ReCAP Project

Understanding the Cost of Retrofitting CO_2 Capture in an Integrated Oil Refinery

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Reference Base Case Plants: Economic Evaluation

SINTEF

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Report

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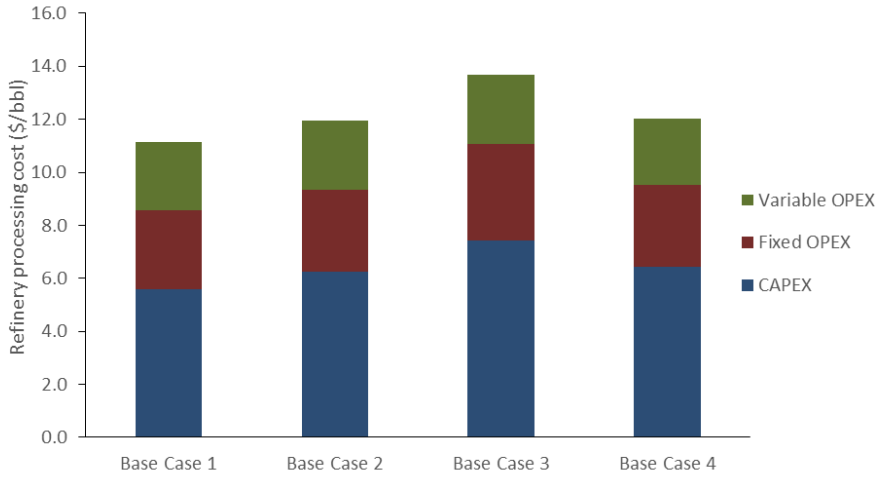

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ABSTRACT
This report provides estimates of CAPEX and fixed and variable OPEX for four different generic refineries ("Base Case refineries"). The performance of the four refinery Base Cases, in terms of mass and energy balances and CO_2 emissions, is described in the report *Performance Analysis – Refinery Reference Plants*, issued by Amec FosterWheeler, which is available on www.sintef.no/recap.

The estimated refinery processing cost is for the four refineries:

- Base Case 1 (crude processing capacity 100 000 bbl/day): 11.13 $/bbl
- Base Case 2 (crude processing capacity 220 000 bbl/day): 11.96 $/bbl
- Base Case 3 (crude processing capacity 220 000 bbl/day): 13.70 $/bbl
- Base Case 4 (crude processing capacity 350 000 bbl/day): 12.01 $/bbl

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VERSION	DATE	VERSION DESCRIPTION
1	2017-04-07	Draft with calculation of CAPEX and OPEX for refinery base cases
2	2017-04-28	Used TIC values from Amec FW that are not rounded off for increased accuracy of costs. Minor corrections in text as suggested by Concawe.
3	2017-08-16	Final version

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1 Introduction

The scope of this report is to provide CAPEX, and fixed and variable OPEX for the four different generic refineries:

- Base Case 1) Simple refinery with a nominal capacity of 100 000 bbl/d
- Base Case 2 and 3) Medium to highly complex refineries with nominal capacity of 220 000 bbl/d
- Base case 4) Highly complex refinery with a nominal capacity of 350 000 bbl/d

These costs are thereafter presented as the refinery processing cost in $/bbl crude. This means that the values for CAPEX and OPEX in this report are not based on any specific existing refineries. The performance of the four generic refinery Base Cases, in terms of mass and energy balances and CO_2 emissions, is described in the report *Performance Analysis – Refinery Reference Plants*, issued by Amec Foster Wheeler. Amec Foster Wheeler has in the present report contributed with estimated investment costs for the four refinery Base Cases, as well as estimated manpower requirements. The contributions from Amec Foster Wheeler are included in Appendix A.

It should be noted that the amount of processed crude is assumed to remain constant in the work presented in the subsequent reports *Performance analysis of CO_2 capture options* and *Cost estimation and economic evaluation of CO_2 capture options for refineries*. This means that there is no direct connection between the results of the economic evaluation presented in the present report and the results presented in the report on economic evaluation of CO_2 capture. Both reports, however, rely on the same economic criteria and assumptions, as described in the *Reference Document – Economic assumptions*. Also, the method for calculating CAPEX and OPEX has followed the same structure in both reports. The Excel sheet made available in connection with the report *Cost estimation and economic evaluation of CO_2 capture options for refineries* provides an understanding of how the economic evaluation was done in the present report.

