Arthur D Little

Proyecto de Modernización de la Refinería de Talara

Opinión experta sobre la diferencia del monto de inversión a nivel conceptual y FEED y las horas hombre utilizadas para el desarrollo del FEED del PMRT

Informe Final

Diciembre 5, 2012

Preparado para:

PETROPERU

Arthur D. Little, Inc.
First City Tower
1001 Fannin Street, Suite 705
Houston, Texas 77002
Tel : +1 281-404-9856
Fax : +1 713-655-0726
Web: www.adlittle-us.com

We made our own 2012 estimation of investment by unit to be able to compare with the overall price indicated by Técnicas Reunidas

Arthur D. Little Methodology for FEED's CAPEX Assessment

- We estimated costs in detail for each refinery unit to compare with the overall price indicated by Técnicas Reunidas (TR) of 3,046 million USD to assess the reasonability of this amount
- We estimated for each of the units (100% of the units/facilities/services) the quantity of equipment, piping, structural steel, electrical, piling, civil, site development, instrumentation and labor required for construction e installation and also the related engineering services.
- We have done our estimation based in actual physical and commercial data for similar units designed and constructed recently.
- We did not included units to be outsourced, like Hydrogen, Power Generation, Nitrogen & Water Desalter units, which are only some of the typically outsourced ones in similar projects.
- We also made our own expert estimation of buy outs and other commercial cost components
- Once we had the physical estimation we calculated its costs in the USGC and its localization in Peru to compare with TR's estimation (for further details see examples in Appendix)
- We also conducted a comparison starting from the TR FEED basis using the quantity data supplied by TR for each of the units (Equipment, Piping, Structural steel, Electrical, Instrumentation, Piling, Civil, Site development, Buildings, Insulation, Painting and Fireproofing, Precommissioning, Other costs, Services costs, Commercial items)

Source: Arthur D. Little analysis

PETROPERU

1 FEED's CAPEX Expert Opinion

The Open Book Estimate by TR represents in ADL opinion the fair costs for the PetroPeru Talara refinery modernization project, which we estimated in 3.1 billion dollars

OBE vs ADL Estimate (2012) – CAPEX ('000 USD)

Description	Capacity	Unit	OBE Peru (TR)	ADL Estimate (2012)*	ADL / OBE
Flexicoker	22,600	bpsd	437,600	421,200	-3.7%
Naphta hydrotreating	13,300	bpsd	84,900	85,200	0.4%
Catalytic reformer	9,500	bpsd	76,300	81,200	6.4%
FCC Gasoline Hydrotreating	13,300	bpsd	77,100	73,500	-4.7%
Diesel Hydrotreating	41,000	bpsd	127,800	113,400	-11.3%
Sulfuric Acid Plant	560	t/d	90,200	97,300	7.9%
LPG treatment		bpsd	33,000	32,700	-0.9%
Catalytic Cracking	25,000	bpsd	225,500	222,700	-1.2%
Vacuum Distillation	52,740	bpsd	114,000	100,900	-11.5%
Gas Recovery II	8,129	kg/hr	59,400	61,500	3.5%
Amine Regeneration	234	m3/hr	37,300	36,100	-3.2%
Sour Water Stripping	196	m3/hr	35,800	36,700	2.5%
Crude Distillation	95,000	bpsd	102,900	89,400	-13.1%
ISBL			**1,501,800**	**1,451,800**	**-3.3%**
Caustic Kero Jet Treatment			17,400	18,300	5.2%
Exhausted Soda Plant			16,700	17,300	3.6%
Interconnecting			342,600	397,400	16.0%
Sanitary Treatment			54,300	56,800	4.6%
Closed Cooling Water			76,100	82,800	8.8%
Crude Tankage			191,300	211,400	10.5%
Flare System			47,700	37,100	-22.2%
Seawater In/Out-Let			3,900	4,000	2.6%
Maritime			10,900	11,600	6.4%
General			380,600	403,400	6.0%
OSBL			**1,141,500**	**1,240,100**	**8.6%**
Subtotal Direct Cost			**2,643,300**	**2,691,900**	**1.8%**
Seawater In/Out Let incl. scope opport.			59,900	59,900	0.0%
Revamp cost allowance			13,600	13,600	-0.4%
Total Direct Cost			**2,716,800**	**2,765,400**	**1.8%**
Buy-outs			(132,400)	(100,000)	-24.5%
Taxes			51,400	53,300	3.5%
Contingency			131,900	135,900	3.1%
Contractors turn key profit & risk provisions			221,500	214,100	-3.3%
Feed cost & OBE Fees			57,000	57,000	-0.1%
Grand Total			**3,046,200**	**3,125,700**	**2.6%**

PETROPERU

(*) USGC costs located in Peru with quantities and subcontract costs adjustments

1 FEED's CAPEX Expert Opinion

Our estimation, which is 2.6% higher than the OBE, includes adjustments on several items such as quantities and subcontract costs

CAPEX – OBE vs ADL Estimate (2012)

	OBE Peru (TR)	ADL Estimate (2012)*	ADL / OBE
Equipment	524,215,100	547,813,100	4.5%
Mechanical, Electrical & instrumentation	975,577,800	986,637,900	1.1%
Civil Works	520,195,000	544,543,500	4.7%
Miscellaneous	31,642,100	32,675,500	3.3%
Subtotal Direct Field Cost	**2,051,630,000**	**2,111,670,000**	**2.9%**
Other costs	150,923,300	144,544,100	-4.2%
Services	440,831,200	435,673,400	-1.2%
Subtotal direct cost	**2,643,300,000**	**2,691,900,000**	**1.8%**
Seawater In/Out-Let including scope opportunity	59,900,000	59,900,000	-
Revamp cost allowance	13,600,000	13,600,000	-
Buy-outs	(132,400,000)	(100,000,000)	-24.5%
Taxes	51,400,000	53,300,000	3.7%
Contingency	131,900,000	135,900,000	3.0%
Contractors turn key profit & risk provisions	221,500,000	214,100,000	-3.3%
Feed cost & OBE Fees	57,000,000	57,000,000	-
Escalation	Excluded	Excluded	-
Grand total	**3,046,200,000**	**3,125,700,000**	**2.6%**

PETROPERU

(*) USGC costs located in Peru with adjustments

1 FEED's CAPEX Expert Opinion

When analyzing by category , TR costs estimate seems reasonable except for piping and structural steel quantities that appear to be overestimated and for mechanical bids sub-estimated

	Estimate	
Piping & steel (quantity)	↑	■ **Economic impact: +180 MMUSD**
Equipment (price)	→	■ Conservative, but reasonable
Piping & Steel (price)	↓	■ Aggressive estimate
Electrical material (price)	→	■ Range of expectations
Instrumentation (price)	↑	■ Slightly high
Mechanical bids	↓	■ **Economic impact: -260 MMUSD**
Civil bids	→	■ Reasonable
Other costs	→	■ Reasonable
Construction management and field indirects	→	■ In line with the direct field man-hours and costs
Home office services	↓	■ Low for the EPC scope

TR Estimate: 3 billion USD

Source: Arthur D. Little Analysis

PETROPERU

(*) Considering
(**) Comparison with most reasonable bid adjusted by a lower amount of piping and steel

↑ Overestimated → neutral ↓ Sub-estimated

Based on historical quantity data from projects for similar units, TR estimate seems reasonable except for piping and structural steel quantities that appear to be high

Quantification	■ Based on historical data from projects for similar units, the above ground pipe length for various units appears to be high by 30% ■ Also, the weight of the structural steel appears to be on the high side by 20% ■ Some other quantities appear to be high, but not unreasonable ■ The economic impact on reducing the piping and structural steel quantities would be around 180 MMUSD	■ Pipe length and structural steel appears to be high ■ Other quantities are reasonable
Equipment costs	■ The equipment cost including the buy-outs and design development allowances looks conservative, but reasonable ■ Compressors and pumps costs maybe somewhat on the high side	■ The equipment cost looks conservative, but reasonable
Material costs	■ Piping cost in the estimate is very aggressive ■ Structural steel cost is also aggressive ■ Electrical material cost is in range of expectations ■ Instrumentation cost is slightly high	■ The total material cost is reasonable, but tight
Subcontract costs	■ Mechanical subcontracts: TR estimate is not supported by the average of the costs as available from the original bids and man-hours and cost per man-hour are too low ■ Civil bids: TR estimate as such appears to be reasonable	■ Mechanical subcontracts seem low ■ Civil Subcontracts are reasonable

Source: Arthur D. Little analysis

PETROPERU

Other costs and services are in line with the direct field man-hours and costs, however home office services would be considered low for the EPC scope if it was not that TR has spent already a large amount of man-hours in preparing the FEED

