremental feeds and products resulting from addition of the DBOP

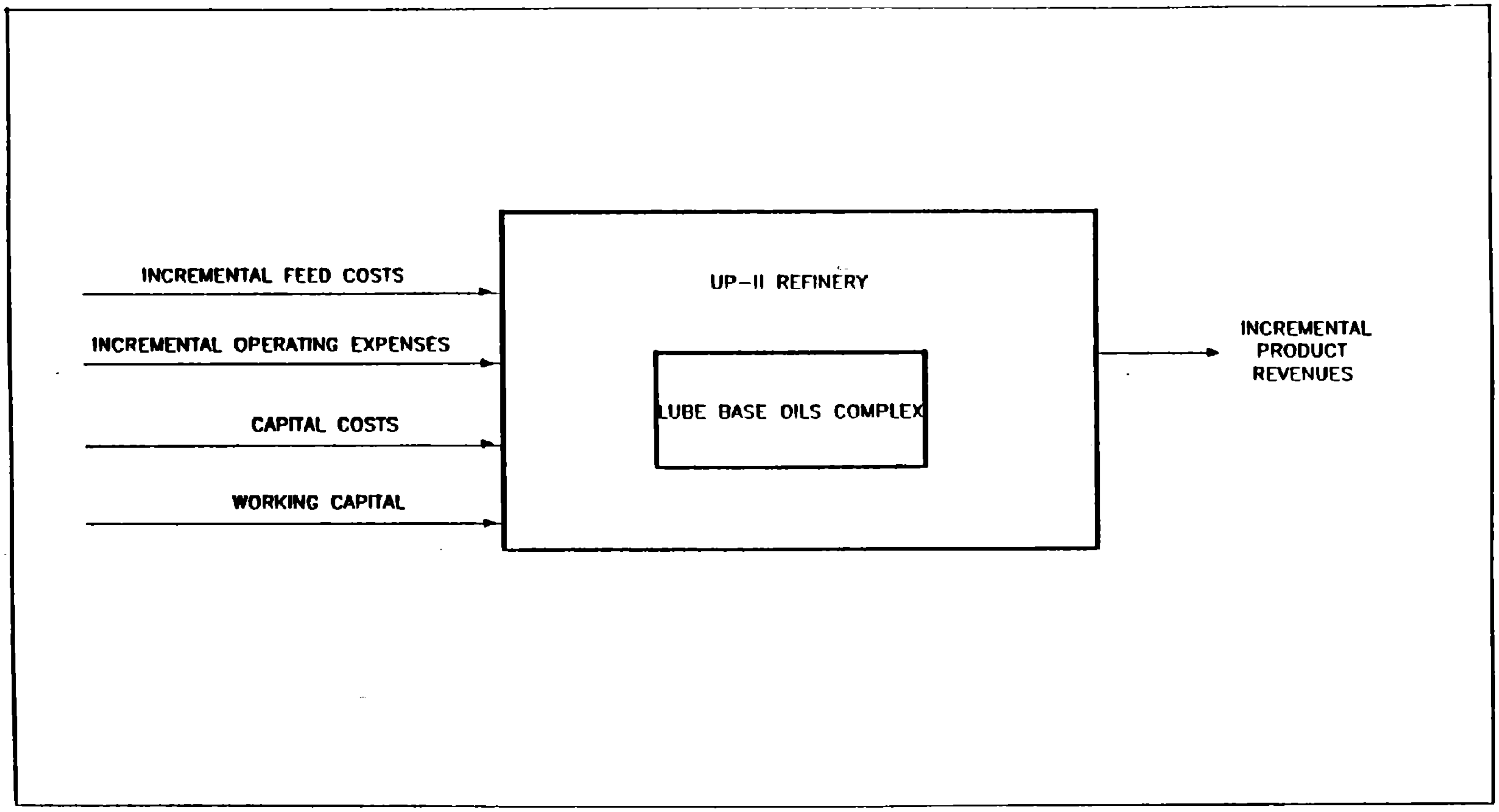


Figure 6-A
UP-II Financial Model

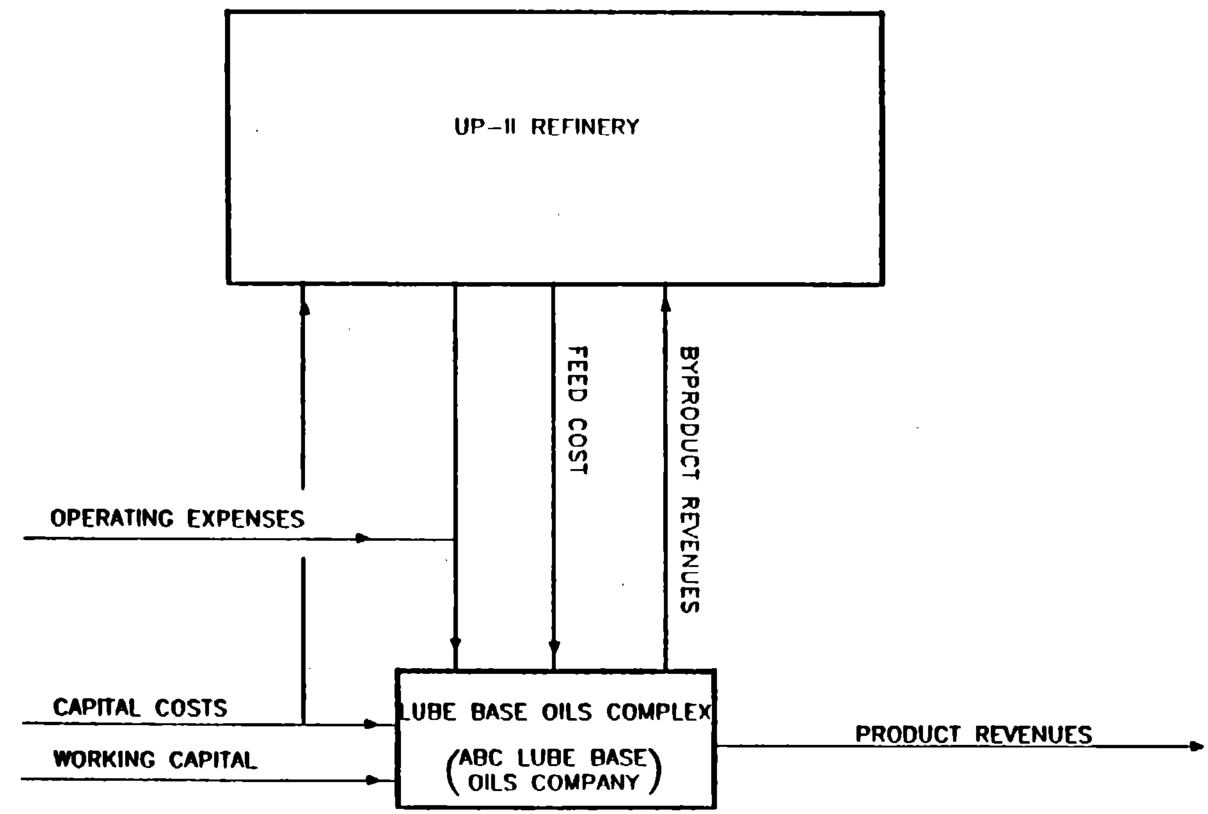


Figure 6-B
Lube Base Oils Complex Financial Model

to the UP-II Refinery are quantified and used in the analysis. On the other hand, in the Lube Base Oils Complex Financial Model, all feeds, byproducts and utilities that are transferred between the new complex and the UP-II Refinery are quantified and used in the analysis.

The UP-II Financial Model was selected for use in the financial evaluation of the study cases primarily due to its simple approach and the ready availability of feedstock prices. The Lube Base Oils Complex Financial Model was not used because it is more complex and involves estimating transfer prices between the UP-II Refinery and the new Lube Base Oils Complex. The economic analysis results obtained from the UP-II Financial Model should not be significantly different from results that would be obtained from using the Lube Base Oils Complex Financial Model. However, specific transfer pricing arrangements, particularly for the feedstocks, could impact the results obtained with the Lube Base Oils Complex Financial Model.

A brief discussion of both financial models is presented below.

UP-II Financial Model

In this financial model, the new Lube Base Oils Complex and support facilities are considered to be a physical part of the existing UP-II Refinery, although the ownership may in fact be separate. Therefore, only those components which enter or leave the UP-II Refinery are used in the model. The streams which enter or leave the Lube Base Oils Complex processing units have no bearing on the financial evaluation. Similarly, since all utilities, with the exception of river water, are internally generated within the UP-II Refinery, the expenses associated with utilities are not directly assessed, but rather are indirectly reflected in the incremental UP-II Refinery LSWR or crude feed requirements. The major expense and revenue components include feed costs, operating expenses, product revenues, and capital costs, including interest and working capital. The capital cost includes all costs, regardless of the ownership, and consists of costs to install new Lube Base Oils Complex units, modify the existing UP-II Refinery units, and add new utilities, offsites and support systems. The incremental feed used for all study cases is LSWR, while the products are lube base oils, incremental coke, and incremental transportation fuels (diesel, kerosene, naphtha, etc.), if any.

The UP-II Financial Model was used to carry out the financial evaluation for each of the four study cases. All evaluations were done on incremental basis over the Base Case. The incremental feed costs and product revenues were based on the stock material balances included in Section 9.3.2. The other financial model input components are identified in the appropriate sections of this report.

Lube Base Oils Complex Financial Model

In this model, the Lube Base Oils Complex is considered to be a separate entity (designated as the ABC Lube Base Oils Company), that is however, integrated to the UP-II Refinery (from the viewpoint of feeds, byproducts and utilities). The ABC Lube Base Oils Company consists of all new lube processing units, and intermediate and final lube products tankage, and dedicated (not integrated to UP-II Refinery) offsite systems. The modified existing process units and additional utility/offsite equipment (added to the existing utility and offsite systems) required to support the Lube Base Oils Complex are considered to be a part of the UP-II Refinery even though the capital required for these modifications and additions are provided by the DBOP.

The Lube Base Oils Complex Financial Model also assumes that the UP-II Refinery supplies all feedstocks and all required utilities to the ABC Lube Base Oils Company and takes back byproducts and effluent streams for further processing, all at agreed-upon costs. A portion of the required ABC Lube Base Oils Company operation support will possibly be supplied by the refinery under agreement with the ABC Lube Base Oils Company. This support may include operating and maintenance labor and the use of the existing dock facilities, laboratories, maintenance shops. Examples of the operating expenses that can be directly allocated to the ABC Lube Base Oils Company include catalysts and chemicals expenses, insurance costs and management expenses.

One of the more difficult tasks is to arrive at a transfer price for each stream or service that is exchanged between the ABC Lube Base Oils Company and the UP-II Refinery. The streams that have an established market can be easily priced. For other streams and services, however, a mechanism must be devised to arrive at equitable transfer prices. This mechanism should take into consideration that ABC Lube Base Oils Company is providing capital to the UP-II Refinery for modifications to the existing process and utility/offsite units. Conversely, the ABC Lube Base Oils Company is using some of the existing excess or spare capacity in the UP-II Refinery process and utility/offsite units. The transfer price agreements between the ABC Lube Base Oils Company and the UP-II may have considerable impact on the results of the financial evaluation. The transfer price and service agreements must be sufficiently developed in order to effectively employ this financial model.

Simplified schematics for the Lube Base Oils Complex Financial Model that identify and define the major transfer streams between the UP-II Refinery and the new Lube Base Oils Complex for each of the four study cases are presented in Figures 6-C through 6-F on the following pages. Note that the feed and byproduct stream rates to and from the Lube Base Oils Complex are slightly different from those included in the stock material balances presented in Section 3.1.2. The stock balance rates shown in Section 3.1.2 are nominal figures, while the numbers presented in these schematics have been further developed.

The economic analysis of these cases has not been carried out using the Lube Base Oils Complex Financial Model because transfer prices have not yet been agreed upon. Also, Figures 6-C through 6-F were not revised based on the Yield Confirmation Study since the UP-II Financial Model was used in the economic analysis. However, the concept of an independent ABC Lube Base Oils Company and its relationship to the UP-II Refinery remains valid. The data on these figures can be revised at a later date when a single case is identified for further evaluation and transfer price agreements are initiated.