2 CAPEX for refinery base cases

The capital expenditures for the refinery base cases are provided in Table 1. The calculation of Total Installed Cost (TIC) by Amec Foster Wheeler is included in Table 4.

Table 1. Capital expenditures for the four refinery base cases.

	Base Case 1	Base Case 2	Base Case 3	Base Case 4
Total installed cost (TIC)	**1 626 000**	**4 014 000**	**4 768 000**	**6 555 000**
Project contingencies	162 600	401 400	476 800	655 500
Total plant cost (TPC)	**1 788 600**	**4 415 400**	**5 244 800**	**7 210 500**
Spare parts	8 943	22 077	26 224	36 053
Inventory of fuel and chemicals	5 081	13 092	14 937	21 522
Start-up cost	43 132	99 048	117 136	157 790
Owner cost	125 202	309 078	367 136	504 735
Interest during construction	284 642	702 677	834 670	1 147 496
Total capital requirement	**2 255 600**	**5 561 372**	**6 604 903**	**9 078 096**

3 Annual operating costs for refinery base cases

Fixed and variable operating costs for the refinery base cases are provided in Table 2. Manpower requirement for calculating labour cost is determined by Amec Foster Wheeler (see Table 6-Table 9).

Table 2. Fixed, variable and total operating costs for the four refinery base cases.

	Base Case 1	Base Case 2	Base Case 3	Base Case 4
Labour cost	29 440	42 960	48 960	54 320
Annual maintenance	66 330	172 260	205 095	290 602
Other	8 943	22 077	26 224	36 053
Annual fixed operating cost	**104 713**	**237 297**	**280 279**	**380 974**
Natural gas consumption	37 647	58 937	29 598	59 716
Chemical and catalyst	51 480	140 195	169 950	240 900
Raw process water (make-up)	84	2 176	1 898	2 436
Waste disposal	0	0	0	0
Annual variable operating cost	**89 211**	**201 308**	**201 447**	**303 052**
Total annual operating cost	**193 924**	**438 605**	**481 726**	**684 026**

4 Refinery processing cost

The refinery processing cost in $/bbl crude is presented in Table 3 and Figure 1. As for the costing of CO_2 capture, an annualization factor of 11.53 was used to calculate the annual capital cost for the refineries. The annualization factor is calculated based on an interest rate of 8% and an economic lifetime of 25 years. (Refer to the *Reference Document – Economic assumptions* for further details.)

Table 3. Refinery processing cost in $/bbl for the four base cases.

	Base Case 1	Base Case 2	Base Case 3	Base Case 4
CAPEX	5.59	6.26	7.44	6.43
Fixed OPEX	2.99	3.08	3.64	3.11
Variable OPEX	2.55	2.61	2.62	2.47
Total	**11.13**	**11.96**	**13.70**	**12.01**