Other costs	■ Includes: – Special lifting – Precommissioning – Vendor representation – Spare parts for commissioning and capital spare parts – Catalyst, chemicals and lubricants – Training – Other costs, such as lab cost – Transportation – Insurances and costs for bonds	■ In general terms these costs are reasonable
Services	■ These costs include construction management, field indirect and home office services costs ■ The cost for the home office services cost would be considered low for the EPC scope if it was not that TR has spent already a large amount of man-hours in preparing the FEED. It maybe assumed that the project is already around 20% complete before the EPC effort starts ■ The construction management and field indirect are in line with the direct field man-hours and costs	■ The construction management and field indirect are reasonable ■ Home office services cost would be considered low

Source: Arthur D. Little analysis

Commercial costs seem reasonable; however before agreement about the fixed price for TR to execute the project has been reached, we recommend that the escalation required during project execution is included in the fixed price

Commercial	■ Buy outs – Buy-outs included for equipment, subcontracts and services and this item also includes the design development allowance for the equipment cost ■ Contingency – Basically around 5% on top of the cost ■ Margin – Profit for the contractor, should also include (if any) an allowance to cover for the contractual terms and conditions. Percentage is around 8% which is considered to be reasonable ■ FEED / OBE Fees – This covers the cost already expended by TR ■ Escalation – At present excluded from the TR price and from ADL cost estimate. We recommend that before agreement has been reached about the fixed price for TR to execute the project, the potential escalation during project execution is minimized. – We believe that using indices to compensate for the cost increase during execution is always very burdensome	■ In general terms these costs are reasonable ■ The buy-out for the subcontract scope included looks rather optimistic

Source: Arthur D. Little analysis

PETROPERU

Piping and structural steel quantities for ISBL appear to be considerably high; OSBL piping length estimate is high while structural steel one sounds reasonable

Piping and steel structure

Description	Pcs	Piping FEED		Piping ADL 2012		Steel FEED	Steel ADL
		length	weight	length	weight	weight	weight
Flexicoker	221	135,500	4,848	77,400	2,769	8,840	7,740
Naphta hydrotreating	69	32,900	997	22,400	679	1,380	1,040
Catalytic reformer	58	17,900	622	14,500	504	870	870
FCC Gasoline Hydrotreating	88	26,300	762	22,000	637	1,540	1,320
Diesel Hydrotreating	65	39,200	1,301	16,300	541	2,930	1,300
Sulfuric Acid Plant	64	9,300	465	11,200	560	1,600	960
LPG treatment	44	11,000	255	11,000	255	1,100	440
Catalytic Cracking	150	68,100	1,973	37,500	1,086	3,380	3,000
Vacuum Distillation	65	43,800	1,488	17,900	608	2,110	1,140
Gas Recovery II	67	23,700	660	18,400	512	1,010	840
Amine Regeneration	37	14,000	452	8,300	268	560	370
Sour Water Stripping	36	8,800	295	8,800	295	1,080	540
Crude Distillation	70	47,900	1,511	21,000	662	2,100	1,400
ISBL	**1,034**	**478,400**	**15,629**	**286,700**	**9,376**	**28,500**	**20,960**
		100%		60%		100%	74%
		M/pc	kg/m	M/pc	kg/m	kg/pc	kg/pc
Parameter		463	32.7	277	32.7	27.6	20.3
Caustic Kero Jet Treatment	20	700	15	700	15	100	100
Exhausted Soda Plant	9	2,400	42	2,400	42	50	50
Interconnecting		254,600	12,089	254,600	12,089	16,500	16,500
Sanitary Treatment	57	23,600	512	20,000	434	290	290
Closed Cooling Water	37	5,100	863	5,100	863		
Crude Tankage	67	117,600	4,408	117,600	4,408	340	340
Flare System	32	46,300	1,453	11,200	351	160	160
Seawater In/Out-Let	7						
Maritime	6	1,000	37	1,000	37		
General	106	35,700	1,320	31,800	1,176	530	530
OSBL	**341**	**487,000**	**20,739**	**444,400**	**19,415**	**17,970**	**17,970**
		100%		91%		100%	100%

PETROPERU

Piping and structural steel for ISBL could be reduced considerably; OSBL piping length could be reduced in a small proportion while the steel should not be altered

Piping and steel structure – Comments

- For the ISBL, the above ground piping is very long and could be reduced considerably
- There are many factors that could have impacted the quantity estimates of TR, such as: pressure and flow speed design criteria and separation standards between towers/equipment within a unit
- A critical review of the plot plan could have a positive impact on piping quantities
- The structural steel quantities for the ISBL is high compared with our estimate based on actual data from similar projects
- For the OSBL the piping length is also high compared with comparable actual units, but in a small proportion (9%), while the steel is reasonable and should not be altered

Source: Arthur D. Little analysis

Most of the hourly rates are consistent, it appears that either the man-hours for the electrical and precommissioning are too high or the cost estimate is too low

Man-hours and subcontract costs

	Pile	Civil	Steel	Eqp	Pref	Pipe	Electr	Instr	BLD	Tks	N&R	Precom	Total
Qty staff	395	35,428	10,079	3,444	19,234	51,184	11,229	7,545	14,819	4,898	7,199	6,099	171,553
Hours ('000)	87	7,794	2,217	758	4,231	11,260	2,470	1,660	3,260	1,078	1,584	1,342	37,742
MUSD	82.0	183.2	172.1	21.5		346.9	28.7	40.2	112.9	32.1	59.4	23.4	
MUSD (material)	80.0	23.2	120.0						40.0	10.1	27.4	-	
MUSD (labour)	2.0	160.0	52.1	21.5	-	346.9	28.7	40.2	72.9	22.0	32.0	23.4	
USD/hr	23.00	20.50	23.50	28.40	-	22.40	11.60	24.20	22.40	20.40	20.20	17.40	

- Most of the hourly rates are consistent, around 20 to 24 USD/hr.
- It appears that either the man-hours for the electrical and precommissioning are too high or the cost is too low

Source: Arthur D. Little analysis

If we keep TR's calculations on material quantities and subcontract cost, our estimate is 3.9% higher than the OBE

OBE vs ADL Estimate (2012) – CAPEX ('000 USD)

Description	Capacity	Unit	OBE Peru (TR)	OBE Distributed*	ADL Estimate w/o adjust. (2012)**	ADL / OBE Dist.
Flexicoker	22,600	bpsd	437,600	490,657	516,000	5.2%
Naphta hydrotreating	13,300	bpsd	84,900	95,194	102,600	7.8%
Catalytic reformer	9,500	bpsd	76,300	85,551	89,800	5.0%
FCC Gasoline Hydrotreating	13,300	bpsd	77,100	86,448	92,700	7.2%
Diesel Hydrotreating	41,000	bpsd	127,800	143,295	149,700	4.5%
Sulfuric Acid Plant	560	t/d	90,200	101,136	102,000	0.9%
LPG treatment		bpsd	33,000	37,001	39,200	5.9%
Catalytic Cracking	25,000	bpsd	225,500	252,841	261,000	3.2%
Vacuum Distillation	52,740	bpsd	114,000	127,822	138,700	8.5%
Gas Recovery II	8,129	kg/hr	59,400	66,602	71,400	7.2%
Amine Regeneration	234	m3/hr	37,300	41,822	45,000	7.6%
Sour Water Stripping	196	m3/hr	35,800	40,141	42,700	6.4%
Crude Distillation	95,000	bpsd	102,900	115,376	127,500	10.5%
ISBL			**1,501,800**	**1,683,886**	**1,778,300**	**5.6%**
Caustic Kero Jet Treatment			17,400	19,510	19,200	-1.6%
Exhausted Soda Plant			16,700	18,725	17,900	-4.4%
Interconnecting			342,600	384,139	436,500	13.6%
Sanitary Treatment			54,300	60,884	63,500	4.3%
Closed Cooling Water			76,100	85,327	87,600	2.7%
Crude Tankage			191,300	214,494	230,000	7.2%
Flare System			47,700	53,483	59,500	11.3%
Seawater In/Out-Let			3,900	4,373	4,100	-6.2%
Maritime			10,900	12,222	11,900	-2.6%
General			380,600	426,746	455,300	6.7%
OSBL			**1,141,500**	**1,279,903**	**1,385,500**	**8.3%**
Subtotal Direct Cost			**2,643,300**	**2,963,789**	**3,163,800**	**6.7%**
Seawater In/Out Let incl. scope opport.			59,900	67,163	-	-
Revamp cost allowance			13,600	15,252	-	-
Total Direct Cost			**2,716,800**	**3,046,204**	**3,163,800**	**3.9%**
Buy-outs			(132,400)			
Taxes			51,400			
Contingency			131,900			
Contractors turn key profit & risk provisions			221,500			
Feed cost & OBE Fees			57,000			
Grand Total			**3,046,200**			

PETROPERU

(*) Other general expenses are distributed to the units, to make costs comparable with ADL estimate
(**) USGC costs adjusted to Peru location using piping and steel quantities and other cost items as used by TR

If we keep TR's assumptions on material quantities and subcontract cost, our estimate is 3.9% higher than the OBE (cont.)