6.2.2 Project Life

[This deleted information is considered confidential and proprietary.]
For purposes of the financial evaluation, operating life is assumed to be 20 years.

[The information contained on pages 6-9 through 6-12 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

6.2.3 Capital Costs

a. ***EPC Contract Costs***

The EPC Contract Costs for the engineering, procurement and construction of the project were prepared by Fluor Daniel and include costs spanning the period from project definition to mechanical completion. The EPC Contract Costs are presented in Table 9.14 in Section 9.3.3.

b. ***Land***

Land costs include the costs associated with infrastructure housing and the land costs inside the UP-II Refinery. Land costs for the infrastructure housing area were provided by Pertamina. Land costs inside the UP-II Refinery were estimated by Fluor Daniel. Land costs are presented in Table 9.16 in Section 9.3.3.

c. ***Other Owner's Costs***

Other owner's costs include process licensor fees and royalties, and the costs assigned to project management, the initial charge of catalyst and chemicals, etc., are shown in Table 9.16 in Section 9.3.3. Most of this information was furnished by Chevron and Pertamina, with the remainder based on Fluor Daniel in-house sources.

d. ***Start-up Costs***

Start-up costs are the Owner's costs associated with the start-up of the facility and include labor and all other associated costs, except raw materials. These costs were provided by Chevron, and are included in Table 9.16 presented in Section 9.3.3.

[This deleted information is considered confidential and proprietary.]

6.2.4 Working Capital

Working capital is defined as current assets minus current liabilities, and typically reflects requirements for operational cash, accounts receivable/payable, inventories, etc. For the purpose of this analysis, working capital was estimated to be equal to 1 month of revenues and is summarized below:

	MM$
• Cases 1 and 2	____
• Cases 3 and 4	____

6.2.5 Interest During Construction

Interest During Construction (IDC) is the interest accrued during the project's engineering and construction phase and prior to plant completion. IDC is capitalized and added to the outstanding principal.

6.2.6 Feedstock

Feedstock into the UP-II Refinery include crude oil and low sulphur waxy residue (LSWR). With the construction of the base oil plant, there will be an incremental increase in LSWR; no increase in crude oil requirements is expected. For the economic analysis, the initial price of LSWR was assumed to be $15 per barrel, which reflects the average 1992 low spot price for LSWR in Singapore as published daily by Platt's. This price has been escalated, beginning in 1993, to reflect 3% annual inflation. As there is no expected increase in crude requirements, no forecast of crude prices was made. The incremental LSWR quantities for each case were obtained from the stock material balances (Table 9.5), presented in Section 9.3.2. These are summarized below:

	Incremental Feedstock (LSWR), BPSD
• Cases 1 and 2	_____
• Cases 3 and 4	_____

6.2.7 Operating Expenses

Annual operating expenses are divided into fixed and variable components. A description of how these components were estimated is provided below:

Fixed Operating Expenses

The fixed operating expenses are essentially independent of the plant operating factor and are composed of the following elements:

- Operating and Maintenance Labor
- Maintenance Material
- Management and Services
- Insurance
- Plant General Expenses.

- **Operating and Maintenance Labor**

The yearly operating and maintenance labor expenses were computed using the estimated number of operating and maintenance personnel and the annual wage rate for each labor category. Pertamina and Chevron provided an estimate of direct manpower requirements for operating and maintaining the new Lube Base Oils Complex and the additional utility and offsite facilities. Pertamina also provided an average wage rate for each classification of plant personnel. Table 6.1 on 6-16 page presents a

Table 6.1

DIRECT OPERATING & MAINTENANCE MANPOWER

	CASES 1 & 2			CASES 3 & 4		
Classification	Staff	Non Staff	Total	Staff	Non Staff	Total
Plant Manager	1		1	1		1
Superintendent	1		1	1		1
Shift Superviser	5		5	5		5
Shift Superviser Assist.	5		5	5		5
Plant Operators	–	65	65	–	90	90
Plant Mgmt. Support	1	1	2	1	1	2
Offsite Operators	–	12	12	–	17	17
Utility Operators	–	12	12	–	12	12
Maintenance Eng/Tech	2	10	12	2	10	12
Infrastructure Main.	–	1	1	–	1	1
Electrical Eng/Tech	–	2	2	–	2	2
Instrument Eng/Tech	1	3	4	1	3	4
DCS Eng/Tech	1	1	2	1	1	2
Rotating Equip Eng/Tech	1	1	2	1	1	2
Equipment Inspectors	1	–	1	1	–	1
Process Engineers	2	–	2	2	–	2
Laboratory Supv/Tech	2	12	14	2	12	14
Safety Inspectors	1	1	2	1	1	2
Plan and Schedule	1	1	2	1	1	2
Personnel Supv	1	–	1	1	–	1
Finance & Accounting	1	3	4	1	3	4
Logistics Supv/Tech	1	1	2	1	1	2
Trainer	1	–	1	1	–	1
Trainee & Relief	–	–	–	–	–	–
Security	–	8	8	–	8	8
TOTAL	29	134	163	29	164	193

Note : The data in this table was provided by Pertamina summary of the required operating and maintenance plant personnel for the new facility listed by labor classification.

- **Maintenance Material**

Annual maintenance material expenses were estimated as being 1.5 percent of the total project cost before escalation. This factor was based on inputs from Chevron, Pertamina and Fluor Daniel's in-house historical data base on similar plants and locations.

- **Management and Services**

Annual management and services expenses were provided by Chevron. The expenses in this category include Chevron's management expenses/ fees and technical support services during operation of the new Lube Base Oils Complex.

- **Insurance**

The basis for estimating the annual insurance expenses were provided by Chevron. Annual insurance expenses were estimated as $____ MM.

- **Plant General Expenses**

Plant general expenses include plant overhead, indirect supervision and administration, non-maintenance supplies, and other indirect expenses. They were estimated as being 100 percent of the operating and maintenance labor expenses. In the financial evaluation model, the plant general expenses are included with the operating and maintenance labor expenses.

Variable Operating Expenses

The variable operating expenses were generated for both financial models as described in Section 6.2.1. The variable operating expenses are dependent on the plant operating factor and consist of the following major components:

- Utilities
- Catalysts and Chemicals
- Feedstocks
- Effluent Streams Treatment

The cost basis of the above items are discussed below:

- **Utilities**

  For the UP-II Financial Model all utilities are internally generated within the refinery. The fuel required for generating the required utilities is derived from the refinery feedstock. The only utility which is imported into the UP-II Refinery is river water. The river water was priced at \$0.04 per m^3 based on Pertamina's input.

  For the Lube Base Oils Complex Financial Model a utility consumption summary for each study case is presented in Table 6.2 on the following page. Note that the numbers presented in Table 6.2 have not been adjusted due to the changes resulting from the Yield Confirmation Study. The unit utility costs were provided by Pertamina. Some of these unit utility costs were adjusted to exclude the capital component of the unit cost since the total installed cost of the Lube Base Oils Complex facility already includes the capital cost of certain utility systems expansion. Annual utility expenses for each case are summarized in the following Table 6.3. Again, Table 6.3 has not been updated for the Yield Confirmation Study.

[The information contained on pages 6-19 through 6-20 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

- **Catalysts and Chemicals**

The annual expenses for catalysts and chemicals were provided by Chevron and UOP, the major process licensors. Note that the Isodewaxer reactor catalyst must be leased, rather than purchased outright, from Chevron. The catalyst operating expense associated with the converted HC Unibon Train 2 in Cases 2 and 4 is not included in the Lube Base Oils Complex Financial Model since it was assumed that the converted HC Unibon train will continue to be a part of the UP-II Refinery.

- **Feedstocks**

The feedstocks and raw materials requirements and expenses are discussed in Section 6.2.6 and are not included in the operating expenses summary.

- **Effluent Streams Treatment**

For the UP-II Financial Model, the effluent streams are treated within the refinery. Therefore, the effluent treatment expenses are not considered in financial evaluation. Additional fuel/power associated with incremental effluent treatment is reflected in the incremental LSWR feed to the refinery. The capital costs required to revamp and/or expand the existing treating units will be paid by the DBOP.

In the Lube Base Oils Complex Financial Model, the effluent streams from the new lube facility must be routed to the UP-II Refinery for further treatment before they can be discharged. These streams include sour water and oily water. The expenses associated with treating these streams were developed from previous plant operating data and the existing UP-II Refinery processing units operating data. The treatment expenses were estimated as \$1.80 per m^3 for sour water and \$0.20 per m^3 for oily water. These expenses include only the operating component of the expenses since the DBOP will provide capital for revamping and/or expanding the existing treating units.

Operating Expense Summary

The annual operating expenses for the four study cases for each financial model are summarized in the following Tables 6.4 and 6.5. Table 6.4 reflects the Yield Confirmation Study adjustments while Table 6.5 has not been updated for the Yield Confirmation Study adjustments since Lube Base Oils Complex Financial Model was not used in the economic analysis.

6.2.8 Salvage Value

Salvage value of the facility was excluded from this evaluation because it was assumed that the plant would be an ongoing concern for an indefinite period of time.

6.2.9 Escalation

To reflect inflationary trends, conservative escalation estimates have been used, as follows:

- Feedstock Prices - 3% annually
- Products Prices - 3% annually
- Operating Expenses - 3% annually
- EPC - 6% annually
- Land - 6% annually
- Start-up Costs - 6% annually
- Other Owner Costs - 3% annually

6.2.10 Taxes

The corporate income tax rate used in the analysis is 35%. A withholding tax rate of 15% on dividends is applied to the balance.

[The information contained on pages 6-23 through 6-24 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

6.2.11 Depreciation

All capital costs, except land and working capital, have been depreciated using a 25% declining balance method over an 8-year economic life.

6.2.12 Product Rates

The lube base oils product in each case is approximately 6000 BPSD. The other incremental product over the Base Case is coke which for Cases 1 and 2 is 68 t/d and for Cases 3 and 4 is 35 t/d.

6.2.13 Product Prices

The initial projected price for calcined petroleum coke is $80 per metric ton based on 1992 market prices and anticipated future softness in demand for aluminum anode material. This value has also been escalated by a 3% annual escalation rate.

[This deleted information is considered confidential and proprietary.]

6.2.14 Onstream Days

Product revenues, feedstock and variable expenses for Cases 1 and 2 are based on 330 onstream days per years. For Cases 3 and 4, 315 onstream days per year were used to allow for block operation for multiple products.

6.3 Preliminary Project Financing Plan

The project has been evaluated on a 100% equity basis and also on a 25% equity leveraged financial basis. The amount of equity required has been given careful consideration to conform to the requirements of financial institutions.

The amount of equity financial institutions require in a project is essentially a function of debt coverage ratios. Depending upon their perception of a project's risk, financial institutions will require debt coverage ratios of 1.3 or greater. For a given projected project cash flow, this ratio effectively determines the amount of equity required.

As a provider of equity usually requires a better return for his capital than the cost of debt, equity is the most expensive form of capital and, to keep the cost of funding to a minimum, equity should in turn be kept to a minimum. It should, in theory, be possible to fund a project entirely with debt. This would be the most attractive form of funding and the one that gives the maximum financial leveraging and best return on investment.

The above concepts drive the amount of equity required by a project in opposite directions: debt coverage ratio requirements increase equity while a desire for minimum cost funding and increased returns on investment reduce equity. Finding the optimum level is a matter for negotiation. While projects have been funded with 100% debt, or with only standby equity, this is increasingly becoming more difficult as financial institutions expect project owners to take risk as evidence of a commitment to make a project successful. Institutions such as the International Finance Corporation (IFC), which is the private ownership institution of the International Monetary Fund, usually require a minimum of 25% equity.

Cash flow projections have been performed. From calculated debt coverage ratio projections it can be seen which of the cases appear to have a sound basis for being financed at this level of equity and which do not. Equity has been calculated as a percentage of all Capital Costs excluding financing.