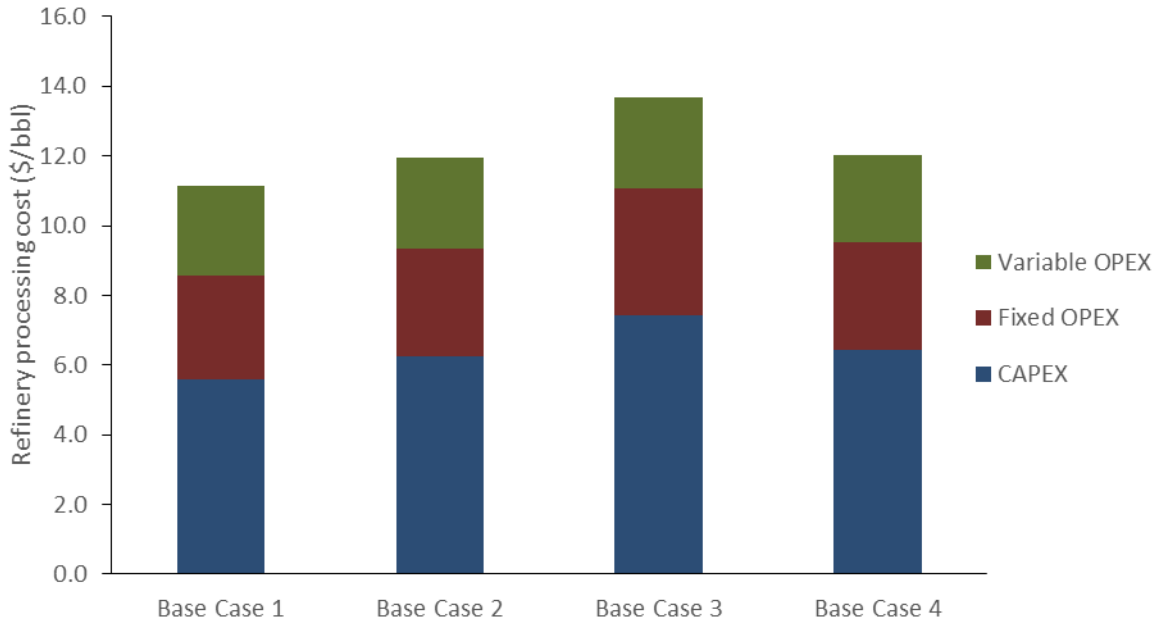

Figure 1. Refinery processing cost in $/bbl for the four base cases.

A Estimated investment cost and manpower requirements for the refinery base cases

The contents of this Appendix have been provided by Amec Foster Wheeler, who has been a subcontractor to SINTEF Energy Research in the project resulting in this study aiming at understanding the costs of CO_2 capture in integrated oil refineries.

A.1 Estimated Investment Cost

Table 4 includes the cost estimate summary for the four Base Case refineries.

The cost estimated for the main units has been evaluated on a pro-rate capacity basis starting from the in-house database for similar units, populated with cost data from previous projects. A location factor has been then applied. The estimate is in current currency.

The table provides the details of the estimate, divided by areas, i.e., Process Units, Auxiliary Units, Power Units, Utilities and Offsite Units. In particular, the investment cost for Utilities and Offsite Units is evaluated as a percentage of the investment cost for the other units.

The estimate is excluding the following:

- The cost of land
- The cost covering process licensors fee such as technology fee, PDP preparation, royalties and the like
- The cost relevant to the local authorities permitting fee's
- The commissioning and start-up cost
- The cost associated to the utilities generation and consumption during the commissioning stage
- The cost of catalyst and chemicals and lubricants
- The local taxes of any kind
- Custom Duties
- All risk insurance
- Financial cost
- Capital and start-up spare
- Interest during construction
- Owner Cost
- EPC risk and profit

On top of the investment costs, some of the other capital costs could be estimated as follows:

- Spare Parts: Typically assumed equal to 0.5% of the TPC.
- Inventory of fuel and chemicals: Typically assumed to be 1 month of operating costs for chemicals, catalysts and raw process water, plus 25% of full load of natural gas consumption for 1 month
- Start-up expenses: Typically assumed equal to 2% of the TPC plus 3 months of labour cost
- Interest during construction: Typically assumed equal to 15.9% of the TPC.
- Owner cost: Typically assumed to be 7% of the TPC.

Table 4. Investment Cost Summary Table

Note: The total investment cost value that is not rounded off below was used for the TIC in Table 1 for slightly improved accuracy.