Adjusted CAPEX – OBE vs ADL Estimate (2012)

	OBE Peru (TR)	ADL Estimate w/o adjust. (2012)*	ADL / OBE
Equipment	524,215,100	558,685,700	6.6%
Mechanical, Electrical & instrumentation	975,577,800	1,323,144,000	35.6%
Civil Works	520,195,000	626,234,000	20.4%
Miscellaneous	31,642,100	39,796,300	25.8%
Subtotal Direct Field Cost	**2,051,630,000**	**2,547,860,000**	**24.2%**
Other costs	150,923,300	146,061,000	-3.2%
Services	440,831,200	469,845,000	6.6%
Subtotal direct cost	**2,643,300,000**	**3,163,800,000**	**19.7%**
Seawater In/Out-Let including scope opportunity	59,900,000	-	-
Revamp cost allowance	13,600,000	-	-
Buy-outs	(132,400,000)	-	-
Taxes	51,400,000	-	-
Contingency	131,900,000	-	-
Contractors turn key profit & risk provisions	221,500,000	-	-
Feed cost & OBE Fees	57,000,000	-	-
Escalation	Excluded	-	-
Grand total	**3,046,200,000**	**3,163,800,000**	**3.9%**

Source: Arthur D. Little analysis

PETROPERU

(*) USGC costs adjusted to Peru location using piping and steel quantities and other cost items as used by TR

1 FEED's CAPEX Expert Opinion

We consider the TR estimate for the project fair for the available FEED package and a good basis for starting the EPC phase of the project

Assessment of FEED CAPEX Going Forward

- After our analysis, we consider TR estimate for the project to be fair and, subject to contract final conditions, a good basis for starting the EPC phase.
- Petroperu has walked a long way since when started the PMRT project and even Petroperu has always have the option of changing the EPC, there are some risks associated with such decision
  - The contract with TR was signed for a "fast track" basis, allowing to convert to an EPC as soon as the FEED was completed and agreed a reasonable cost of the EPC for Petroperu
  - A new bidding process for EPC could bring higher costs
  - If other EPC company is selected, significant work done at the FEED level will not be used efficiently
  - Any contracting process for a new EPC company would take months and there is a cost involved on the delay on the project

Source: Arthur D. Little analysis

PETROPERU

The OBE by TR represents in ADL opinion the fair costs for the PetroPeru Talara refinery modernization project and a good starting point for the EPC phase

Main conclusions

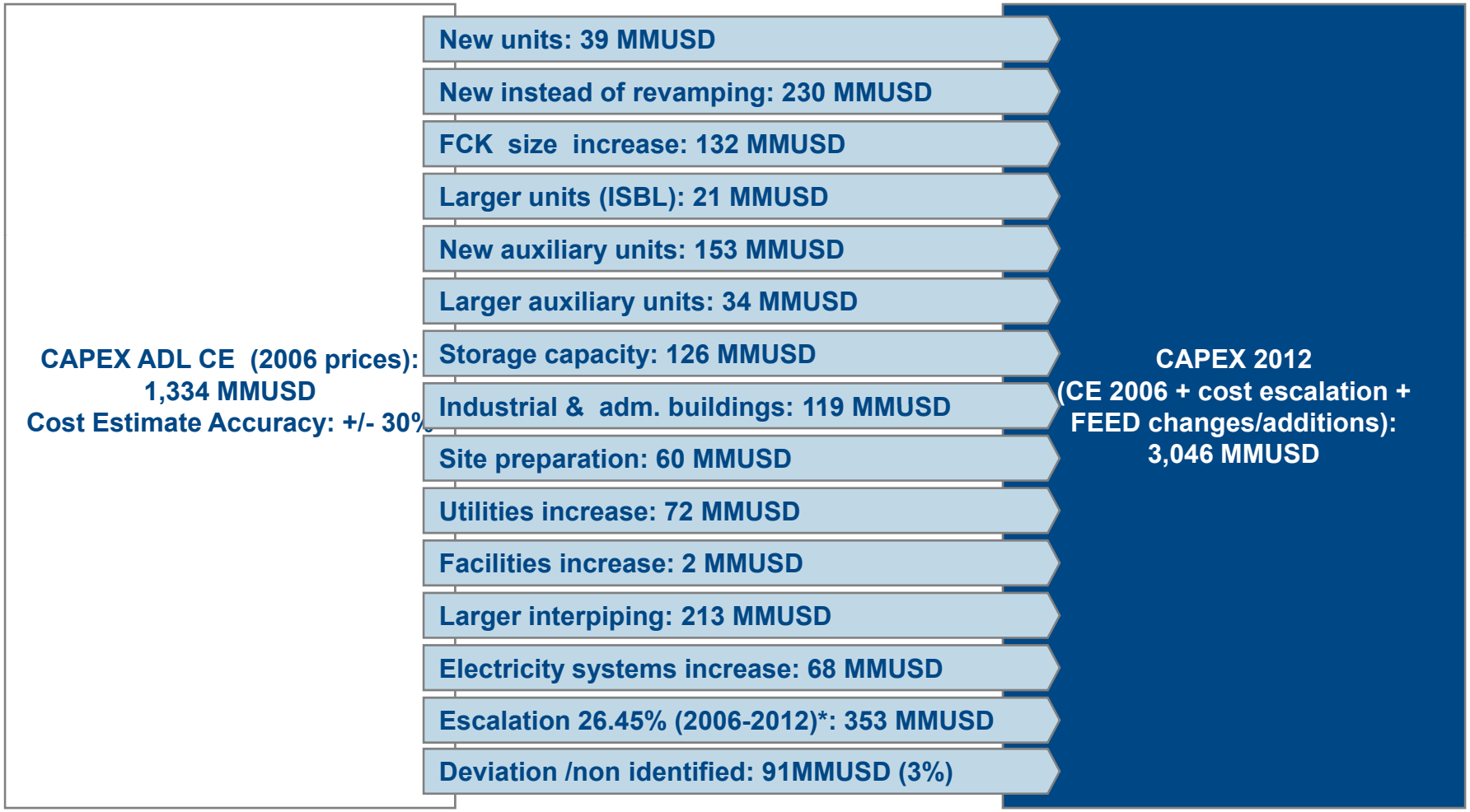
- We have compared our cost estimate of Talara refinery modernization with the Open Book Estimate and ours is 2.6% higher than TR's
- The Open Book Estimate as presented by TR represents in ADLs opinion after our expert review the fair global cost for the PetroPeru Talara refinery modernization project based on the scope as outlined in the TR FEED package
- There are certain items that can be questioned in the estimate, such as the quantities, in particular for piping and structural steel which seems high and the mechanical construction cost which seems low. However in aggregated global terms the OBE cost estimate is reasonable and in many items very tight.
- If we keep TR's calculations on material quantities and contractors, our global estimate is 3.9% higher than the OBE (instead of 2.6%).
- It should also be realized that the TR and ADL estimate are based on a current cost level 4th quarter 2012 with escalation required during project execution excluded
- We consider the TR estimate for the project fair for the available FEED package and a good basis for starting the EPC phase of the project

Source: Arthur D. Little analysis

PETROPERU

2 FEED's CAPEX vs CE's CAPEX Assessment

2012 FEED CAPEX estimate is consistent with Conceptual Engineering CAPEX estimate considering the escalation, scope, changes and additions made to the project, which rationality has been previously proved by Arthur D. Little



Note: ADL opinion about the evolution of the configuration of the FEED has been included in a previous study

PETROPERU

(*) Escalation=
Δ Nelson Farrar Index(2006-2012)*Materials share + Peruvian Construction Price Index(2006-2012)*Labour Share

2 FEED's CAPEX vs CE's CAPEX Assessment

FEED design did not change much the size of main process units, but built some key units instead of revamping and there are significant changes on those related to sulfur content and hydrogen, and utilities

Critical Design Aspects – Units Capacity (BPSD)