6.3.1 Sources of Funding Terms and Conditions

The project finance structure will include an Export Credit Agency Loan (ECA), a commercial loan and equity. Terms for each component are outlined below.

ECA Loan

Interest Rate:	8.00%
Exposure Fee:	7.00%
Repayment Period:	10 years 20 semiannual level principal payments plus interest; first payment will be made 6 months after completion
Size:	85% of the cost of eligible goods and services being imported from the U.S. for construction.

Commercial Loan

Interest Rate:	12.00%
Front End Fee:	2.00%
Repayment Period:	7 years 14 semiannual level principal payments plus interest; first payment will be made 6 months after completion
Size:	Remainder of loan balance

Equity

Size:	25% of all capital costs excluding financing.

6.4 Financial and Sensitivity Analysis

6.4.1 Financial Analysis

This analysis has been performed to measure the project's ability to generate sufficient cash flows to pay operating expenses, service debt, and provide an acceptable return to investors. Results include computation of annual debt service ratios, after-tax returns on investment and equity, and net present value. The financial analysis results are briefly discussed below. Section 6.5 contains the complete printouts.

Case 1

[This deleted information is considered confidential and proprietary.]

Case 2

[This deleted information is considered confidential and proprietary.]

Case 3

[This deleted information is considered confidential and proprietary.]

Case 4

[This deleted information is considered confidential and proprietary.]

6.4.2 Sensitivity Analysis

The sensitivity analysis measures the impact on profitability when key variables are different than those used in the base case financial analysis. The key variables selected for the sensitivity analysis include capital costs, product prices, feedstock prices, operating days, and project schedule. The operating expenses have relatively minor impact on the project profitability.

Table 6.6 shows the impact of changing the project schedule on return on equity (ROE) and return on investment (ROI). As expected, a shorter schedule improves the returns. In this analysis, it is assumed that the unescalated capital costs do not change with the project schedule.

Tables 6.7 through 6.10 show sensitivity of product prices, operating days, feedstock prices, and capital costs on ROI and ROE.

Figures 6-G through 6-0 reflect the ROE for the study cases as a result of changing the key variables in graphical form. Similarly ROI sensitivity to the key variables are presented in Figure 6-P through 6-X. All ROE sensitivity analyses were done on 25% equity basis.

[The information contained on pages 6-31 through 6-55 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

6.5 Financial Analysis Printouts

Computer-generated financial analysis printouts for the four study cases are included in this section. Included in these printouts are listing of assumptions, year by year cash flows and debt service cover ratios, product revenues, expenses, and sources and uses of funds. The computed values of ROI, ROE and NPV are also listed in these printouts.

[The information contained in the following financial printouts is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

7.0 RECOMMENDATIONS

7.0 RECOMMENDATIONS

The information that was used to complete the Dumai Base Oils Project Feasibility Study was developed just to the point where the study objectives could be met (e.g., assess the technical and economic feasibility of project). There are several major outstanding issues which should be addressed before the project can be successfully implemented. Not all issues are required to be addressed and resolved at the same time, but rather should be dealt with in the appropriate phase of the project.

The major issues and recommendations for further work are segregated into two broad categories. Near term issues should be addressed immediately after the completion of this feasibility study, while other, less pressing issues can be resolved prior to or during Phase II (Project Definition Document development phase) of the project.

7.1 Near Term Recommendations

The major near term issues associated with this project that should be addressed as soon as possible after the completion of the Feasibility Study are summarized below:

- Further develop and optimize the overall process configuration based on Case 2.
- Investigate an enhanced Case 2 (referred to as Derivative Case 2), which should include additional Chevron pilot plant and capital cost optimization studies.
- Establish the optimum plant capacity.
- Develop a firm basis for the lube base oils product slate and product specifications.
- Evaluate the impact of other potential projects planned for the UP-II Refinery on the Dumai Base Oils Project.
- Reach agreement on the overall location for the new facilities. Two potential plot sites were considered within the UP-II Refinery during the Feasibility Study.

- Establish the permitting requirements for the project.

- Identify and reach agreement on the potential Joint Venture partners for the DBOP.

- Identify the requirements of the financial institutions who may finance the DBOP.

- Identify all products, byproducts, feedstocks, effluent streams, utilities, and operating and maintenance services that are to be exchanged between the DBOP and the UP-II Refinery. Establish a basis for transfer pricing. The Feasibility Study project economic evaluation was based on a simplified overall "UP-II Financial Model." Confirm the project economic evaluation based on the agreed upon transfer prices.

7.2 Recommendations for Next Phase

The remaining major issues which should be addressed during the subsequent phases of the project include, but are not necessarily limited to, the following items:

7.2.1 Technical Issues

The following major technical issues should be addressed in the next phase of the DBOP:

- Thoroughly examine the impact of recent Indonesian government regulations on the project scope of work and economics (including those regulations pertaining to environmental limits, project execution, and commercial aspects).

- Resolve any outstanding environmental issues (e.g., application of current and/or past regulations with respect to modified existing facilities).

- Obtain additional Pertamina input (from Jakarta and the UP-II Refinery) to the project definition and scope to ensure full understanding and acceptance by all Consortium members.

- Determine what optimization studies are required (e.g., selection of steam turbine versus motor drivers for large power consumers, optimization of process unit heat integration, etc.) to improve project viability.

- Perform, if necessary, the following additional site surveys:

  - Bathymetric Survey for the new construction dock
  - Construction Surveys
  - Geotechnical and Topographic Surveys
  - Indonesian and Subcontractor
  - Vendor Surveys
  - Engineering Surveys for the revamp work.

- Review the need for reestablishing the Base Case definition based on the "Balanced Operation" study discussed in Section 9.2.

- Opportunities exist to improve production of middle distillate products from the UP-II Refinery. This effort should be continued and extended further to optimize the integration of the DBOP with the UP-II Refinery operation.

- Confirm the required distillate product quality specifications.

- Further review the operation and design modifications for all affected existing UP-II Refinery units, e.g., the Delayed Coker Unit, Vacuum Unit, Sour Water Treating Unit, etc.

- Firm up the quality of waxy lube base stock produced from the existing HC Unibon Units, because the quality affects the design of the downstream units. For example, the sulfur content dictates the metallurgy of the downstream lube units.

  [This deleted information is considered confidential and proprietary.]

- Confirm the lube base oil product shipping data (ship size, cargo size, ship frequency, etc.) used to determine product storage and shipping requirements.

- Perform a Marine Survey to assess the adequacy of using the existing UP-II Refinery jetties for shipping lube base oil products.

- Review and reach agreement on a River Water System design basis.

- Define additional requirements in the UP-II Refinery operating and maintenance program to support the DBOP. In particular, the following areas should be evaluated.

  - Size and capabilities of existing maintenance facilities and equipment
  - Maintenance procedures and methods used
  - Spare parts program
  - Training programs.

- Review the adequacy of the existing fire, safety, laboratory, and other support facilities for meeting the DBOP needs.

7.2.2 Commercial Issues

The following commercial issues should be addressed in the next project phase to further improve overall project viability.

- Issues such as joint venture partnership, establishing operating and feedstock agreements, and satisfying financial institution requirements are key issues in the successful development of this project. These issues will greatly impact capital costs and the economic viability of the project. These issues will begin to be addressed during the next phase of the project.

- An ongoing product market survey should be undertaken to confirm the product slate, location of markets, pricing, etc.

- If the project continues to be economically attractive, emphasis should be placed on reducing the overall project schedule to repay the debt earlier and further improve the profitability of the project.

  [This deleted information is considered confidential and proprietary.]

- Project economics are dependent on the EPC Contract Costs and Owner's Costs. If feasible, these cost should be reduced to improve viability.

- Project economics are also dependent on the annual operating costs, which, if reduced, can improve project economics. In particular, catalysts and chemicals costs are a large components of the total operating costs and should be closely evaluated.

8.0 OPPORTUNITIES FOR U.S. SOURCES OF SUPPLY

8.0 OPPORTUNITIES FOR U.S. SOURCES OF SUPPLY

8.1 Summary

This section includes information related to the potential opportunity for U.S. goods and services exports from the United States, which is estimated at $250 - $450 million, depending on the case selected. This amount represents about 65 - 70% of the total Project Costs. Specifically included are:

- Breakdown of goods and services
- Suggested list of U.S. suppliers of major equipment and materials for the project.
- Probable U.S. locations for sources of supply of these goods and services.

8.2 Breakdown of Goods and Services

A breakdown of estimated goods and services which are probable sources of U.S. suppliers is included below. These amounts represent about 65 - 70% of the total dollar value of the project.

	Case 1	Case 2	Case 3	Case 4
		(U.S. $ x	1,000,000)	
EPC Contract Costs				
- Equipment & Materials	*[This deleted information is considered confidential and proprietary.]*			
- Engineering & Misc. Services				
- Ocean Freight and Miscellaneous				
Owner's Costs				
- Project Management & Misc. Services				
- Catalysts and Chemicals				
- Licensor Eng. & Royalties				
Total				

8.3 Suggested List of U.S. Suppliers

This section also includes a suggested list of potential U.S. vendors who may be asked to supply equipment and materials for the Dumai Base Oils Project. As part of the EPC Contract, this list is not intended to be all inclusive but merely to show the extent and qualifications of typical U.S. suppliers required. Not included on this list are U.S. engineering companies, process licensors, catalyst and chemical suppliers, etc. which will supply goods and services to the Owner.

8.4 Probable U.S. Locations for Sources of Supply

Figure 8-A is a map of the United States illustrating probable U.S. locations for sources of supply of U.S. goods and services for the Dumai Base Oils Project.