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INVESTMENT COST ESTIMATE

UNIT			Unit of measure	BASE CASE 1		BASE CASE 2		BASE CASE 3		BASE CASE 4	
				Design Capacity	CAPEX [MM USD]	Design Capacity	CAPEX [MM USD]	Design Capacity	CAPEX [MM USD]	Design Capacity	CAPEX [MM USD]
PROCESS UNITS											
0100A	CDU	Crude Distillation Unit (1)	BPSD	100,000	**124**	100,000	**124**	100,000	**124**	175,000	**184**
0100B	CDU	Crude Distillation Unit (1)	BPSD	-	**-**	120,000	**141**	120,000	**141**	175,000	**184**
0250	LSW	LPG Sweetening	BPSD	4,000	**12**	14,000	**23**	14,000	**23**	19,000	**27**
0280A	KSW	Kerosene Sweetening	BPSD	5,000	**4**	5,000	**4**	5,000	**4**	12,000	**6**
0280B	KSW	Kerosene Sweetening	BPSD	-	**-**	10,000	**5**	10,000	**5**	12,000	**6**
0300A	NHT	Naphtha Hydrotreater	BPSD	23,000	**46**	23,000	**46**	23,000	**46**	40,000	**62**
0350A	NSU	Naphtha Splitter Unit	BPSD	23,000	**71**	23,000	**71**	23,000	**71**	40,000	**104**
0300B	NHT	Naphtha Hydrotreater	BPSD	-	**-**	27,000	**56**	27,000	**56**	40,000	**62**
0350B	NSU	Naphtha Splitter Unit	BPSD	-	**-**	27,000	**79**	27,000	**79**	40,000	**104**
0400	ISO	Isomerization	BPSD	8,000	**20**	15,000	**27**	15,000	**27**	23,000	**34**
0500A	CRF	Catalytic Reforming (2)	BPSD	15,000	**154**	15,000	**154**	15,000	**154**	30,000	**251**
0500B	CRF	Catalytic Reforming (2)	BPSD	-	**-**	18,000	**175**	18,000	**175**	30,000	**251**
0600A	KHT	Kero HDS	BPSD	14,000	**51**	14,000	**51**	14,000	**51**	15,000	**53**
0600B	KHT	Kero HDS	BPSD	-	**-**	5,000	**30**	12,000	**47**	15,000	**53**
0700A	HDS	Gasoil HDS	BPSD	26,000	**117**	26,000	**117**	26,000	**117**	42,500	**165**
0700B	HDS	Gasoil HDS	BPSD	-	**-**	34,000	**141**	39,000	**155**	42,500	**165**
0800	VHT	Vacuum Gasoil Hydrotreater	BPSD	6,000	**69**	35,000	**236**	50,000	**302**	36,000	**240**
0900	HCK	Vacuum Gasoil Hydrocracker	BPSD	-	**-**	-	**-**	-	**-**	60,000	**496**
1000	FCC	Fluid Catalytic Cracking (3)	BPSD	-	**-**	50,000	**350**	60,000	**405**	60,000	**405**
1050	PTU	FCC Gasoline Post-Treatment Unit	BPSD	-	**-**	20,000	**77**	24,000	**85**	24,000	**85**
1100A	VDU	Vacuum Distillation Unit	BPSD	35,000	**71**	35,000	**71**	35,000	**71**	65,000	**109**
1100B	VDU	Vacuum Distillation Unit	BPSD	-	**-**	45,000	**84**	51,000	**92**	65,000	**109**
1200A	SMR	Steam Reformer	Nm^3/h Hydrogen	-	**-**	22,500	**42**	35,000	**58**	65,000	**89**
1200B	SMR	Steam Reformer	Nm^3/h Hydrogen	-	**-**	-	**-**	-	**-**	65,000	**89**
1300	SDA	Solvent Deasphalting	BPSD	-	**-**	-	**-**	-	**-**	30,000	**85**
1400	DCU	Delayed Coking (4)	BPSD	-	**-**	-	**-**	35,000	**308**	50,000	**395**
1500	VBU	Visbreaking Unit	BPSD	13,000	**54**	28,000	**92**	-	**-**	-	-
		Total Process Units			**794**		**2,198**		**2,598**		**3,811**
AUXILIARY UNITS											
2000A	ARU	Amine Washing and Regeneration	t/d Sulphur	55	**22**	55	**22**	55	**22**	375	**81**
2000B	ARU	Amine Washing and Regeneration	t/d Sulphur	-	**-**	165	**47**	395	**84**	375	**81**
2100A	SWS	Sour Water Stripper	m^3/h	30	**22**	30	**22**	30	**22**	190	**85**
2100B	SWS	Sour Water Stripper	m^3/h	-	**-**	90	**47**	200	**88**	190	**85**
2200A	SRU	Sulphur Recovery & Tail Gas Treatment	t/d Sulphur	55	**34**	55	**34**	55	**34**	3 x 250	**208**
2200B	SRU	Sulphur Recovery & Tail Gas Treatment	t/d Sulphur	-	**-**	2 x 82.5	**73**	2 x 197.5	**132**		
2300A	WWT	Waste Water Treatment / API Separator	m^3/h	100	**64**	100	**64**	100	**64**	500	**207**
2300B	WWT	Waste Water Treatment / API Separator	m^3/h	-	**-**	150	**84**	200	**104**	-	**-**
		SubTotal Auxiliary Units			**142**		**393**		**550**		**747**
POWER UNITS											
2500	POW	Power Plant	kW	40,000	**80**	80,000	**176**	78,000	**140**	175,000	**298**
UTILITY UNITS											
3000	SWI	Sea Water Intake									
3100	CWS	Cooling Water System									
3200	SRW	Service & Potable Water Systems									
3300	DEW	Demineralized Water System									
3350	BFW	Boiler Feed Water System									
3400	STS	Steam System									
3450	CON	Condensate Recovery System									
3500	FFW	Fire Water and Fire Fighting System									
3600	AIR	Plant and Instrument Air System									
3700	FGS	Fuel Gas System									
3750	FOS	Fuel Oil System									
3800	NGU	Nitrogen System									
3900	CHE	Chemical Systems									
		SubTotal Utility Units			**254**		**554**		**658**		**728**
OFF-SITES UNITS											
4000	FLA	Flare System									
4100	TAN	Tankage and Pumping System									
4200	INT	Interconnecting System									
4300	COH	Coke Handling System									
4400	SEW	Sewer Systems									
4500	TLA	Trucks Loading Area									
4600	JPF	Jetty and Port facilities									
	BUI	Buildings, DCS, S/S									
		SubTotal Off-Sites Units			**356**		**692**		**822**		**971**
		TOTAL			**1,626**		**4,014**		**4,768**		**6,555**
		say			**1,600**		**3,900**		**4,700**		**6,500**