Unit	CE	FEED	Change
Catalytic Cracking Unit – FCC	25,000	25,000	New instead of revamping
FlexiCoker – FCK	21,000	22,600	Larger
Atmospheric Distillation Unit – DP1	95,000	95,000	New instead of revamping
Naphtha Hydrotreating Unit – HTN	13,300	13,300	No major change
FCC Gasoline Hydrotreating Unit – HTF	9,500	9,500	No major change
Sulfuric Acid Plant – WSA	362 TPD	560 TPD	Larger
Diesel Hydro treating Unit – HTD	41,000	41,000	No major change
Amine Plant – AM2	144 mt/hr.	234 mt/hr.	Larger
Catalytic Reformer – RCA	9,500	9,500	No major change
Vacuum Distillation Unit – DV3	22,000 (Revamp) + 35,000 (New)	52,700	New instead of revamping
Gas Recovery II – RG2 kg/hr	8,129	8,129	No major change
LPG Treatment – TGL	-	8,200	New
Sour Water Treatment Disposal II – WS2	-	196 m3/h	New
Caustic Kero/Jet Treatment – TKT	-	9,680	New
Exhausted Soda Plant – OX/SCG	-	1 m^3/hr.	New
Cooling Water Closed System – CWC gpm	-	81,000	New
Maritime facilities/ Sea Water Inlet & Outlet	Extension of tug pier	New pier	New
Flare System/Torch – FB2	Revamp ground flare	3 new vertical flares	New
Crude Product Storage – TKS	0/0/5	2/4/5	New
Sanitary Treatment – SA2	-	20 m^3/hr	New
Buildings number.-m2 total	2 - 3,100	30 - 65,084	Larger
Interconnections – INT MMUSD	85	320	Larger
Nitrogen Plant – NIS	1,500 m^3 /hr.	3,500 m^3 /hr.	Larger
Hydrogen Unit – PHP	21 MMSCFD	30 MMSCFD	Larger
Cogeneration Plant – GE	46 MW	100 MW	Larger

2 FEED's CAPEX vs CE's CAPEX Assessment

The requirement of new units that were not considered previously entails an additional investment of 39 MMUSD

New units (ISBL)

LPG Treatment (TGL)

- Amine pretreatment designed by TR and new caustic treatment using Axens technology
- Sulfrex unit using technology to remove H2S, COS and mercaptans
- 8.2 KBPSD
- CAPEX: 28 MMUSD

Caustic Kero/Jet Treatment (TKT)

- Caustic Kero/Jet treatment project moved to Talara Expansion
- Capacity: 9.7 KBPSD
- CAPEX: 11 MMUSD

New units requires an additional CAPEX of 39 MMUSD

Source: Arthur D. Little analysis

2 FEED's CAPEX vs CE's CAPEX Assessment

Safety & insurance requirements, future flexibility and age of the units drive the construction of the DP1, DV3 and FCC with an additional investment of 230 MMUSD

New instead of revamping units (ISBL)

Atmospheric Distillation Unit (DP1)	Vacuum Distillation Unit (DV3)	Catalytic Cracking Unit (FCC)
■ New 95,000 BPSD fractionator and stripper, & new condenser ■ Use feed furnace and existing desalter with new heat exchangers before and after desalter. ■ Main new equipment: – New atmospheric tower – 28 pumps – 33 heat exchangers – 4 containers – 4 Air coolers ■ Additional CAPEX: 75 MMUSD	■ Add new unit, DV3, capacity: 52.740 BPSD ■ DP1 and DV3 can work independently. (DV3 designed for loading from DP1 or from storage) ■ Dismantle DV2 and DV1 ■ New furnaces, pumps, etc. ■ Additional CAPEX: 17 MMUSD	■ Replace 90% of the equipment : – Reactor regenerator section: 37 new equipment, 2 modified – Fractionation section: 23 new equipment, 1 maintained, 1 eliminated – Gas Plant: 30 new equipment, 6 modified, 8 maintained, 2 eliminated ■ New capacity is 25.000 BPSD ■ Additional CAPEX: 138 MMUSD

Construction of DP1, DV3 and FCC requires an additional CAPEX of 230 MMUSD

Source: Arthur D. Little analysis

PETROPERU

2 FEED's CAPEX vs CE's CAPEX Assessment

Due to crude feedstock mix and carbon content change, a larger flexicoker and larger related charges require an additional investment of 132 MMUSD

Larger Flexicoker (FCK)

- New Flexicoking unit using EMRE technology
- Carbon Content for Flexicoker feed change from 27.3 to 32.4 % wt, requiring more capacity: 22,600 BPSD (vs. 21,000 BPSD), 7.6% larger
- Two feed cases: 27.3% CCR (Blend case) and 32.4% CCR (Heavy case)
  - The Blend sets the equipment sizes for the liquid products recovery
  - Heavy sets the sizes for the coker gas recovery, reactor, heaters and gasifier
- Main related new equipment:
  - 12 towers
  - 5 reactors
  - 2 compressors
  - 87 pumps
  - 47 heat exchangers
  - 31 containers
  - 12 air coolers
  - 4 Heaters
- The capacity increase with larger related charges (site and overhead items) implies an additional investment: 434 MMUSD (vs. 302 MMUSD)

A larger Flexicoker with larger related charges involves an additional investment of 132 MMUSD

2 FEED's CAPEX vs CE's CAPEX Assessment

FEED design introduced significant changes on units related to sulfur content and hydrogen requiring an additional investment of 21 MMUSD

Larger units (ISBL)

Amine Plant (AM2)	Hydrogen Unit (PHP)
■ Treat H2S from Flexicoker OH, Diesel HDS, Naphtha HDS, FCC Gas Plant & Vacuum pump ring. Amine type: DEA ■ Design based on 234 mt/hr. of amine solution ■ Open art technology TR design ■ Capacity: 934 gpm (vs. 632 gpm) ■ Additional CAPEX: 21 MMUSD	■ New 30 MMscfd (33,489 m3/hr.) hydrogen plant using Haldor Topsoe technology (vs. 21 MMSCFD) ■ Reformer hydrogen is fed to the H2 plant PSA for cleanup and added to the plant output ■ Feedstock for hydrogen plant is light naphtha and refinery fuel gas or natural gas ■ This unit will be outsourced

Added capacity on units related to sulfur content and hydrogen requires an additional investment of 21 MMUSD

Source: Arthur D. Little analysis

2 FEED's CAPEX vs CE's CAPEX Assessment

The requirement of new units that were not considered previously entails an additional investment of 153 MMUSD

New auxiliary units

Sour Water Treatment Disposal II (WS2)	Exhausted Soda Plant (OX/SCG)	Caustic Soda Facilities (CAF)	Flare System/Torch (FB2)	Sanitary Treatment (SA2)
■ The sour water treater takes sour water containing ammonia, H2S, and CO2 and treats the stream with caustic soda. ■ Capacity: 196 m3/h ■ CAPEX: 32 MMUSD	■ Plant uses spent caustic to neutralize out of specification and waste acid ■ Capacity: 0.9 m3/h ■ CAPEX: 13 MMUSD	■ Unit mixes caustic soda ■ 2 mixers for 15% and 40% dilution ■ Electrical heater ■ 6 Caustic Soda pumps ■ Capacity: 4,102 m3/month	■ New vertical pipe systems ■ 3 independent flares of same height – Hydrocarbons 721.191 kg/hr. – Low BTU Gas-FCK 222.440 kg/hr. – Acid Gas 44.450 kg/hr. ■ CAPEX: 49 MM USD	■ A new Sanitary Effluents treatment plant with capacity of 700 m3/hr. ■ CAPEX: 59 MMUSD

New units requires an additional CAPEX of 153 MMUSD

Source: Arthur D. Little analysis

PETROPERU

2 FEED's CAPEX vs CE's CAPEX Assessment

Capacity design has been used for Sulfuric Acid Plant given the criticality of it to the environmental compliance of the plant requiring 34 MMUSD in addition

Larger auxiliary units – Sulfuric Acid Plant (WSA)

- New 560 MTD plant (98% sulfuric acid) plant (vs. 362 TPD)
- Haldor Topsoe Wet Sulfuric Acid technology used.
- Two new 82,000 bbl. storage tanks for sulfuric acid
- Additional CAPEX: 34 MMUSD

Additional CAPEX: 34 MMUSD

Source: Arthur D. Little analysis

PETROPERU

2 FEED's CAPEX vs CE's CAPEX Assessment

New tanks for new products and replacement of tanks demolished for site development increases the investment in 126 MMUSD

Tankage – MB

Product	CE	FEED	New Tanks
Crude	2,700	1,707	CE: 0, TR: 2, PP: 4
LPG	132	86.4	CE: 2, TR: 0 , PP: 3
Butane	9.6	9.6	No new
Naphtha	-	515.5	CE: 0, TR: 1, PP: 0
Gasoline	626	358.6	CE: 0, TR: 0, PP: 2
Turbo	255	262.5	CE: 0, TR: 0 , PP: 1
Diesel	645	823.8	CE: 0, TR: 0, PP: 4
Industrial products	320	305.8	CE: 0, TR: 1, PP: 0
Intermediates	451	630.3	CE:0, TR: 4, PP: 0
Solvents 1 & 3	Not considered since production will not increase significantly	22	No new
Marine diesel		78.1	No new
Bunker		58.6	CE: 0, TR: 1, PP: 0
Asphalt		59.8	CE: 0, TR: 0, PP: 3
Sulfuric Acid	3 x 36	2 x 82	CE: 3, TR: 2, PP: 0
Coke	514 mt/d	144 mt/d	
CAPEX	**31 MMUSD**	**157 MMUSD**	**Δ: 126 MMUSD**