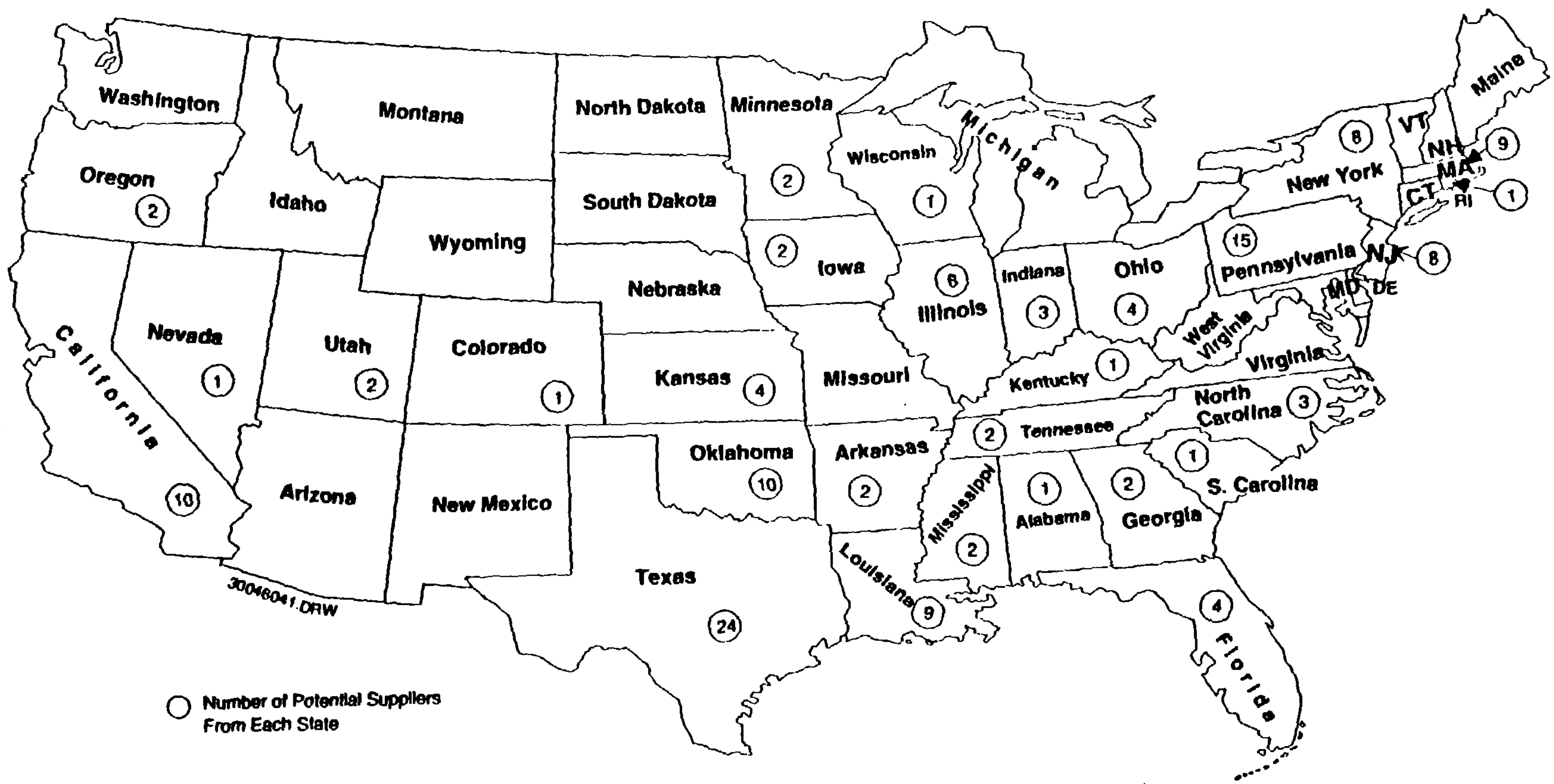


Figure 8-A. Probable U.S. Supplier Locations Dumal Base Oils Project

U.S. VENDORS
TABLE OF CONTENTS

1. Boilers
ABB Combustion Eng.
Babcock & Wilcox
Foster Wheeler
Zurn - Energy Division

2. Turbines - General Purpose
Coppus (Less Than 50 HP Only)
Elliott
Turbodyne (Dresser-Rand)

3. Turbines - special purpose
General Electric Company
Siemens A. G.
Turbodyne (Dresser-Rand)

4. Engines (Drivers)
Caterpillar
Cummins Engine Company
Detroit Diesel
Waukesha - Pearce Industries

5. Engines - Gas or Multi Fuel - Non Integral Compressor Drivers
Cooper Energy
Ingersoll - Rand Company
Waukesha - Pearce Industries

6. Compressors

a. Centrifugal Compressors API
AC Compressor Corporation
Dresser-Rand Company
Elliott Company
IMO Delaval, Inc.

b. Reciprocating Compressors
Cooper Energy
Dresser-Rand Company
Pennsylvania Process Compressors

c. Instrument & Plant Air Compressors
Dresser-rand
Elliott
Joy Manufacturing Company (Cooper Energy)

d. Rotary Compressors
Dresser Industries
Gardner-Denver (Division of Cooper Industries)
Ingersoll-Rand

7. Pumps, Reciprocating
Dresser-Worthington Pumps
Ingersoll-Rand
Union Pump
Wilson-Snyder

8. Pumps, Centrifugal & Rotary

a. Centrifugal Horizontal - General Service
BW/IP International (BJ & UCP)
Dresser-Worthington Pumps
Goulds Pump
Ingersoll-Rand
Sundstrand Fluid Handling

9. Pumps, Centrifugal & Rotary

a. Centrifugal Vertical - General Service
BW/IP International (BJ & UCP)
Dresser Pumps
Goulds Pumps
Ingersoll-Rand Company
Johnston Pumps Co.

b. In Line & API Process Centrifugal Pumps
BW/IP (BJ & UCP)
Dresser Pacific Pumps
Ingersoll Rand Company
Sundstrand Fluid Handling (Sundyne)

c. Barrel (API)
BW/IP (BJ & UCP)
Dresser - Pacific
Ingersoll Rand

d. Submersible Pump
Gorman - Rupp
Goulds Pumps Inc.
Ingersoll Rand

e. Rotary
IMO Delaval Turbine Division
Roper Pumps
Viking

10. Pumps, Miscellaneous

a. Metering Pumps
Durco
Milton Roy Company
Pulsafeeder (Subsidiary of Eagle Industries)

b. Ansi Pumps
Durco
Goulds
Ingersoll Rand

11. Mechanical Seals
Borg Warner (BW/IP)
Durametallic
John Crane
Seacol

12. Hoisting & Lifting Equipment
American Crane and Hoist Int. Inc.
Craneveyor
Kranco

13. Vessels/Columns/Drums
Allied Industries
Beaird Industries, Inc.
Berry Fabricators
Bi-con Services, Inc.
Brighton Corporation (Trinity Ind.)
General Welding Works, Inc.
Mississippi Tank Company
Mittemight Boiler Works
Modern Welding
Nooter Corporation
Riley Beaird Company
Sauder Custom Fabrication
Tex-Fab, Inc.

14. Heavy Walled Vessels and Reactors (>3"Thick)
ATB
General Welding Works
Sauder Custom Fabrication

15. Column Trays & Internals
Vessel Internals and Packing
Beaird Industries, Inc. (Reactors Only)
Glitsch, Inc.
Koch Engineering Company
Nooter Corporation (Reactors Only)
Norton Company
Nutter Engineering
Offenhauser Company (Reactors Only)

16. Fired Heaters
Foster Wheeler Energy Corp.
Optimized Process Furnaces
Petro-Chem.
Radco
Selas
Thermoflux
Tulsa Heaters

17. Burners
Callidus Technologies
Coen
John Zink
National Air Oil
North American
Todd

18. Blowers
ABB Flakt Garden City Fan Company
Buffalo Forge
Centrifugal Blowers
Chicago Blower
Howden - Scirrocco
Robinson Industries
Sheldon/Novenco
Zurn Air System Division
Rotary Blower
Compressor Service Company

19. Heat Exchangers (Specialty Type)
Astro Metallurgical
Fansteel
Nooter Corporation
R.M. Armstrong/Chemtec

20. Shell & Tube (High Pressure)
Efco
Energy Exchanger Company
Heat Transfer Equipment
Hughes-Anderson
Krueger Engineering
Nooter
Ohmstede Heat Exchangers
Struthers-Wells, Gulfport

21. Shell and Tube (General)
Energy Exchanger Company
Efco
Fabsco
Heat Transfer Equipment Company
Hughes - Anderson
Ohmstede Heat Exchangers
Shell and Tube Inc.
Yuba Heat Transfer

22. Surface Condensers
Crane Cochrane
Delaval Condenser Division (IMO Industries)
Graham Manufacturing Co.
Jay Manufacturing (Emerson Ecqlaire)
Krueger Engineering & Mfg.
Yuba Heat Transfer

23. Air Cooled Exchangers
Cooling Products
Ecodyne MRM
Gea Rainey
Hammco
Hudson Product Corp.
Phoenix Process Equipment
Rainey GEA
Smithco
Yuba

24. Double Pipe Exchangers
Alco Products
Armstrong Associates
Brown Fintube-Bastex
R.W. Holland Company

25. Plate Heat Exchangers
A.P.V.
Alfa - Laval
Graham
ITT Standard
Karbate Vicarb

26. Chemical Injection Systems
Bran & Lubbe
Fisher & Porter
Hydro Dynamics Systems
Johnson March Corp.
Milton Roy

27. Chlorinators
Capital Controls
Electrocatalytic (Chlorbpac)
Fisher & Porter
Johnson March Corporation
Acqa Control Supply
Johnson Maren
Wallace & Tierman

28. Deaerators
Crane Cochrane
Graver
Kansas City Heater
Sterling
Stork

29. Desuperheaters
BTG, Inc.
Copes Vulcan, Inc.
Graham Manufacturing
Schutte & Koerting
Yarway

30. Ejectors & Eductors
Graham Manufacturing Company
Jet-Vac Corp.
Kinema
Nash Engineering
Penberthy
Shutte & Koerting

31. Filter Separators
Burgess Manning
Consler Corp.
Cuno Process Filtration Products
Facet
Pall Process Filtration Co.
Peerless Mfg. Co.
Perry Equipment Co.
Southwest

32. Flare Stacks
John Zink
Mc Gill
National Airoil Burners

33. Silencers
Fuid Kinetics Corp (Liquids Only)
Peerless
Vanec

34. Mixers and Agitators
Chemineer
Jensen Mixers International
Lightning
Philadelphia Mixer Corp.

35. Instrument Air Dryer Systems
Benz Engineering
C.M. Kemp Mfg. Co.
Pall Western
Pneumatic Products
Zurn Industries, Inc.

36. Coalescers
Facet Quantek, Inc.
Perry Equipment Co.
Southwest Filter Co.

37. Dust Collectors
Dustex Corporation
Carter Day
Flex-kleen Corp.
Mikropul Corp.
Young Industries

38. Dissolved Air Flotation Systems
Envirex
Infilco Degremont

39. Nitrogen Plants
Air Products & Chemicals
Linde (Union Carbide)

40. Inert Gas Generators
Air Products
Airco Air Cryo, Inc.

41. Seawater Strainers
Aitkin
Albany Eng. System
Atlantik
Enpro
Filter Fab. Inc.
Kinney S.P. Eng. Inc.
RP. Adams

42. Sample Coolers
Aquachem
Filter Fab
Graham Manufacturing Company
Johnson March Corporation
Winston Manufacturing

43. Demineralizers
Illinois Water Treatment
Infilco Degremont
L.A. Water
Permutit

44. Lime Feed and Slurry Agitators
Chemineer
Cleveland Mixer
Lightning Industries

45. Sanitary Lift Stations
Clow
Smith & Loveless
Usemco

46. In Line Mixers (Static)
Charles Ross and Son
Komax Systems

47. Electric Tank Heaters
Armstrong Engineering Associates
Chromalox Industrial Heating Products
Emerson Electric Pacific (Chromalox Division)
Watlow Electric Mfg.
Wellman Thermal Systems Corp.

48. Refrigeration Systems
Frick Company (Carrier)
Lewis Refrigeration
York Division (Borg Warner Corporation)

49. Water Filters
Infilco Degremont
L A Water
Permutit

50. Sewage Treatment Plants (Packaged)
Envirex
Infilco Degremont

51. Seawater Hypochlorite Generators
Electro Catalytic Inc.
Ionics
Sanilec

52. Water Clarifiers
Clow
Dorr Oliver
Eimco
Envirex
Graver
Infilco Degremont

53. Waste Water Clarifiers
Eimco
Envirex
Infilco Degremont
Permutit

54. C.P.I. Oil Separators
Heil
Monarch
Pielkenroad

55. Marine Loading Arms
Emco
LSI Corp (FMC)

56. Flame Arresters
GPE (Shand & Jurs)
John Zink
Johnson & Jennings
Protectoseal Company
Shand and Jurs
Varec International

57. Traveling Screens
Envirex
FMC Corp.

58. Instruments, Meters and Gauges

a. Pressure Transmitters (Smart)
Foxboro
Honeywell
Rosemount
Taylor

b. Pneumatic Local Controllers
Fisher Controls
Foxboro
Moore Products

Taylor

c. P, DP & T Transmitters
Fischer & Porter
Foxboro
Honeywell "Smart"
Moore Products
Rosemount
Taylor

d. Pressure Gauges
Amitech
Ashcroft (Dresser)
U.S. Gauge

e. draft Gauges
Bailey
Dwyer Instruments Inc.
Hays Republic

f. Flow Switches (Thermal)
FCI

g. Transmitters - Smart & Electronic (DP, Mass or Coriolis, Magnetic, Electric Vortex)
Fischer & Porter (Electric Vortex Only)
Foxboro (Electric Vortex Only)
Honeywell (Smart DP, Smart Magnetic)
Rosemount (Smart DP, Mass, Magnetic)

h. Temperature Transmitters (Smart)
Foxboro
Honeywell "Smart"
Rosemount

i. Temperature Indicators
Ashcroft
Taylor
Tel-tru
U.S. Gauge
Weston

j. Thermocouples
Claude C. Gordon
Gayesco
Ram Sensors
Thermetrics
Thermocouple Products

k. Tube Fittings
Parker CPI
Swagelok

l. Pneumatic Relays
Moore Products

m. Positive Displacement Type
A.O. Smith
Brooks
Neptune (Utility Only)

n. Variable Area Type (Rotameters)
Brooks
Fischer & Porter
Wallace & Tierman

o. Pitot Tubes
Coleman
Dietrich Standard (Annubars Only)
Foxboro
Taylor

p. Flow Sight Glasses
Brooks
Fischer & Porter
Jacoby - Tarbox
Jergurson

q. Turbine Meters
A.O. Smith
Daniel
Haliburton
Brooks

r. Orifice Plates & Meters Runs
Crane
Daniel Industries
Fluidic Techniques
Peco/Robinson