Notes
(1) CDU includes Saturated Gas Plant (SGP), unit 0200, composed of Naphtha Stabilizer, Deethanizer, C3/C4 Splitter
(2) CCR includes Pressure Swing Adsorption (PSA), unit 1700.
(3) FCC includes C3/C3= Splitter and LPG Sweetening.
(4) DCU includes LPG Sweetening.

A.2 Estimated Operating Costs

In addition to the main utility costs already accounted for in the refinery balances, there are a number of yearly fixed operating costs to be considered.

The main items composing the yearly fixed operating cost are:

- *Labour costs*: Labour costs include operating labour, administrative and support labour and are calculated based on the total number of employees and an annual average salary of 80,000 $/y. The number of personnel engaged is estimated for each case with the consideration of a 5-shift work pattern. The man power requirement for the four Base Cases is reported in Table 6, Table 7, Table 8, and Table 9. The labour cost is estimated by multiplying the number of workers times the annual average salary.
- *Insurance and local property taxes*: The total annual cost of insurance, local property taxes and miscellaneous regulatory and overhead fees is to be 0.5% of the TPC.
- *Maintenance cost*: Maintenance costs include cost of preventive maintenance, corrective maintenance (repair and replacement of failed components). In this study the following assumptions are used in estimating the annual maintenance costs:
    - Whole Refinery Major Processes 3.0% of the unit relative TPC
    - Hydrogen Production Units 1.5% of the unit relative TPC
    - Power plant 2.5% of the unit relative TPC
    - Utilities and Off-sites Units 1.0% of the unit relative TPC
- *Chemical and catalyst costs*: The costs of chemicals and catalysts are assumed to be 3.0% of the unit relative TPC, i.e., the plant cost associated with the Whole Refinery Major Processes unit.

Other fixed operating costs could be accounted for Land Rental, Environmental Tax, Administration Expenses, etc. These are, however, quite site-specific and very difficult to generalize for reference cases.

The variable operating costs include costs associated with the consumption of natural gas and raw process water (make-up). The costs are evaluated based on the assessed utilities and make-up consumption combined with the utilities costs given in Table 5.

Table 5: Utility costs

Utility	**Cost**
Natural Gas [$/GJ]	6.6
Raw process water make-up [$/m^3]	0.1

Table 6: Base Case 1) Estimated manpower requirement

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REFINERY STAFF - BASE CASE 1

OPERATION MANPOWER (shift breakfactor = 5.5)

		Shift Leader	Boardman	Field Operator	Loading Master	Jetties	Senior Shift Supervisor	Total Shift Personnel	Total Personnel
OPERATING AREA 1		1	1	3	0	0	0	5	27.5
0100	Crude Distillation Unit								
0200	Saturated Gas Plant								
0250	LPG Sweetening								
0280	Kerosene Sweetening								
1100	Vacuum Distillation Unit								
1500	Visbreaking Unit								
OPERATING AREA 2		1	1	3	0	0	0	5	27.5
0300	Naphtha Hydrotreater								
0350	Naphtha Splitter Unit								
0400	Isomerization								
0500	Catalytic Reforming								
OPERATING AREA 3		1	1	4	0	0	0	6	33.0
0600	Kero HDS								
0700	Gasoil HDS								
0800	Vacuum Gasoil Hydrotreater								
2000	Amine Washing and Regeneration								
2100	Sour Water Stripper								
2200	Sulphur Recovery & Tail gas Treatment								
OPERATING AREA 7		**2**	**2**	**4**	0	0	0	8	44.0
3000	Utility Units								
OPERATING AREA 8		1	1	2	1	3	0	8	44.0
4000	Off-sites Units								
	Senior Shift Supervisor						**2**	2	11.0