PETROPERU

The demolition and rebuilding of almost every building adds 119 MMUSD of investment

Additional buildings

- Construction of new process units and tanks require extra space and more relocations required:
  - 65,084 m2 (vs. 3,100 m2)
- Main new buildings
  - Administrative area (administrative, laboratory, access control): 10,832 m2
  - Plant area (control, medical, canteen, changing room): 3,100 m2
  - Maintenance and workshops area (heavy fleet workshop, parking, painting area, maintenance area): 7,940 m2
  - Logistics area (warehouse, hangar, etc.): 15,200 m2
  - Substations building (processes, tankage, effluent treatment, water, piers, etc.): 24.052 m2
  - Other (new pier control room, warehouse, office) : 3,960 m2
- It is also considered demolition of existing buildings, as FEED includes relocation and demolition of almost all existing buildings

The demolition and rebuilding of almost every building adds 119 MMUSD of investment

Source: Arthur D. Little analysis

PETROPERU

A number of minimum measures to be met were recommended in order to cover risks due to ground conditions requiring 60 MMUSD

Site preparation

- The geotechnical study determined the general terrain characteristics establishing the design basis and considerations required for infrastructure and foundations of buildings, structures and equipment:
  - The groundwater level recorded in the hilly area varies between 15.00 and 25.70 m depth, while in the lower part of the site varies between 1.10 and 2.60 m depth
  - Additionally, given the proximity to the sea, the water table is influenced by sea level and may fluctuate depending on the variations of tidal levels
  - Soils are contaminated with petroleum hydrocarbons at depths varying between 2.70 and 11.30 m above the level of the ground surface. Contents of total petroleum hydrocarbons up to 22.374 mg / kg, so that it can be concluded that the depth of contamination is greater
  - There is soil liquefaction potential where the perforations and auscultations in the lower part of the site were made
  - Considering the seismicity of the area, in the Building Technical Standard E030: Earthquake Resistant Design, the project area (Department of Piura) is considered in Zone 1 of seismicity, corresponding to high seismicity.
- Therefore, a number of minimum measures to be met were recommended in order to cover risks due to ground conditions: deep foundation in the lower part of the site for structures and equipment, using structural piles

Cover risks due to ground conditions requires 60 MMUSD

Source: Arthur D. Little analysis

2 FEED's CAPEX vs CE's CAPEX Assessment

Modification of utilities to handle new/larger units increases investment in 72 MMUSD

Utilities					
Cogeneration	**Steam Generation System**	**Cooling Water Closed System**	**Nitrogen Plant**	**Sea Water Inlet & Outlet**	**Demineralizing Plant / Desalination Plant**
■ 3 steam boilers driving 2 steam turbine generators (50MW each) and making high pressure (42.2 kg/cm2) and medium pressure (12.6 kg/cm2) steam ■ Boilers use flexigas together with fuel gas and natural gas. ■ Covers refinery power needs of 85 MW ■ This unit will be outsourced	■ Modification of distribution system to handle new/larger units ■ New deareator with capacity of 461.6 mt/hr ■ New Pumps: – Very high pressure: 2x107 m3/hr (to cogen) – High pressure: 2x224 m3/hr – Medium pressure : 2x126 m3/hr – Low pressure: 2x4.1 m3/hr ■ Part of the cogeneration plant cost	■ Sea water intake off Punta Gallosa has 2 towers and 2 parallel pipelines delivering 196,958 gpm ■ Seawater exchanged with CWC circulating 80,863 gpm. Turbidity meters at exchanges isolate process leaks for segregation. ■ CAPEX: 50 MMUSD	■ 3,500 m3/hr. cryogenic separation plant ■ This unit will be outsourced	■ Intake and return are both in the Pacific Ocean ■ Inlet covered with heavy duty slotted screen with openings <5mm. ■ Sea water cooling flow of 196,958 gpm ■ Additional CAPEX: 22 MMUSD	■ New plants (desalination and demineralization) to produce: ■ Desalinated water demand of 16,000 m3/d to a maximum of 20,000 m3 /d using reverse osmosis. ■ Demineralized water of 10.602 m3/d using deionization ■ This unit will be outsourced

Modification of utilities to handle new/larger units increases investment in 72 MMUSD

Source: Arthur D. Little analysis

PETROPERU

Replace a two sided extension of the current tug dock with a new dock costs 2 MMUSD more than CE estimates

Facilities – Dock

- New dock (MU2) built on south side of Talara Bay.
- MU2 will handle up to 52,000DWT vessels and 34 ft. draft
- Existing dock (MU1) will be refurbished and will handle ships up to 35,000DWT
- Temporary dock (MU3) built for construction materials, can accommodate 700 ton crane

Replace a two sided extension of the current tug dock with a new dock costs 2 MMUSD more

Source: Arthur D. Little analysis

PETROPERU

Larger interpiping is required given standards and local regulations for spacing between units, demanding 213 MMUSD extra

Interpiping

- Standards and local regulations for spacing between units requires larger area, more relocation and thus larger interconnection/interpiping: 97,190 m2 (vs. 38,400 m2)
- Total number of lines: 992
  - Lines < 2" 117
  - 2" Lines: 333
  - 3"-6" Lines: 316
  - 8"-14" Lines: 133
  - 16"-20" Lines: 31
  - Lines >20" 62

Larger interpiping is required given standards and local regulations for spacing between units, demanding 213 MMUSD extra

Source: Arthur D. Little analysis

An increase of investment of 68 MMUSD is considered due to higher power needs because of new units, larger units and new cooling water system

Electricity system

- 13 new substations as follows:
  - 1 principal substation (SEP),
  - 4 substations for process plants (SE 1/2/3/4), 3
  - substations for OSBL areas (SO 1/2/3/6),
  - 2 substations for general facilities (SO5/SO9),
  - 3 minor substations for buildings areas (SO4/SO7)
- Energy requirements 85 MW
- Electrical material including 1500 km of cable, power transformers, electric tracing, control stations, etc.

An increase of investment of 68 MMUSD is considered due to higher power needs

Source: Arthur D. Little analysis

3 FEED's Engineering Hours & Cost

Radical changes of scope and a completely new layout for the refinery project increased the complexity of engineering required which implied more than double of hours, with a cost that is still in the % of CAPEX range for this kind of projects

CAPEX ADL CE (2006 prices): 1,334 MMUSD
Cost Estimate Accuracy: +/- 30%

FEED Budget Cost (2009): 24.5 MMUSD (1.83% of CAPEX in 2006 USD) (1.63% of CAPEX Adj. to 2009 USD)

- New units: 39 MMUSD
- New instead of revamping: 230 MMUSD
- FCK size increase: 132 MMUSD
- Larger units (ISBL): 21 MMUSD
- New auxiliary units: 153 MMUSD
- Larger auxiliary units: 34 MMUSD
- Storage capacity: 126 MMUSD
- Industrial & adm. buildings: 119 MMUSD
- Site preparation: 60 MMUSD
- Utilities increase: 72 MMUSD
- Facilities increase: 2 MMUSD
- Larger interpiping: 213 MMUSD
- Electricity systems increase: 68 MMUSD
- Escalation 26.45% (2006-2012)*: 353 MMUSD
- Deviation /non identified: 91MMUSD (3%)

CAPEX 2012 (CE 2006 + cost escalation + FEED changes/additions): 3,046 MMUSD
Cost Estimate Accuracy: +/-10%

FEED Projected Cost: 65 MMUSD (2.13% of CAPEX)

Note: ADL opinion about the evolution of the configuration of the FEED has been included in a previous study

PETROPERU

(*) Escalation=
Δ Nelson Farrar Index(2006-2012)*Materials share + Peruvian Construction Price Index(2006-2012)*Labour Share

3 FEED's Engineering Hours & Cost

There are several units that were not considered initially, which required additional resources to design them