59. Level Instruments

a. Displacement Transmitters & Controllers (Electronic & Pneumatic)
Fisher Controls
Masoneilan

b. Differential Pressure Type Transmitters
Fisher Controls
Foxboro
Honeywell
Rosemount

c. Tank Gauging Systems
Enrof-Nonius (Radar, Servo-operated)
Foxboro (Hydrostatic)
Rosemont (Hydrostatic)
Varec

d. Gauge Glasses
Daniel Industries
Jerguson
Penberthy

e. Level Interface - Capacitance
Agar
Drexelbrook
Endress & Hauser
K-ray

60. Control Valves

a. Globe or Cage Type
Cashco
Fisher Controls
Masoneilan
Valtek

b. Butterfly Type
Adams
Fisher Controls
Keystone
Masoneilan
Valtek

c. Ball Type
Argus
Fisher Controls
Hills-McCanna
Jamesbury
Masoneilan
Valtek
Valvtron
Xomox

d. Low Noise Valves
Fisher Controls
*Valtek
Masoneilan

e. Self Contained Regulators
Fisher Controls
Jordan
Leslie
Masoneilan

f. Filter Regulators
Fisher Controls
Leslie
Masoneilan

g. Piston Type On/Off Valve Actuators (Pneumatic/Hydraulic)
Limitorque
Rotork
Worchester

h. Electric Motor Valve Actuators
Limitorque
Rotork

61. Pressure Relieving Devices

a. Relief Valves
Anderson Greenwood
Consolidated (Dresser)
Crosby
Dresser
Farris
Kunkle

b. Tank Vents
Anderson Greenwood
Varec

62. Traps & Strainers
Armstrong
Gestra
Sarco
Yarway

63. Strainers
Armstrong
Clark

64. Switches, Solenoid Valves, Annunciators

a. Level Switches
Magnetrol
Mercoid
MSW (Magnetic Sensing Waves)
Omnitrol
SOR, Inc.
Static-O-Ring (MSW)

b. Pressure and Filled System Temperature Switches
Asco
Ashcroft
Barksdale
Custom Control, Dualsnap
ITT Barton
ITT Neodyne

Magnetrol
Mercoid
Static-O-Ring
United Electric

c. Solenoid Valves
Asco
Skinner Honeywell
Versa

d. Annunciators
Beta Products
Panalarm
Riley (SCAM)
Rochester Ins. System
Ronan

e. Current Switches
Acromag
Action Instruments
Moore Industries
Rochester
Transmation

65. Panel Instruments

a. Miniature Receiver Instruments
Fischer Controls
Foxboro
Honeywell
Taylor

66. Analytical Instruments

a. Oxygen
Ametek/Thermox
Beckman (Paramagnetic)
Cosa
Rosemount Analytical
Servomex
Teledyne

b. pH
Foxboro/Siebe
Great Lakes
Leeds & Northrup
Rosemount Analytical (Smart)
TBI/Bailey

c. Analyzer Systems or Sampling Systems
Comsip
Pastech
United Control Systems

d. Distillation, Viscosity
Fluid Data
Precision Scientific

e. Conductivity
Foxboro
Leeds & Northrup
Rosemount Analytical (SMART)
TBI/Bailey

f. H_2S Analyzer (Process)
Houston Atlas
Western Research

g. Radial and Axial Displacement Instruments
Bently Nevada
Dymac

h. Speed Transmitters
Air Pax

i. Water Hardness
Hach
Leeds & Northrup
Rosemount Analytical

j. Flame Failure System
Honeywell

k. Gas Specific Gravity
Arco
Ranarex
Sarasota
Schlumberger

l. Reid Vapor Pressure
Fluid Data
Precision Scientifc

m. Residual Chlorine
Hach
Rosemount Analytical

n. Colorimetric Switches
Fluid Data
Totco (Precision Scientific)

o. SO_2, NO, NO_X
Dupont/Ametek (SO_2 Only)
Rosemount Analytical (NO, NO_X Only)
TECO (NO, NO_X Only)
Western Research (SO_2 Only)

p. Water Hardness
Hach
L & N
Rosemount

q. Moisture
Dupont
Panametrics

r. Chromatograph
Applied Automation
Beckman
Combustion Engineering
Fluid Data/Amscor
H & B/Applied Automation

s. Pour Point
Precision Scientific

t. Boiling Point/End Point
Fluid Data
Precision Scientific

u. Water Quality
Hach
Leeds & Northrup
Rosemount Analytical

v. Thermometers
Ashcroft

67. Detectors, Ambient Gas Monitoring

a. H_2S
General Monitors
IST (Portable)
MSA

b. Combustible Gas
Detronics (Rexnord)
General Monitors

c. Flame Scanner VV/IR
Detronics
General Monitors
Systron-Donner

68. Programmable Controllers
Allen Bradley
Modicon
Siemans
Texas Instruments

69. Distributed Control System
Honeywell
Johnson-Yokogawa

70. Generators, Transformers, Batteries

a. AC Generators
ABB
Electric Machinery (Dresser Rand)

b. Batteries and Chargers
Nife Incorporated

c. Cathodic Protection Equipment
Harco Corporation

d. Neutral Grounding Resistors
Cgi Systems
Electrical Power Systems, Inc.
Harvey Hubbell
General Electric Co.
Line Power Mfg.
Powell Industries, Inc.
Siemens
Square "D"
Westinghouse

e. Power Transformers
Abb Electric
Brush Electric
Ferranti-Packard
General Electric Company
Heavy Duty Electric
Magnetek
Mc Graw - Edison
RTE (Cooper Industries)

f. Transformers - (Dry Types) - Lighting
General Electric Company
GTE Sylvania
Heavy Duty Electric
Siemens
Westinghouse Electric Corporation

71. Electric Motors
D-R Electric Machinery
Electric Machinery (Dresser Rand)
General Electric Corporation
Louis Allis
Reliance Electric
Siemens
Westinghouse Motor Company

72. Major Electrical Equipment (Motor Control Centers)
Allen Bradley
General Electric
Siemens
Westinghouse Electric

73. Major Electrical Equipment (High Voltage)
General Electric Corporation
Siemens
Westinghouse Electric Corporation

a. Pushbutton - Control Stations
Appleton Electric Company
Crouse Hinds Company
General Electric
Pushbutton - Control Stations

74. Starters (480 V) - Explosion Proof
Appleton Electric Company
Crouse Hinds Company

75. Transfer Switches (Automatic) - Low Voltage
Rosselectric, Inc.
Westinghouse Electric Corporation

76. Bus Duct System
Siemens
Unibus

77. Panels (Custom) - Control and Relay
General Electric

78. Switchgear (480 V) Low Tension
General Electric
Siemens
Westinghouse Electric

79. Switchgear (Medium Voltage and High Voltage)
CGI Systems
Controlled Power Corp.
Electrical Power Systems, Inc.
General Electric
Line Power Mfg.
Powell Industries, Inc.
Siemens
Square "D"
Westinghouse

80. Transfer Switches (Automatic) - High Voltage
G & W Electric Specialty Company
S & C Electric Company
Westinghouse

81. Cable Trays and Troughs
B-Line
Husky Products, Inc.
P-W Industries, Inc.
T. J. Cope

82. Connectors (Power)
Burndy Corporation
O.Z./Gedney Company
Raychem
Thomas and Betts

83. Heating Cable (M.I. Cable & Control)
Chemelex (Electro Wrap)
Thermon Manufacturing Company

84. Conductors (Instrument Wire)
Alpha
Belden
Furon Dekoron Division
Okonite
Thermo - Electric

85. Conductors (Thermocouple)
Continental Wire (Cablec)
Furon Dekoron Division
Thermo Electric

86. Conductors (600 V and Above)
Cablec
Kerite
Okonite Company
Rockbestos

87. Communications Cable
Alpa
American Insulated Wire
Belden
Brand Rex

88. Cable Marking System
3M
A.M.P.
Raychem

89. Emergency Lighting System
E.S.B. Incorporated
Teledyne

90. Panelboards (Lighting and Power)
Appleton Electric Company
Crouse Hinds Company
General Electric Company
Nelson Electric Manufacturing Company
Square "D" Company
Westinghouse Electric Corporation

91. Condulet Type Fittings
Appleton Electric
Crouse Hinds
Killark Electric Manufacturing
O.Z. Gedney

92. Communication Systems
Gai - Tronics Corporation
Gultom - Femco Inc.

93. Piping

a. Pressure Cast Iron Pipe
American Cast Iron Pipe
Clow
U. S. Pipe

b. Cast Iron Pipe - Soil Pipe
Central Foundry
Charlotte
Clow
U.S. Pipe

c. Alloy and Stainless Steel Pipe
Armco Steel
Cameron Iron Works
Swepco Tube
Youngstown Welding and Engineering

d. Aluminum and Brass Pipe
Anaconda
Reynolds Aluminum

e. Carbon Steel Welded Pipe (Other Than Spiral)
Armco
United States Steel Corporation

f. Carbon Steel Welded Pipe (Spiral)
Kurvers
Lone Star

g. Stainless/Carbon Steel Pipe
Bethlehem Steel
United States Steel Corporation

h. Galvanized - Pipe
Consumers Pipe
Gulf Supply

94. Alloy Steel - Ball Valves
Argus (Bogart Bullock)
Hills Mc Canna
K.T.M.
Velan

95. Alloy Steel - Check Valves
Chicago Tube and Iron
Crane Co.
Ghiz, Inc.
Henry Vogt
M&n Valve
Marlin Check Valve
McJunkin Corp.
Mid-Valley Supply Co.
Mission Mfg. Co.
Stockham Valve and Fitting
TRW/Mission
Valve Systems
Wallace

96. Carbon Steel - Ball Valves
Argus (Bogard Bullock)
Henry Vogt Mach Co.
Henry Vogt
Hill McCauna
K.T.M
Marlin

97. Carbon Steel - Check Valves
Chicago Tube and Iron
Ghiz, Inc.
M&N Valve
McJunkin Corp.
Mid-Valley Supply Co.
Valve Systems
Velan
Wallace

98. Alloy Steel - Gate and Globe Valves
Chicago Tube and Iron
Crane Co.
Ghiz, Inc.
M&N Valve
MCC Pacific Valves
McJunkin Corp.
Mid-Valley Supply Co.
Valve Systems
Velan
Wallace

99. Carbon Steel - Gate and Globe Valves
Chicago Tube and Iron
Ghiz, Inc.
M&N Valve
McJunkin Corp.
Mid-Valley Supply Co.
Pacific Valves Inc.
Stockham Valve & Fitting
Valve Systems
Vogt
Wallace

100. Butterfly Valves
I.T.T. Grinnel Valve & Co. Ltd.
MCC Center Line
N.B.S. Corp.
Posiseal International

101. Carbon Steel - Plug Valves
Rockwell
Stockham Valve & Fittings
Tufline Division
W.K.M Valve Div.
WKM Valve Div.

102. Slide - Valves
Dezurik
W.K.M. Valve Div.

103. Needle - Valves
Henry Vogt

104. Carbon Steel Screwed and Socket Welded Valves (All Type)
Henry Vogt
Smith Valve

105. Alloy and Stainless Steel Flanges
Chicago Tube & Iron
Gulf Supply, Inc.
Ladish Co.
McJunkin Corporation
Mid-Valley Supply Co.
Tube Turns Inc.
Van Leeuwen
Wallace
Western Forge

106. Alloy Fittings and Flanges
Chicago Tube & Iron
Gulf Supply, Inc.
McJunkin Corporation
Mid-Valley Supply Co.
Stockham Valve & Fittings
Van Leeuwen
Wallace