DAY PERSONNEL	Superintendent	Assistant Superintendent	Manager Operation					
	4	6	**3**					13.0

TOTAL OPERATING PERSONNEL	**200**

MAINTENANCE MANPOWER

TOTAL MAINTENANCE PERSONNEL	**80**

SUPPORT FUNCTIONS / MANAGEMENT MANPOWER

Refinery Manager	2
Logistics	10
Administration	15
Management Log / Admin	4
Purchasing	4
Stores	6
Personnel	3
Info Systems	5
Laboratory	24
Process Engineering	15

TOTAL SUPPORT / MGMT PERSONNEL	**88**
TOTAL REFINERY STAFF	**368**

Table 7: Base Case 2) Estimated manpower requirement

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REFINERY STAFF - BASE CASE 2

		Shift Leader	Boardman	Field Operator	Loading Master	Jetties	Senior Shift Supervisor	Total Shift Personnel	Total Personnel
OPERATION MANPOWER (shift breakfactor = 5.5)									
OPERATING AREA 1A / 1B		1	2	6	0	0	0	9	49.5
0100	Crude Distillation Unit								
0200	Saturated Gas Plant								
0250	LPG Sweetening								
0280	Kerosene Sweetening								
1100	Vacuum Distillation Unit								
1500	Visbreaking Unit								
OPERATING AREA 2A / 2B		1	2	6	0	0	0	9	49.5
0300	Naphtha Hydrotreater								
0350	Naphtha Splitter Unit								
0400	Isomerization								
0500	Catalytic Reforming								
OPERATING AREA 3A / 3B		**2**	2	**9**	0	0	0	13	71.5
0600	Kero HDS								
0700	Gasoil HDS								
0800	Vacuum Gasoil Hydrotreater								
1200	Steam Reformer								
2000	Amine Washing and Regeneration								
2100	Sour Water Stripper								
2200	Sulphur Recovery & Tail gas Treatment								
2000	Amine Washing and Regeneration								
2200	Sulphur Recovery & Tail gas Treatment								
OPERATING AREA 4		1	1	3	0	0	0	5	27.5
1000	Fluid Catalytic Cracking								
1050	FCC Gasoline Post-Treatment Unit								
OPERATING AREA 7		**2**	**2**	**5**	0	0	0	9	49.5
3000	Utility Units								
OPERATING AREA 8		1	1	2	1	3	0	8	44.0
4000	Off-sites Units								
Senior Shift Supervisor							**4**	4	22.0

DAY PERSONNEL	Superintendent	Assistant Superintendent	Manager Operation					
	6	8	**5**					19.0

TOTAL OPERATING PERSONNEL	**333**
MAINTENANCE MANPOWER	
TOTAL MAINTENANCE PERSONNEL	**100**
SUPPORT FUNCTIONS / MANAGEMENT MANPOWER	
Refinery Manager	3
Logistics	12
Administration	18
Management Log / Admin	6
Purchasing	6
Stores	8
Personnel	3
Info Systems	5
Laboratory	24
Process Engineering	19
TOTAL SUPPORT / MGMT PERSONNEL	**104**
TOTAL REFINERY STAFF	**537**

Table 8: Base Case 3) Estimated manpower requirement

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REFINERY STAFF - BASE CASE 3

amec foster wheeler

OPERATION MANPOWER (shift breakfactor = 5.5)