Budget – Man hour

Unit	Budgeted Hours	Initial capacity (CE)	Actual capacity (FEED)	Change
Project management	21,400			
Technical services	21,236			
ISBL				
Atmospheric Distillation – DP1	9,529	95,000	95,000	New instead of revamping
Vaccum Distillation – DV3	29,000	22,000 (Revamp) + 35,000 (New)	52,700	New instead of revamping
Flexicoker – FCK	71,274	21,000	22,600	Larger
Naphtha Hydrotreating – HTN	15,093	13,300	13,300	No major change
Reformer – RCA	14,203	9,500	9,500	No major change
Catalytic Cracking Unit – FCC	28,793	25,000	25,000	New instead of revamping
FCC Gasoline Hydrotreating – HTF	18,051	25,000	25,000	No major change
Diesel Hydro treating Unit – HTD	23792	41,000	41,000	No major change
Gas Recovery Unit – RG1 RG2 kg/hr	20,714	8,129	8,129	No major change
Turbo treatment plant – TKT	9,207	-	9,680	Independent project (new)
Amine Plant – AM2	13,942	144 mt/hr.	234 mt/hr.	Larger
Sulfuric Acid Plant - WSA	15,519	362 TPD	560 TPD	Larger
Hydrogen Unit – PHP	2,367	21 MMSCFD	30 MMSCFD	Larger
LPG Treatment – TGL	1,186	-	8,200	New
Caustic Soda Facilities– CAF	5,177	-	4,102 m3/month	New
Sour water treatment – WS2	1,233	-	196 m3/h	New
Caustic Naphta treatment – TNS	-	-	9,600	Independent project (new)
Exhausted Soda Plant – OX/SCG	-	-	1 m^3/hr.	Independent project (new)

3 FEED's Engineering Hours & Cost

There are several units that were not considered initially, which required additional resources to design them (cont.)

Budget – Man hour

Unit	Budgeted Hours	Initial capacity (CE)	Actual capacity (FEED)	Change
OSBL				
Cogeneration Plant – GE	10,688	46 MW	100 MW	Larger
Storage	9,071	0/0/5	2/4/5	New instead of revamping
Instruments air – PAR	2,761	21,000 m3/hr	7,910 m3/hr * 3	Modification (3 instead of 1)
Flare system	2,765	Existing	3 new flares	New instead of revamping
Oily Water Treatment	-	-	400 m3/hr	New
Nitrogen Plant – NIS	1,972	1,500 m^3 /hr.	3,500 m^3 /hr.	Larger
Steam Generation System – SGV	-	Deareator	Dearator (461.6 mt/hr)	Larger
Cooling water system - CWC	2,959	-	80,863 gpm	New
Sea water & sewage water outlet	2,467	50.000 gpm	196,958 gpm	Larger
Sewage water treatment	2,959	-	20 m3/hr.	New instead of revamping
Demineralizing Plant – DM2/ Desalination Plant – OR2	-	2,200 m3/d.	16,000-20,000 / 10.602 m^3/d	New instead of revamping
Fireproof system	2,958			
Fuel gas system	1,480	Flexigas/refinery fuel	Refinery fuel/butanes	Modification
Interconnections	-	38,400 m2	97,190 m2	Larger
Other				
Buildings – number/m2	3,945	2 / 3,100	30 / 65,084	Larger
Port facilities	6,577	35,000 DWT * 2 (ext.)	52,000DWT (new)	New instead of extension
Electricity	-	1 substation	13 substations	Larger
Plot plan	-	199,219 m^2	307,924 m^2	Larger
Total	**382,647**			**Δ: + 520,121 Hours** **Total : 902,768 Hours**

PETROPERU

Fuente: informe CPT Octubre 2012

Feed cost & OBE Fees account for 2.13 % of the total cost, which is in line with international parameters that range between 1.5 and 2.5%

Analysis of Feed Engineering Hours

- 2012 FEED projected cost & OBE Fees account for 2.13% of the total cost of Talara refinery modernization, which is in line with international parameters that range between 1.5 and 2.5% for projects
- Bids for FEED differed in structure and cost
  - TR 2009 bid of 24.5 MMUSD (aprox. 20 MMUSD + 20% fee mark up) was based in about 380 thousand engineering hours
  - Other bidder offered 116 MMUSD, (aprox. 44MMUSD + 163% fee mark up), with a basis of about 580 thousand engineering hours
- The bidding and contracting process for the FEED included a budget based on hours to be dedicated by unit for the FEED design, but cannot be tracked through the execution
  - FEED has been done and hours have been recorded and authorized in a different basis than the used in the bidding process
  - The Project Management Contractor reviewed and approved monthly dedication based on description of activities carried out by TR, related to the new scope of the engineering services

Source: Arthur D. Little analysis

Besides refinery project change of scope and modifications, many factors contributed to the need of a higher amount of hours for the FEED

Analysis of Feed Engineering Hours

- They were some context conditions that impacted on the engineering needs for the FEED
  - At FEED level
    - Configuration changes
    - Inclusion in the scope of units not part of the original scope
    - Development of better information determined the need of new units Radical plot plant change, with many iterations
    - Better environmental and soil information impacted in redesigns and larger magnitudes
    - Changes on the criteria used for design standards during the project forced additional redesigns
    - Schedule delays for licensors design forced changes on FEED work plans, organization and global integration process
    - Value engineering carried out, including review and adjustments of basis, balances, plot plan, specifications and technical information
    - Some redesign needs for licensors plants after integration
  - At OBE level
    - Strategy for conversion: changed during the FEED
    - OBE for new requirements and recalculation

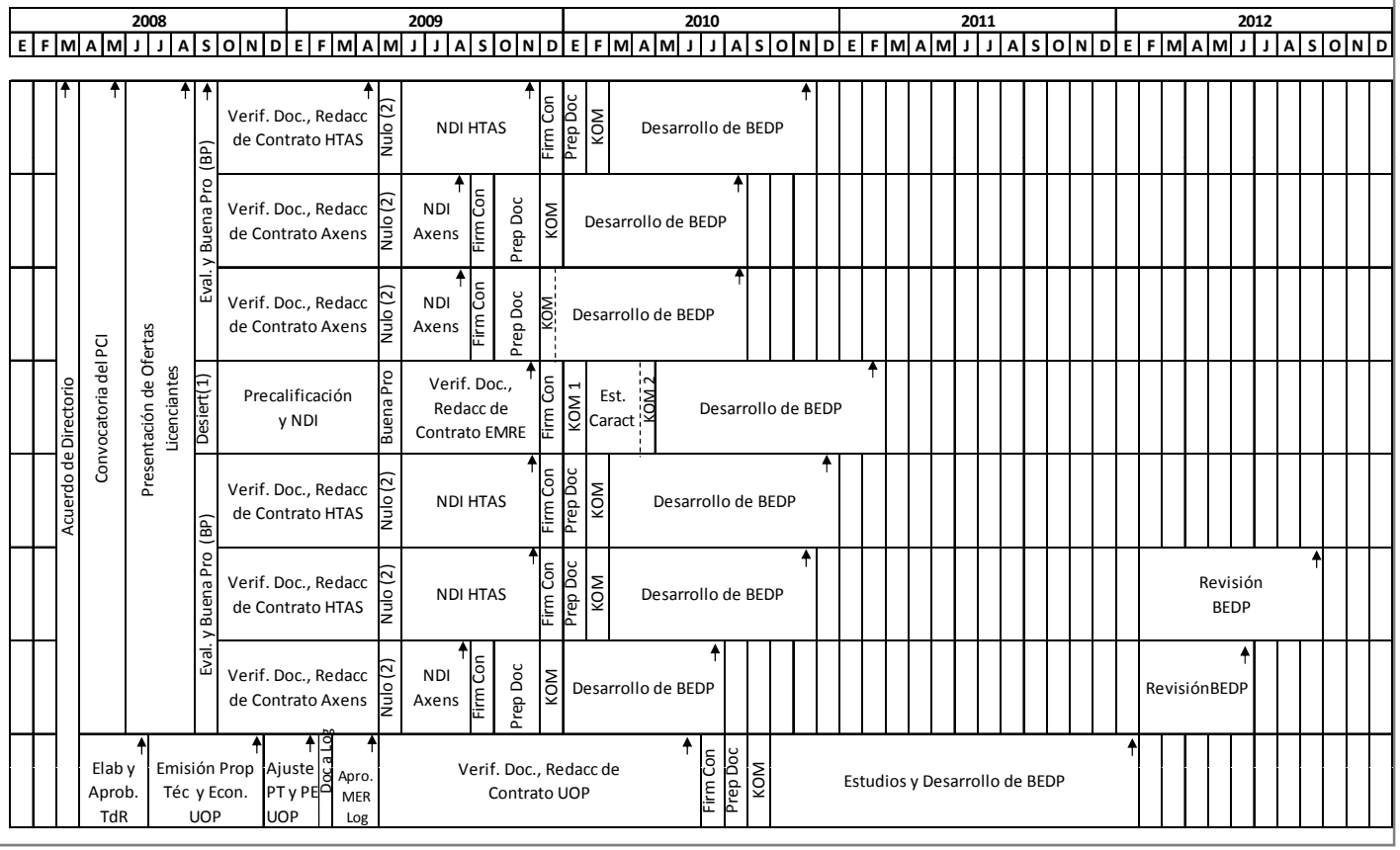
Source: Arthur D. Little analysis

3 FEED's engineering hours & cost

Schedule delays for licensors design forced delay and changes on FEED work plans, organization and global integration process