107. Alloy and Stainless Steel Butt Weld Fittings
Chicago Tube & Iron
Flowline Corp.
Gulf Supply, Inc.
Ladish Co.
McJunkin Corporation
Mid-Valley Supply Co.
Swepco
Van Leeuwen
Wallace

108. Alloy and Stainless Steel Screwed and Socket Weld Fittings
Bonney Forge
Chicago Tube & Iron
Gulf Supply, Inc.
Henry Vogt Machine Co.
Ladish Co.
McJunkin Corporation
Mid-Valley Supply Co.
Van Leeuwen
Wallace

109. Carbon Steel Butt Weld Fittings
Bonney Forge
Chicago Tube & Iron
Gulf Supply, Inc.
ITT Grinnell
Ladish Co.
McJunkin Corporation
Mid-Valley Supply Co.
Taylor Forge and Pipe
Van Leeuwen
Wallace

110. Carbon Steel Flanges
Chicago Tube & Iron
Gulf Supply, Inc.
McJunkin Corporation
Mid-Valley Supply Co.
Taylor Forge & Pipe
Tube Turns, Inc
Tubeline
Van Leeuwen
W.M. Maass
Wallace

111. Carbon Steel Screwed and Socket Weld Fittings
Bonney Forge
Capitol Pipe and Steel Products
Chicago Tube & Iron
Gulf Supply, Inc.
Henry Vogt Machinery Co.
Ladish Co.
McJunkin Corporation
Mid-Valley Supply Co.
Van Leeuwen
Wallace

112. Plate - Carbon Steel
Bethlehem Corp.
U.S. Steel

9.0 ADDENDUM

9.0 ADDENDUM

9.1 Overview

This section is devoted to additional studies and adjustments, including the "UP-II Balanced Operation" study, UP-II Plant Tests, and the adjustments due to Chevron's Yield Confirmation Study (YCS). The YCS was completed after the original Final Report was drafted. It was felt that for consistency and maintaining the original overall outline of the Study Report, a separate Addendum Section was the most appropriate way to include this information in this version of the Final Report.

UP-II Balanced Operation

During the course of the feasibility study it became apparent that an opportunity existed to use idle HC Unibon Unit capacity in Cases 1 and 3 to produce more kerosene and diesel products. The HC Unibon Unit capacity is fully used in study Cases 2 and 4. As discussed during the Mid-Point Review Meeting on November 16, 1992, it was agreed that an additional study activity would be initiated to assess all reasonable incremental steps that could be taken to more fully utilize the available HC Unibon Unit capacity. It was decided to focus this evaluation on study Case 1 because it is more likely to be selected for further development than Case 3. A preliminary evaluation of the technical feasibility of producing more middle distillates is presented in Section 9.2. The UP-II Balanced Operation study was completed prior to the completion of the Yield Confirmation Study (YCS). Minor adjustments to the UP-II Balanced Operation study resulting from the YCS have not been included here.

The preliminary results of the UP-II Balanced Operation study indicate that it is possible to increase the production of middle distillates as compared to Case 1. The amount of incremental distillate production depends on the extent of modifications made to the existing UP-II Refinery units, and optimization of various refinery operating parameters (e.g., LVGO/HGVO cutpoint in the High Vacuum Unit).

Adjustments Due To Yield Confirmation Study Results

Chevron completed the Yield Confirmation Study (YCS) in May 1993. The YCS involved pilot plant tests in the area of Isocracking, Isodewaxing, and Hydrofinishing processes using HVGO samples from the UP-II Refinery. Based on the pilot plant tests, a revised process information package was developed by Chevron. The information contained in the revised process package was used by Fluor Daniel to carry out adjustments to the Feasibility Study. Section 9.3 describes the adjustments to the appropriate sections of the Study Report which have not been revised due to YCS results.

UP-II Plant Tests

The capacity of the existing UP-II Refinery units was defined at the beginning of the feasibility study in order to provide a basis for the study case evaluations. However, as the study progressed it became increasingly important to more firmly establish the maximum capacity of the High Vacuum Unit and the Hydrogen Plant. Therefore, it was decided to perform test runs on these units to determine their capacity limits and to identify the bottlenecks that caused the limits. These test runs were jointly conducted by Pertamina, Chevron, UOP, and Fluor Daniel at the Dumai UP-II Refinery during the period from January 26, 1993, through February 3, 1993. A brief description of the test-run methodology, the relevant operating parameters, and the conclusions and recommendations is presented in Section 9.4. A detailed report on the UP-II Plant Tests, prepared by UOP, is included in Appendix C-7.

The results of the UP-II Plant Tests indicate that the High Vacuum Unit can operate at a throughput of approximately 101,500 BPSD. However, certain minor modifications are suggested to improve the unit operation. The Hydrogen Plant capacity was successfully tested at a rate equal to approximately 110% of the original plant design capacity. Above this capacity, the first bottleneck is a reformer tube metal temperature in excess of the design temperature.

9.2 UP-II Balanced Operation

The UP-II Balanced Operation study was completed prior to the completion of the Yield Confirmation Study. No attempt was made to revise the UP-II Balanced Operation Study due to adjustments resulting from the Yield Confirmation Study.

9.2.1 Introduction

During the course of the feasibility study it became apparent that an opportunity existed to use idle HC Unibon Unit capacity in Cases 1 and 3 to produce more kerosene and diesel products above and beyond the Base Case as defined in the Terms of Reference. The HC Unibon Unit capacity is fully utilized in study Cases 2 and 4. As discussed during the Mid-Point Review Meeting on November 16, 1992, it was agreed that an additional study activity would be initiated to assess all reasonable incremental steps that could be taken to more fully utilize the available HC Unibon unit capacity. It was decided to focus this evaluation on study Case 1 because it is more likely to be selected for further development than Case 3. During the course of this evaluation it became apparent that the proposed Case 1 operation could be optimized to produce more distillate products without substantially increasing the HC Unibon unit throughput. This addendum section of the study report presents a preliminary evaluation of the technical feasibility of producing more middle distillates via two alternate scenarios.

Several design bases, evaluation methods, and assumptions were made in order to complete this Balanced Operation evaluation. They include the following:

- The Case 1 Stock Material Balances, as presented in Section 3.1.2, are used as the basis for estimating new stock balances for two alternative Balanced Operation cases. Adjustments due to the Yield Confirmation Study are not included.

- The Crude Distillation Unit (CDU) feed rate and composition, and product yields are not changed from the Case 1 values.

- The High Vacuum Unit (HVU) product cutpoints are varied in the alternate cases to produce more LVGO and HVGO. The new cutpoints are based on original design data and on data collected during the January/February 1993 UP-II Plant Tests. The expected HVU product yields at these new cutpoints are calculated from the TBP distillation data for the study CDU feed.

- Delayed Coker Unit (DCU) product yields are assumed to be similar to the Case 1 yields. Some minor adjustments are made to account for the heavier vacuum residue feed used in all alternate cases.

- The HC Unibon Unit yields are assumed to be the same as the Base Case yields.

- The amount of vacuum residue used as fuel oil is assumed to be unchanged from the Case 1 rate.

- *[This deleted information is considered confidential and proprietary.]*

- Hydrogen balances for each alternate case were estimated using the same methods as were used to arrive at the Case 1 balance.

9.2.2 Case Descriptions

Two alternate cases are included in the UP-II Balanced Operation study (designated as Cases 1A and 1B). Each case involves modifying the operation (capacity, performance, etc.) of one or more processing units in a logical, incremental manner. The intent in Case 1A is to increase the middle distillate production while minimizing additional modifications. To achieve this objective, the hydrogen system is operated at 106% of the original Hydrogen Plant design capacity. This represents the makeup hydrogen compression system design capacity limit. Case 1B results from the next level of logical progression, where further increase in HVU throughput would most likely require major revamps of the HVU and DCU. This limiting HVU throughput is estimated to be 105.0 MBPSD.

In each Balanced Operation case the product cutpoints in the HVU are adjusted to improve middle distillate production. The HVGO/vacuum residue cutpoint is increased from _____________, which increases HVU gas oil product lift from ________ of total LSWR feed to ________. The _______ cutpoint yields an HVGO ASTM end point of approximately ______________, which is the original design specification for HVGO feed to the HC Unibon Unit.

The LVGO/HVGO cutpoint is increased from the Case 1 value of ______________ (the original design LVGO/HVGO cutpoint was ______). It is important to note that this cutpoint adjustment results in a significant increase in diesel pool volume due to a shift from HVGO production to LVGO (diesel) production in the HVU. This shift unloads the HC Unibon Unit, which in turn allows the processing of additional SPK LSWR feed to maximize the HC Unibon Unit throughput (which is limited by makeup hydrogen availability in Case 1A and maximum debottlenecked HVU capacity in Case 1B).

During the January/February, 1993 UP-II Plant Tests the LVGO/HVGO cutpoint had to be carefully monitored to ensure that the diesel pool pour point specification was not exceeded. The Plant Test results do not contain sufficient data to firmly establish what the maximum allowable cutpoint was during the test run period, although it appears that it may have been somewhat lower than 375°C. However, because the test run was conducted at conditions different from those used to define the feasibility study (e.g., the CDU throughput was 130.0 MBPSD during the test run, while the study CDU throughput is set at 120.0 MBPSD), it may not be reasonable to extrapolate the test results to arrive at a study design LVGO/HVGO cutpoint. If the maximum acceptable LVGO/HVGO cutpoint is indeed lower than 375°C, then the increases in diesel pool volume reported for Case 1A will be significantly impacted.

In Case 1B, extensive modifications will be required to the hydrogen system (Hydrogen Plant and makeup hydrogen compression system) in order to produce the same amount of incremental middle distillates. However, it was felt that insufficient information is available at this time to more accurately determine the optimum cutpoint. Any determination of the optimum cutpoint must include an assessment of the CDU operation (including both throughput and atmospheric gas oil/LSWR fractionation efficiency) and the HC Unibon Unit operation (to minimize the amount of high-pour point fractionator bottoms that is routed to the diesel pool). This determination is beyond the scope of this study. In spite of all this, the conclusions from Cases 1A and 1B are reasonable regarding mid-distillate production steps.

The two Balanced Operation cases are discussed below. A case definition matrix is presented in the following Table 9.1, while Stock Material Balances for the study Base Case and Cases 1, 1A, and 1B are presented in Table 9.2 on page 9-7.

Table 9.1
UP-II Balanced Operation
Case Definition Matrix

	Base Case	Case 1	Case 1A	Case 1B
Percent of Hydrogen Plant Design Capacity	80.0	103.6	106.0	110.5
Percent of HVU Unit Design Capacity	92.9	101.5	107.9	113.4
Percent of Hydrogen Compression System Design Capacity	75.5	97.7	100.0	104.3
Percent of HC Unibon Unit Design Capacity	91.8	81.4	83.5	88.9
LVGO TBP Cutpoint (°C)	323-357	323-357	323-375	323-375
HVGO TBP Cutpoint (°C)	______	______	______	______
HVU Gas Oil Product Lift (LV%)	____	____	____	____
Mid Distillate Production LV% of Base Case	100	100	~106	~112

[The information contained on page 9-7 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

Case 1A - For this case the hydrogen system operates at 106.0% of the original Hydrogen Plant design capacity (versus 103.6% for Case 1), which allows processing of ____ MBPSD of gas oils in the HC Unibon Unit, up 1.2 MBPSD from Case 1. In addition, the HVGO/Vacuum Residue cutpoint and the LVGO/HVGO cutpoints are adjusted as described above. The required DCU throughput falls from ____ to ____ MBPSD.

The total Case 1A distillate (kerosene and diesel) production increases by ____ MBPSD (6.8%) over Case 1, while the total refinery LSWR feed rate increases by _____ MBPSD (36.9%). The net effect is that distillate production is shifted away from the DCU to the HC Unibon Unit, which tends to improve the overall refinery economics. Because hydrogen production is limited to 106% of original design, no modifications are required to either the Hydrogen Unit or the makeup hydrogen compression system. As compared to Case 1, the HVU will require a few additional modifications, while the recommended Sour Water Treating Unit modifications remain unchanged. As with Case 1, no modifications are required to the Amine Treating/LPG Recovery Unit for Case 1A.