		Shift Leader	Boardman	Field Operator	Loading Master	Jetties	Senior Shift Supervisor	Total Shift Personnel	Total Personnel
OPERATING AREA 1A / 1B		1	2	6	0	0	0	9	49.5
0100	Crude Distillation Unit								
0200	Saturated Gas Plant								
0250	LPG Sweetening								
0280	Kerosene Sweetening								
1100	Vacuum Distillation Unit								
OPERATING AREA 2A / 2B		1	2	6	0	0	0	9	49.5
0300	Naphtha Hydrotreater								
0350	Naphtha Splitter Unit								
0400	Isomerization								
0500	Catalytic Reforming								
OPERATING AREA 3A / 3B		**2**	**3**	**9**	0	0	0	14	77.0
0600	Kero HDS								
0700	Gasoil HDS								
0800	Vacuum Gasoil Hydrotreater								
1200	Steam Reformer								
2000	Amine Washing and Regeneration								
2100	Sour Water Stripper								
2200	Sulphur Recovery & Tail gas Treatment								
2000	Amine Washing and Regeneration								
2200	Sulphur Recovery & Tail gas Treatment								
OPERATING AREA 4		1	1	3	0	0	0	5	27.5
1000	Fluid Catalytic Cracking								
1050	FCC Gasoline Post-Treatment Unit								
OPERATING AREA 5		1	1	4	0	0	0	6	33.0
1400	Delayed Coking								
OPERATING AREA 7		**2**	**2**	**7**	0	0	0	11	60.5
3000	Utility Units								
OPERATING AREA 8		1	1	3	1	4	0	10	55.0
4000	Off-sites Units								
	Senior Shift Supervisor						**4**	4	22.0

DAY PERSONNEL	Superintendent	Assistant Superintendent	Manager Operation					
	8	10	**6**					24.0

TOTAL OPERATING PERSONNEL	**398**

MAINTENANCE MANPOWER

TOTAL MAINTENANCE PERSONNEL	**110**

SUPPORT FUNCTIONS / MANAGEMENT MANPOWER

Refinery Manager	3
Logistics	12
Administration	18
Management Log / Admin	6
Purchasing	6
Stores	8
Personnel	3
Info Systems	5
Laboratory	24
Process Engineering	19

TOTAL SUPPORT / MGMT PERSONNEL	**104**
TOTAL REFINERY STAFF	**612**

Table 9: Base Case 4) Estimated manpower requirement

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REFINERY STAFF - BASE CASE 4

OPERATION MANPOWER (shift breakfactor = 5.5)

		Shift Leader	Boardman	Field Operator	Loading Master	Jetties	Senior Shift Supervisor	Total Shift Personnel	Total Personnel
OPERATING AREA 1A / 1B		1	2	6	0	0	0	9	49.5
0100	Crude Distillation Unit								
0200	Saturated Gas Plant								
0250	LPG Sweetening								
0280	Kerosene Sweetening								
1100	Vacuum Distillation Unit								
OPERATING AREA 2A / 2B		1	2	6	0	0	0	9	49.5
0300	Naphtha Hydrotreater								
0350	Naphtha Splitter Unit								
0400	Isomerization								
0500	Catalytic Reforming								
OPERATING AREA 3A / 3B		**2**	**4**	**10**	0	0	0	16	88.0
0600	Kero HDS								
0700	Gasoil HDS								
0800	Vacuum Gasoil Hydrotreater								
1200	Steam Reformer								
2000	Amine Washing and Regeneration								
2100	Sour Water Stripper								
2200	Sulphur Recovery & Tail gas Treatment								
2000	Amine Washing and Regeneration								
2200	Sulphur Recovery & Tail gas Treatment								
OPERATING AREA 4		1	1	3	0	0	0	5	27.5
0900	Vacuum Gasoil Hydrocracker								
OPERATING AREA 5		1	1	3	0	0	0	5	27.5
1000	Fluid Catalytic Cracking								
1050	FCC Gasoline Post-Treatment Unit								
OPERATING AREA 6		1	1	4	0	0	0	6	33.0
1300	Solvent Deasphalting								
1400	Delayed Coking								
OPERATING AREA 7		**2**	**3**	**7**	0	0	0	12	66.0
3000	Utility Units								
OPERATING AREA 8		1	1	3	1	4	0	10	55.0
4000	Off-sites Units								
Senior Shift Supervisor							**4**	4	22.0

DAY PERSONNEL	Superintendent	Assistant Superintendent	Manager Operation					
	8	10	**6**					24.0

TOTAL OPERATING PERSONNEL	**442**

MAINTENANCE MANPOWER

TOTAL MAINTENANCE PERSONNEL	**120**

SUPPORT FUNCTIONS / MANAGEMENT MANPOWER

Refinery Manager	4
Logistics	14
Administration	18
Management Log / Admin	7
Purchasing	8
Stores	10
Personnel	3
Info Systems	5
Laboratory	26
Process Engineering	22

TOTAL SUPPORT / MGMT PERSONNEL	**117**
TOTAL REFINERY STAFF	**679**

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