Licensors and technologies basic design schedule

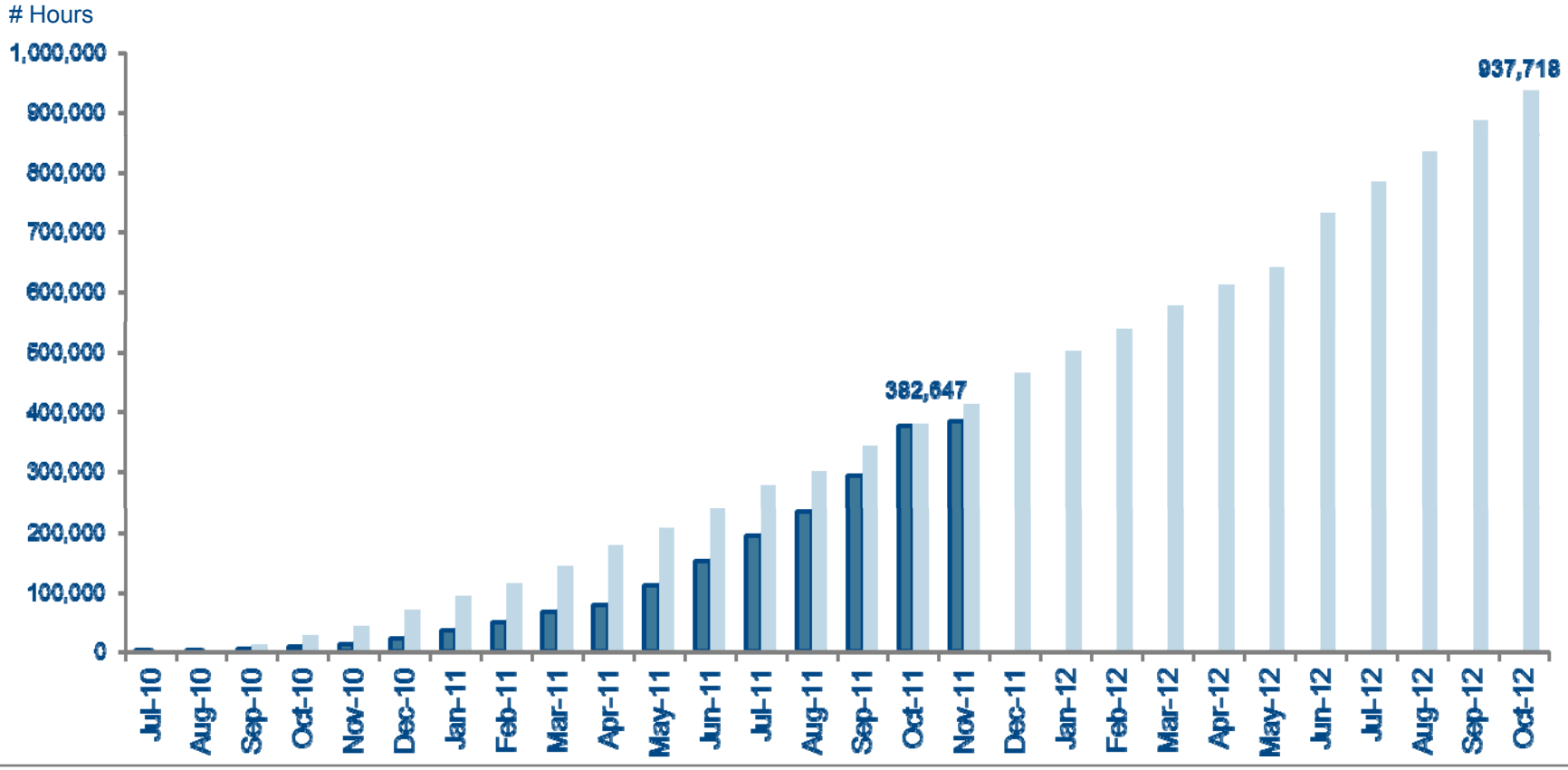
ITEM	TECNOLOGÍA	PROCESO
1	Hidrotratamiento y Mejoramiento de Diesel HTD	Procso por Competencia Internacional - PCI
2	Hidrodesulfurización y Reformación Catalítica de Nafta HTN & RCA	
3	Hidrodesulfurización de Nafta Craqueada HTF	
4	Coquificación de Residuo de Vacío FCK	
5	Producción y Purificación de Hidrógeno PHP	
6	Recuperación de Azufre vía Producción de Ácido Sulfúrico WSA	
7	Tratamiento de GLP TGL	
8	Ampliación y Modernización de FCC FCC	Negoc. Directa Int. NDI



3 FEED's engineering hours & cost

Some context conditions impacted on the engineering needs for the FEED and OBE, increasing required hours from 382 to 937 thousand

Budget vs real hours – Accumulated hours



Source: Arthur D. Little analysis

PETROPERU

For each unit we estimated its cost in the USGC and adjusted to Peru location

Example - FCC

Description	pcs	Quantity	um	weight (mt)	man-hours	Labor	Material	Total
Furnaces	2	43	mw	897.6	71,800	2,872,000	5,575,500	8,447,500
S&T exchangers	40	14,002	m2	314.8	4,400	176,000	5,636,800	5,812,800
Air coolers	5	6,601	m2	374.3	11,200	448,000	2,012,000	2,460,000
Towers & internals	6	883	m3	670.8	20,200	808,000	14,918,000	15,726,000
Reactor & internals	2	2,445	m3	1,048.1	14,600	584,000	11,097,800	11,681,800
Vessel	23	1,270	m3	257.6	3,600	144,000	2,271,000	2,415,000
Storage equipment	3	1,426	m3	89.3	-	-	423,400	423,400
Pump incl drivers	54	6,523	kw	45.8	6,800	272,000	7,659,000	7,931,000
Compressor incl drivers	3	17,208	kw	249.7	25,000	1,000,000	21,668,200	22,668,200
Package unit	4	-		238.9	7,200	288,000	4,870,700	5,158,700
Miscellaneous eqpt	8	-		45.5	2,200	88,000	1,394,300	1,482,300
EQUIPMENT	**150**			**4,232.4**	**167,000**	**6,680,000**	**77,526,700**	**84,206,700**
Piping (AG) Above Grade		37,500	m1	1,086.0	524,300	15,729,000	3,670,000	19,399,000
Piping (UG) Under Ground		1,200	m1	33.0	11,300	339,000	364,000	703,000
Pipe (FAB) Prefab		540	mt	-	85,500	2,565,000		2,565,000
Structural Steel				3,000.0	187,500	5,625,000	9,000,000	14,625,000
Electrical (connected load)		7,200	kw		108,000	2,700,000	5,400,000	8,100,000
Control Systems (control valves)		180	ea		135,000	3,375,000	7,200,000	10,575,000
MECHANICAL, E&I				**4,119.0**	**1,051,600**	**30,333,000**	**25,634,000**	**55,967,000**
Piling		750	ea		8,000	280,000	3,960,000	4,240,000
Concrete work / civil		7,500	m3		470,000	11,750,000	1,687,500	13,437,500
Site works & development		-	m2		-	-	-	-
Buildings		-	m3		-	-	-	-
Insulation		22,500	m2		63,300	1,582,500	2,250,000	3,832,500
Painting		22,500	m2		57,500	1,437,500	360,000	1,797,500
Fireproofing		15,000	m2		95,000	2,375,000	225,000	2,600,000
CIVIL WORKS					**693,800**	**17,425,000**	**8,482,500**	**25,907,500**
Notes :	Precommissioning				50,000	1,250,000	200,000	1,450,000
	Heavy haul, heavy lift						2,087,500	2,087,500
	Miscellaneous allowance				(2,400)	2,000	(700)	1,300
	MISCELLANEOUS				**47,600**	**1,252,000**	**2,286,800**	**3,538,800**
	S/T DIRECT FIELD COST				**1,960,000**	**55,690,000**	**113,930,000**	**169,620,000**
	Vendor representation						1,290,000	1,290,000
	Spare parts for commissioning						619,000	619,000
	Capital spare parts						2,713,000	2,713,000
	Catalyst					in owner's cost	-	-
	Chemicals & lubricants						1,124,000	1,124,000
	Training costs						1,163,000	1,163,000
	Other costs						1,473,000	1,473,000
	Transportation						6,877,100	6,877,100
	Construction all risk & costs for bonds						1,557,400	1,557,400
	OTHER COSTS						**16,816,500**	**16,816,500**
	Constr. mngmnt TR				8,300	664,000	415,000	1,079,000
	Constr. mngmnt Local				147,000	5,145,000	1,250,000	6,395,000
	Field indirects				-	-	2,952,000	2,952,000
	HO Engineering TR				225,000	18,000,000	4,500,000	22,500,000
	HO Engineering LCE				75,000	3,000,000	375,000	3,375,000
	SERVICES							**36,301,000**
	rounding							(37,500)
	S/T DIRECT COST							**222,700,000**