Case 1B - In Case 1B the HVU throughput is set at 105.0 MBPSD (up 11.0 MBPSD from Case 1) which, based on the January/February 1993 UP-II Plant Tests, is the approximate maximum HVU capacity that can be attained without making major modifications. The HVU product cutpoints are unchanged from Case 1A. The HC Unibon Unit throughput in Case 1B is ____ MBPSD, up ____ MBPSD from Case 1. The hydrogen system is required to operate at 110.5% of the original Hydrogen Unit capacity. The required DCU throughput is ____ MBPSD, with an estimated coke product rate of ____ t/d. This exceeds the original design coke product rate of ____ t/d, and it appears the DCU may be near its maximum coke production capacity in Case 1B.

The total distillate production increases by ____ MBSD (10.9 %) over Case 1, which requires an additional ____ MBPSD of LSWR feed (up 68.8% from Case 1). As in Case 1A, more efficient use is made of the DCU and HC Unibon Unit capacities. However, because the HVU throughput is increased, this case requires more extensive changes to the HVU than Case 1A. Also, the makeup hydrogen requirement exceeds the original design capacity of the makeup hydrogen compression system. Therefore, either the existing system must be modified, or a new, parallel makeup hydrogen compression train must be added. Based on the recent UP-II Plant Tests, the existing Hydrogen Plant capacity is most likely adequate for Case 1B.

The recommended Case 1B Sour Water Treating Unit modifications are unchanged from Cases 1 and 1A. As with Cases 1 and 1A, no modifications are required to the Amine Treating/LPG Unit for Case 1B.

9.2.3 Process Unit Evaluations

a. Hydrogen System

The Balanced Operation Case 1B will require certain modifications to the existing hydrogen system. In this study context, the hydrogen system includes the hydrogen production plants, hydrogen distribution and make-up hydrogen compression. The make-up hydrogen compressors are located in the HC Unibon Units.

Hydrogen Plants

UOP has completed a very preliminary review of expanding the capacity of the existing hydrogen plants at the UP-II Refinery. A copy of UOP's report is included in the Appendix C-5 of this study report.

The following two cases were examined:

- Expansion to 110% of the existing design capacity
- Expansion to 125% of the existing design capacity

UOP has indicated that no changes are necessary to the existing hydrogen plants for the 110% case if the same feedstock as the original design feedstock is used. With LPG as the supplemental feedstock, UOP recommends changing a portion of the reformer catalyst. The product hydrogen purity can be maintained at __ volume percent. At capacities between 110% and 115% of the original capacity varying degrees of modifications are required. The January/February UP-II Plant Tests confirmed that the existing Hydrogen Unit can produce 97 volume percent purity hydrogen operating at 110% of existing design capacity. Above this capacity the reformer tubes may need to be replaced with higher-grade metallurgy tubes which are designed to withstand higher tube skin temperature. The unit can possibly operate at 125% capacity with moderate modifications but the purity of the product hydrogen may drop below 97 volume percent. In order to maintain the purity above 97 volume percent the unit capacity may be limited to 117% of the original design. Major modifications necessary for the 125% capacity case are summarized below:

- *[This deleted information is considered confidential and proprietary.]*

Make-up Hydrogen Compression

Presently, the UP-II Refinery has three make-up hydrogen compression trains; one for each HC Unibon train and one common spare. The combined capacity of the two make-up hydrogen compression trains is about 106% (94,900 Nm^3/h) of the existing hydrogen plants design capacity.

For Balanced Operation Case 1B, additional compression capacity will be required. It may be possible to revamp the existing compression train to meet the Case 1B requirements. However, a detailed equipment evaluation is required before this assessment can be made. Therefore, a new parallel make-up compression train, identical to the existing compression train, is added in this case to meet the requirements. The new compression train consists of a three-stage reciprocating compressor with interstage coolers and knockout drums.

b. HC Unibon Unit

[This deleted information is considered confidential and proprietary.]

c. Lube Processing Units

The design and operation of the new lube processing units (Lube Isocracker and Lube Isodewaxer/Hydrofinisher Units) is identical for Cases 1, 1A and 1B, and no modifications are required.

d. High Vacuum Unit

Study Case 1 required minor modifications to the High Vacuum Unit (HVU) in order to process the required LSWR throughput. The two Balanced Operation cases also will require some HVU modifications. The potential modifications recommended for each case are summarized in Table 9.3 on page 9-13. In addition to the tabulated modifications, the modifications that are recommended as a result of the UP-II Plant Tests (discussed in Section 9.4.2) are also required in the Balanced Operation cases (as well as the original four study cases). The two Balanced Operation cases are discussed below:

Case 1A - The required Case 1A HVU throughput has increased by 6.3% over the Case 1 throughput (99.9 MBPSD vs. 94.0 MBPSD), and the gas oil lift has increased from 56.0 LV% (on unit feed) to 61.8 LV%. During the January/ February, 1993 UP-II Plant Tests the HVU was successfully operated at 101.5 MBPSD throughput with a gas oil lift of approximately 60-62 LV%. Therefore, based on the Plant Tests, the proposed Case 1A HVU operation should be attainable with the existing, unmodified HVU.

However, during the Plant Tests the LVGO/HVGO cutpoint was considerably lower (approximately 355°C) than the original design cutpoint of 382°C. Based on information gathered during the Plant Tests, an LVGO/HVGO cutpoint of 375°C was determined to be the practical upper limit due to diesel product pool pour point limitations. This higher cutpoint is used in Case 1A, which results in the production of significantly more LVGO than was produced during the Plant Tests (14.5 MBPSD vs. 12.7 MBPSD). As a result, the existing LVGO Pumparound system heat removal capacity will be inadequate.

Based on the product cutpoints used in this study, Case 1A requires that a new LVGO pumparound pump be added in parallel to the two existing pumps, with two operating and one as spare. Also, two new LVGO air cooler bays should be added to the existing five bays, and a new LVGO/tempered water cooler (one shell) should be added in parallel to the existing exchanger in this service.

The proposed LVGO pumparound system modifications are not required if the Crude Distillation Unit (CDU) crude tower is operated at its original design atmospheric gas oil/LSWR cutpoint. The Case 1 cutpoint, based on the Chevron Stock Material Balances, is approximately 323°C, while the original design cutpoint is 343°C. The Case 1 cutpoint was used for both Balanced Operation cases. If, instead, the original design cutpoint is used in the CDU, then significantly less diesel boiling range material (LVGO) would be fed to the HVU, thus significantly unloading the vacuum tower LVGO pumparound system.

Table 9.3
UP-II Balanced Operation
Potential HVU Modifications

System	Case 1	Case 1A	Case 1B
Feed Charge, Feed Preheat, Desalter	No modifications required.	No modifications required.	Add parallel charge pump to 2 existing pumps, more preheat surface area provided by new HVGO P/A exchanger (see below).
Charge Heater, Transfer Line	No modifications required.	No modifications required.	Possibly no modifications required – must be evaluated in more detail.
Vacuum Tower	No modifications required.	No modifications required.	Possibly no modifications required, check with packing vendor.
Vacuum Equipment, Overhead Line	No modifications required.	No modifications required.	No modifications required.
LVGO Pumparound, Product System	No modifications required.	Add new pumparound pump in parallel to existing 2 pumps, add 2 new air cooler bays to existing circulating LVGO cooler, add 1 shell in parallel to existing tempered water cooler.	Add new pumparound pump in parallel to existing 2 pumps, add 2 new air cooler bays to existing circulating LVGO cooler, add 1 shell in parallel to existing tempered water cooler.
HVGO Pumparound, Product System	No modifications required.	No modifications required.	Add new HVGO/feed exchanger (3 shells).
Vacuum Bottoms System	Add parallel vacuum bottoms cooler (2 shells).	No modifications required.	Add parallel vacuum bottoms cooler (2 shells).

Because the vacuum residue product rate has decreased from Case 1, the vacuum bottoms system modifications specified for Case 1 are not required for Case 1A.

Case 1B - The required Case 1B throughput (105.0 MBPSD) is significantly higher than the Case 1 rate, and the product lift is increased (to the same level as in Case 1A). As a result, several HVU modifications are required. More feed preheat exchanger surface area is required to maintain the vacuum heater inlet temperature at an acceptable level. It is anticipated that this incremental preheat duty can be provided by adding an additional HVGO pumparound exchanger (discussed later).

The fraction of LVGO (diesel) in the LSWR feed in all of the study cases is higher than the original design (the Crude Distillation Unit crude tower product lift percentage is lower than original design). Therefore, in order to match the original HVU HVGO/vacuum residue cutpoint, the vacuum heater outlet percent vaporization must be increased. This fact, coupled with the high Case 1B throughput, may indicate that the vacuum heater and transfer line are hydraulically bottlenecked. It is beyond the scope of this study to determine the exact modifications, if any, that are required to these HVU components. Apart from hydraulic concerns, the existing vacuum heater is adequate to meet the Case 1B thermal requirements.

The existing vacuum tower internal vapor and liquid loads will increase due to higher throughput. A preliminary examination of these loads indicates that the existing tower has adequate capacity in Case 1B. This result will be verified with the packing vendor prior to the issuance of the final study report.

Although the Case 1B throughput is higher than the original design rate, the existing vacuum system (ejectors, condensers and vacuum pump) should be adequate. Although the Case 1B HVU throughput has increased by 13.4%, the tower operating pressure profile is less stringent than the original design values (the required Case 1B tower overhead operating pressure is 25 mmHga versus 15 mmHga in the original design).

Case 1B LVGO production, as with Case 1A, has increased significantly over Case 1. Therefore, the same LVGO pumparound system modifications recommended for Case 1A are required in Case 1B.

The required Case 1B HVGO pumparound heat removal capacity is marginally higher than the required Case 1A capacity or the observed Plant Test capacity. However, based on a preliminary evaluation, it appears that the existing HVGO pumparound system can handle the proposed Case 1B operation without modification.

The Case 1B vacuum residue product rate is almost as high as the Case 1 rate. Therefore, the vacuum bottoms system modifications specified for Case 1 are also required for Case 1B.

e. Sour Water Treating Unit

The Sour Water Treating Unit throughput is 119% of the original design capacity for Case 1. The required throughput for the Balanced Operation cases varies between 120% and 122% of original design throughput. All of these throughputs are lower than the Case 4 rate, which is 128% of original design capacity. Therefore, by inspection, the recommended Case 1 Sour Water Treating Unit modifications (which are based on the Case 4 throughput) are adequate for the two Balanced Operation cases. No further modifications are required.

f. Amine Treating/LPG Recovery Unit

The liquid feed (LPG) rate to the Amine Treating/LPG Recovery Unit is 90% of original design for Case 1, and varies between 93% and 98% of original design for the Balanced Operation cases. Therefore, the LPG absorber section of the Amine Treating/LPG Recovery Unit is adequate for both Balanced Operation cases.

The Amine Treating/LPG Recovery Unit vapor absorber operates at 108% of original design for Case 1, and at between 110% and 114% for Cases 1A and 1B. The existing amine absorber and stripper systems were previously evaluated based on the Case 4 rate of 114% of original design, and found to be adequate. Therefore, no modifications are required for Balanced Operation Cases 1A and 1B.

9.2.4 Cost Estimate

A rough order of magnitude cost estimate study was performed to implement Case 1A and Case 1B. A summary of the incremental capital cost over Case 1 is presented below:

	Incremental Capital Cost Over Case 1, MM$
	(1st Quarter 1993)
Case 1A	____
Case 1B	____

The incremental costs in Case 1A are primarily in the area of HVU modifications. While in Case 1B bulk of the incremental costs are associated with the Hydrogen Compression and HVU.

9.3 Adjustments Due to Yield Confirmation Study Results

9.3.1 Introduction

Chevron Research and Technology Company (CRTC) conducted the Yield Confirmation Study (YCS) from August 1992 through May 1993 in Richmond, California. The study involved pilot plant tests in the area of Isocracking, Isodewaxing and Hydrofinishing using HVGO samples from the UP-II Refinery. The YCS was originally scheduled to be completed by November 1992 and accordingly, the Dumai Base Oils Feasibility Study which draws the bulk of its process input from YCS, was targeted to be issued in February 1993. A draft version of the Final Feasibility Study Report was issued in February 1993 based on the best available information at that time. It was agreed and understood by all study consortium members that the Final Feasibility Study Report would be issued after the completion of the CRTC pilot plant and YCS work and subsequent inclusion of any resulting adjustments or changes into the Final Feasibility Study Report.

Sections 2, 3, and 4 of the Final Report have not been revised to reflect the changes due to the Yield Confirmation Study. Instead, the necessary adjustments to the material in those sections are described in Section 9.3.2. It was agreed that the entire revisions to these sections would involve a major effort and it can be appropriately handled by discussing the necessary adjustments in the addendum section. Included in this section are changes to the stock material balances, process configurations, new and existing processing units, utility and offsites systems, and capital cost estimates. All other sections of the Final Report have been updated to reflect YCS adjustments.

The basis for the adjustments were provided by Chevron in May 1993, which comprised a revised Chevron Process Package (included in Appendix C-1, Volume II), revised stock balances for the four cases, revised owners' costs, catalysts and chemicals consumption, and other relevant information. Fluor Daniel used this information to identify the necessary changes to the process, utility, and offsite units in all four study cases. The capital cost estimates were revised to reflect these changes. For most units, the adjustments were minor, and therefore did not warrant a revision of their associated cost estimates. The revised operating expenses for economic evaluation are included in Section 6 of this report.

9.3.2 YCS Process Configuration Adjustments

Table 9.4 presents a summary of the adjustments made to each of the four study cases as a result of the Yield Confirmation Study. Only those units or items where adjustments were required are included in the table. These adjustments are briefly described below.

Case Description

[This deleted information is considered confidential and proprietary.]

[The information contained on pages 9-19 through 9-22 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

[The information contained on pages 9-23 through 9-35 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

Process Unit Adjustments

Lube Isocracker (Unit 010): *[This deleted information is considered confidential and proprietary.]*

Lube Vacuum Column (Unit 011): Originally, the Lube Vacuum Column was used only in Cases 2 and 4. In the adjusted Case 2, the Vacuum Column Unit is not required since only one lube product is produced. The fractionator bottoms produced by the converted HC Unibon Unit Train 2 can be directly routed to the Lube Isodewaxer/Hydrofinisher Unit.

In the adjusted Case 4, where two lube products are made from DAO feedstock and one product is made from HVGO feedstock in a blocked operation mode, a stand-alone Vacuum Column Unit is not required. Instead, a new, smaller sized vacuum column is added at the back end of the DAO Hydrocracker Unit for separating the hydrocracked Heavy Neutral from the Bright Stock. These intermediate products are further processed in the Isodewaxer Unit in a blocked operation mode.

Lube Isodewaxer/Hydrofinisher (Unit 012): *[This deleted information is considered confidential and proprietary.]*

Distillate Hydrotreater (Unit 013): *[This deleted information is considered confidential and proprietary.]*

DAO Hydrocracker (Unit 014): *[This deleted information is considered confidential and proprietary.]*

Makeup Hydrogen Booster Compressor (Unit 015): In the original design, makeup hydrogen requirements for the new lube process units are supplied from the existing hydrogen compressors located in the HC Unibon Units. Some of the new lube units required makeup hydrogen at pressure levels higher than that available from the existing compressors. Therefore, booster compressors were included in the original design to meet the pressure level requirements of the individual units in each case.

[This deleted information is considered confidential and proprietary.]

[This deleted information is considered confidential and proprietary.]

HC Unibon Unit Train 2 (Unit 212): The converted HC Unibon Unit Train 2 is included in Cases 2 and 4 only. A lower required throughput has reduced the extent of required modifications to this unit, as shown on the revised block flow diagrams (Figures 9.3.1-C and 9.3.1-E) presented earlier in this section.

Utility and Tankage Systems Adjustments

Utility Systems: A revised utility summary for each adjusted case is presented in Table 9.12. In general, overall utility consumptions have gone down primarily due to the elimination or reduction in capacity of several units. However, there is little impact on the equipment in the new utility systems because they have been sized to match the capacities of the existing equipment, which in most cases is larger than the actual incremental requirement.

Adjustments have been made only in those cases where the adjusted utility requirements have been reduced to the point where an entire equipment item can be eliminated. As an example, in the original design, two boilers (68 t/h capacity each), identical to the existing UP-II Refinery boilers, were required for all four cases. As a result of adjustments, only

[The information contained on page 9-39 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

one of the two new boilers is required for Cases 1 and 2. Utility system changes of these type are reflected in the adjusted cost estimates.

Intermediate Storage (Unit 045): *[This deleted information is considered confidential and proprietary.]*

Product Lube Storage (Unit 046): *[This deleted information is considered confidential and proprietary.]*

[The information contained on page 9-41 is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

9.3.3 YCS Capital Cost Estimates Adjustments

The capital cost estimates were revised primarily to reflect the changes resulting from the Yield Confirmation Study. In general, the methodology, assumptions and qualifications presented in Section 4 of this report are still applicable to the adjusted estimates. The adjusted, unescalated capital cost estimates are based on instantaneous mid-1993 prices, whereas those presented in Section 4 are based on instantaneous January, 1993 prices. The escalation charts used to generate the instantaneous costs for the above time frames, from the mid-1990 Fluor Daniel data base, were recently updated to reflect the lower than anticipated material escalation that has occurred from mid-1990 to present. This has resulted in a net decrease in the capital costs for all four cases. Finally, minor cost redistribution was done among units to better represent the individual unit or area costs.

A six percent annual escalation factor was applied to the EPC and a portion of the Owner's costs (land and start-up costs). The remaining portion of the Owner's costs was escalated at three percent annually.

Summaries of the adjusted capital costs are presented in the following tables. Table 9.14 shows an overall summary of the adjusted capital costs. The adjustments have resulted in lower EPC, Owners', and Total Project Costs for all four cases. Table 9.15 presents the adjusted EPC Contract Total Installed Costs, broken down by unit. The adjusted Owners' Costs are summarized in Table 9.16. An adjusted summary of the two alternates considered during the course of the study are shown on Table 9.17.

[The information contained on pages 9-43 through 9-46) is considered confidential and proprietary to the Dumai Base Oils Project or to the licensors who have provided the information under a secrecy and/or licensor agreements. This information has been removed from this Study Report in order to comply with the required agreements.]

9.4 UP-II Plant Tests

In this section of the report, a brief description of the UP-II Plant Tests is included. It is intended to provide a summary of an overall methodology of the tests, relevant selected operating parameters, conclusions, and recommendations. A detailed report of the UP-II Plant Tests prepared by UOP is included in Appendix C-7 of this study report.

9.4.1 Overview

The test runs on the High Vacuum Unit (HVU) and the Hydrogen Plant of Dumai UP II Refinery were jointly conducted by Pertamina, Chevron, UOP, and Fluor Daniel during the weeks of January 26, 1993 through February 3, 1993. The objective of these tests was to determine capacity limits of the units and to identify bottlenecks responsible for the established capacity limits.

The refinery was in good operating condition after having gone through a start-up and an internal test program of two weeks following a maintenance turnaround period. At this time, the HVU was operating at ________, 10 percent above its rated capacity and the Hydrogen Plant at ________ of product hydrogen, at approximately 80 percent of its rated capacity.

The UOP/Fluor Daniel team arrived in Dumai on January 25, 1993 and was joined by Chevron on January 28, 1993. Meetings were held with Pertamina to review test methodology, stepwise changes in operating conditions, data logging, data collection, sample collection, sample analysis, responsibility matrix, etc. The participants agreed to meet daily to review test progress, take corrective action on test plans where needed, and plan for the next step.

It was unanimously agreed that plant and personnel protection and safety superseded test or any other objectives. It was also decided to conduct tests so that existing operations will not be impeded.

A brief outline of tests, conclusions and recommendations for the two process units tested is presented in the following sections.

9.4.2 High Vacuum Unit (HVU)

(a) ***Operating Details***

- The unit throughput was maintained at ______ BPSD, the same as it was during Pertamina's test; i.e., 10 percent above the rated capacity of the unit.

- Heater "B" outlet temperatures were to be maintained at 395°C due to high skin temperature for a couple of passes.

- Heater "A" temperatures were to be increased in 10°C steps in order to increase the combined outlet from two heaters by 5°C. Pertamina decided to limit the heater outlet temperature for Heater "A" to 416 - 418°C. This constraint limited the combined outlet from the two heaters to 405°C.

- Wash oil rate to the slop wax section was to be regulated to obtain HVGO color at 6 or less.

- HVGO pumparound reflux rate was regulated to adjust cut point between HVGO and LVGO while maintaining LVGO pour point at 65 - 70°F. (**Note**: LVGO [essentially diesel lifted in HVU], a diesel pool component, pour point was limited to less than 70°F in order for the diesel pool pour point not to exceed diesel pour point specification of 65°F.)

- Flash zone pressure was to be maintained at _________ by suitably adjusting vacuum column top pressure until a combined heater outlet temperature of 405°C was attained. Subsequently, the vacuum column top pressure was to be decreased in 5mm Hg steps till a bottleneck either in the column or steam jet ejector system was reached.

(b) *Data Collection and Laboratory Analysis*

- The data being logged for the normal plant operation was deemed to be adequate for the test runs.
- Some of the important flow, pressure, and temperature data was averaged from the plant data recorders.
- Samples were collected in duplicate every four hours.
- Laboratory distillations and analysis performed were as done routinely. Requests for additional analysis were handled on a case by case basis.

(c) *Conclusions*

- The test runs indicated that the HVU can be operated at least 10 percent above design with no major design constraints.
- The total gas oil lift increased by 4.5 liquid volume percent from the Base Case.
- The LVGO rate increased by 3 liquid volume percent over the Base Case.
- The HVGO yield increased by 1 liquid volume percent over the Base Case.
- The vacuum bottom yield decreased by 4.5 liquid volume percent over the Base Case.
- There was no evidence of cracking in the heater as little or no gas was produced.

(d) ***Recommendations***

- Continue to operate HVU with higher gas oil lift. The additional virgin gas oil recovered is considerably more valuable than coker gas oil.

- Modify slop wax pan to minimize liquid inventory in the pan.

- Install vacuum jet spill back system to allow automatic pressure control of the column. Also, evaluate vacuum system to achieve lower column pressure.

- Provide higher horsepower motor for the slop wax pumps to maximize slop wax recycle to the vacuum heaters.

- Repair faulty skin thermocouples and check all other skin thermocouples.

- Further adjust operating conditions to optimize LVGO/HVGO production.

9.4.3 Hydrogen Plant

(a) ***Operating Details***

- The unit hydrogen production was increased to nominal _____ Nm^3/h, approximately 12 percent above design.

- Hydrogen purity was maintained at __ volume percent or better.

- Steam/carbon ratio was maintained at a minimum of ___.

- Hydrogen production was increased in 5 percent steps till a bottleneck was reached.

- Data being logged for the normal plant operations was deemed to be adequate for the test runs.

- Important flow, pressure, and temperature data was averaged from the plant data recorder.

- Plant pressure survey was conducted with a single, large dial, calibrated pressure gauge, with a range of 0-50 kg/cm^2.

(b) ***Conclusions***

- The plant ran well at a nominal hydrogen production rate of _____ Nm^3/h, 12 percent above design, producing ___ volume percent purity hydrogen.

- There appeared to be no pressure-drop problems at this hydrogen throughput.

- The maximum allowable temperature of the reformer furnace tubes was exceeded at this throughput for a majority of the tubes indicating a bottleneck.

- No problems were encountered with the Benfield section of the plant.

(c) ***Recommendations***

- If the hydrogen plant is required to produce hydrogen at 125 percent of design, the reformer tubes may have to be replaced.

- The pressure survey provided enough data for UOP and/or Fluor Daniel to identify bottlenecks and develop solutions to the identified bottlenecks.