Source: Arthur D. Little analysis

PETROPERU

For each unit we estimated its cost in the USGC and adjusted to Peru location

Example - FCK

Description	pcs	Quantity	um	weight (mt)	man-hours	Labor	Material	Total
Furnaces	2	25	mw	264.9	21,200	848,000	3,230,200	4,078,200
S&T exchangers	45	19,980	m2	883.6	12,400	496,000	12,050,800	12,546,800
Air coolers	12	14,059	m2	714.9	21,400	856,000	5,334,900	6,190,900
Towers & internals	14	4,992	m3	1,531.6	46,000	1,840,000	13,431,700	15,271,700
Reactor & internals	5	8,852	m3	2,470.1	34,600	1,384,000	16,588,600	17,972,600
Vessel	28	2,170	m3	769.9	10,800	432,000	5,418,300	5,850,300
Storage equipment	10	10,128	m3	590.0	-	-	4,343,900	4,343,900
Pump incl drivers	81	8,977	kw	81.6	12,200	488,000	14,419,500	14,907,500
Compressor incl drivers	2	20,532	kw	181.0	18,200	728,000	22,071,400	22,799,400
Package unit	12	-		998.0	30,000	1,200,000	20,182,900	21,382,900
Miscellaneous eqpt	10	-		235.2	11,800	472,000	4,991,300	5,463,300
EQUIPMENT	**221**			**8,720.8**	**218,600**	**8,744,000**	**122,063,500**	**130,807,500**
Piping (AG) Above Grade		77,400	m1	2,769.0	1,401,800	42,054,000	13,284,000	55,338,000
Piping (UG) Under Ground		2,200	m1	46.0	15,800	474,000	216,000	690,000
Pipe (FAB) Prefab		1,830	mt	-	288,000	8,640,000		8,640,000
Structural Steel				7,740.0	485,000	14,550,000	23,220,000	37,770,000
Electrical (connected load)		17,600	kw		210,000	5,250,000	13,200,000	18,450,000
Control Systems (control valves)		288	ea		215,000	5,375,000	17,136,000	22,511,000
MECHANICAL, E&I				**10,555.0**	**2,615,600**	**76,343,000**	**67,056,000**	**143,399,000**
Piling		1,990	ea		20,000	700,000	10,507,200	11,207,200
Concrete work / civil		14,400	m3		720,000	18,000,000	3,240,000	21,240,000
Site works & development		-	m2		-	-	-	-
Buildings		-	m3		-	-	-	-
Insulation		33,200	m2		90,800	2,270,000	3,320,000	5,590,000
Painting		44,200	m2		110,000	2,750,000	707,200	3,457,200
Fireproofing		27,600	m2		172,500	4,312,500	414,000	4,726,500
CIVIL WORKS					**1,113,300**	**28,032,500**	**18,188,400**	**46,220,900**
Notes :		Precommissioning			103,800	2,595,000	415,000	3,010,000
		Heavy haul, heavy lift					3,006,300	3,006,300
		Miscellaneous allowance			(1,300)	(4,500)	800	(3,700)
		MISCELLANEOUS			**102,500**	**2,590,500**	**3,422,100**	**6,012,600**
		S/T DIRECT FIELD COST			**4,050,000**	**115,710,000**	**210,730,000**	**326,440,000**
		Vendor representation					2,363,800	2,363,800
		Spare parts for commissioning					1,135,000	1,135,000
		Capital spare parts					4,272,000	4,272,000
		Catalyst				in owner's cost	-	-
		Chemicals & lubricants					1,770,000	1,770,000
		Training costs					1,831,000	1,831,000
		Other costs					2,319,000	2,319,000
		Transportation					12,606,800	12,606,800
		Construction all risk & costs for bonds					3,014,400	3,014,400
		OTHER COSTS					**29,312,000**	**29,312,000**
		Constr. mngmnt	TR		17,000	1,360,000	850,000	2,210,000
		Constr. mngmnt	Local		306,000	10,710,000	2,601,000	13,311,000
		Field indirects			-	-	6,120,000	6,120,000
		HO Engineering	TR		381,000	30,480,000	7,620,000	38,100,000
		HO Engineering	LCE		127,000	5,080,000	635,000	5,715,000
		SERVICES						**65,456,000**
		rounding						(8,000)
		S/T DIRECT COST						**421,200,000**

Source: Arthur D. Little analysis

PETROPERU

For each unit we estimated its cost in the USGC and adjusted to Peru location

Example - Reformer

Description	pcs	Quantity	um	weight (mt)	man-hours	Labor	Material	Total
Furnaces	4	23	mw	1,012.0	81,000	3,240,000	6,915,500	10,155,500
S&T exchangers	8	949	m2	115.6	1,600	64,000	3,769,000	3,833,000
Air coolers	3	760	m2	69.1	2,000	80,000	343,200	423,200
Towers & internals	1	75	m3	60.6	1,800	72,000	899,500	971,500
Reactor & internals	3	77	m3	91.8	1,200	48,000	724,600	772,600
Vessel	12	104	m3	101.3	1,400	56,000	692,100	748,100
Storage equipment	-	-	m3	-	-	-	-	-
Pump incl drivers	14	422	kw	14.1	2,200	88,000	735,400	823,400
Compressor incl drivers	3	2,763	kw	70.0	7,000	280,000	9,745,400	10,025,400
Package unit	6	-		11.4	400	16,000	752,600	768,600
Miscellaneous eqpt	4	-		3.6	200	8,000	71,400	79,400
EQUIPMENT	**58**			**1,549.5**	**98,800**	**3,952,000**	**24,648,700**	**28,600,700**
Piping (AG) Above Grade		14,500	m1	504.0	249,800	7,494,000	2,105,000	9,599,000
Piping (UG) Under Ground		100	m1	2.0	-	-	13,000	13,000
Pipe (FAB) Prefab		250	mt	-	40,500	1,215,000		1,215,000
Structural Steel				870.0	55,000	1,650,000	2,610,000	4,260,000
Electrical (connected load)		2,600	kw		60,000	1,500,000	3,250,000	4,750,000
Control Systems (control valves)		52	ea		57,500	1,437,500	3,567,000	5,004,500
MECHANICAL, E&I				**1,376.0**	**462,800**	**13,296,500**	**11,545,000**	**24,841,500**
Piling		410	ea		4,000	140,000	2,164,800	2,304,800
Concrete work / civil		2,600	m3		162,500	4,062,500	585,000	4,647,500
Site works & development		-	m2		-	-	-	-
Buildings		-	m3		-	-	-	-
Insulation		7,300	m2		19,300	482,500	548,000	1,030,500
Painting		5,800	m2		15,000	375,000	92,800	467,800
Fireproofing		4,400	m2		27,500	687,500	66,000	753,500
CIVIL WORKS					**228,300**	**5,747,500**	**3,456,600**	**9,204,100**
Notes :	Precommissioning				21,000	525,000	84,000	609,000
	Heavy haul, heavy lift						-	-
	Miscellaneous allowance				(900)	(1,000)	(4,300)	(5,300)
	MISCELLANEOUS				**20,100**	**524,000**	**79,700**	**603,700**
	S/T DIRECT FIELD COST				**810,000**	**23,520,000**	**39,730,000**	**63,250,000**
	Vendor representation						452,500	452,500
	Spare parts for commissioning						217,000	217,000
	Capital spare parts						863,000	863,000
	Catalyst					in owner's cost	-	-
	Chemicals & lubricants						357,000	357,000
	Training costs						370,000	370,000
	Other costs						468,000	468,000
	Transportation						2,412,900	2,412,900
	Construction all risk & costs for bonds						588,000	588,000
	OTHER COSTS						**5,728,400**	**5,728,400**
	Constr. mngmnt TR				3,500	280,000	175,000	455,000
	Constr. mngmnt Local				60,000	2,100,000	510,000	2,610,000
	Field indirects				-	-	1,224,000	1,224,000
	HO Engineering TR				66,000	5,280,000	1,320,000	6,600,000
	HO Engineering LCE				29,000	1,160,000	145,000	1,305,000
	SERVICES							**12,194,000**
	rounding							27,600
	S/T DIRECT COST							**81,200,000**

Source: Arthur D. Little analysis

PETROPERU