Arthur D Little

Proyecto de Modernización de la Refinería de Talara

Evaluación y opinión sobre configuración técnica y dimensionamiento del FEED

Informe Final

November 16, 2012

Preparado para:

PETROPERU

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We support the rational of the majority of changes considered in the development of the FEED, which were intended to provide operating flexibility, allow for long term growth and comply with safety standards applicable to new facilities

ADL Opinion

- The philosophy of the Conceptual Engineering study (CE) for the configuration of the refinery was spending the absolute minimum amount of CAPEX The FEED was based on technical and economical drivers which led to many incremental adjustments to the low cost configuration concept used in the CE study.

- The adjustments developed by the FEED design are the kind of adjustments that could take place when moving from a conceptual engineering study to a FEED study, considering
  - New and detailed technical information from licensors
  - Licensors simulations and requirements for guarantee of the units
  - Compliance to regulations and industry standards
  - Level of certainty of crude quality
  - Market and company needs
  - Environmental studies and special soil conditions found after geotechnical studies
  - Mechanical analysis of existing units
  - Operating flexibility to handle maintenance, emergencies and specialty products

- Arthur D. Little was not involved in the project during the FEED design, but probably would have supported the key decisions made on the process units if involved
- Arthur D. Little supports the inclusion of the units that are part of the FEED and the overall dimension (sizes) and configuration of them

We support the rational of the majority of changes considered in the development of the FEED, which were intended to provide operating flexibility, allow for long term growth and comply with safety standards applicable to new facilities

ADL Opinion

- We support the replacement of the atmospheric tower and vacuum tower with new units given better information on the status of the existing equipment
- The decision to replace the FCC is an expensive upgrade, but the analysis of condition of the unit, the economic impact of stopping the unit, the incremental capacity and processing capabilities of the new unit, and need to comply with new environmental standards justifies the replacement.
- The FEED design has a relatively high conversion configuration, with majority of new units giving Talara refinery a long term operational competitive advantage
- As a consequence of the development of the design of the process units and better information from licensors about material flows and utilities requirements, the need for auxiliary units, power, cooling water, water treatment and other general facilities is significantly greater than what was considered in the estimate of the CE. However, we judge these new estimates to be technically reasonable.
- A refinery the size of Talara could operate with less square meters of buildings, although some specific conditions of Talara, such as a remote location may justify part of those facilities. Petroperu may consider keeping some temporary buildings for initial operations of the refinery.

We support the rational of the majority of changes considered in the development of the FEED, which were intended to provide operating flexibility, allow for long term growth and comply with safety standards applicable to new facilities

ADL Opinion

- Development of the FEED design introduced unit site sizes and interspacing criteria between units that followed new unit industry standards. Most spacing codes allow some discretion related with allocated space, compensated with extra fire and safety protection.
- Petroperu could assess the economic option of maintaining the existing, unmodified units and running sweet crude train in parallel with the new sour train.
- We recommend to continue now or during the EPC phase the efforts to identify additional value engineering, like the plot plan sizes and spacing, the utilities requirements, the number and size of the auxiliary units, and the amount of general facilities.

Key drivers for changes between conceptual engineering and FEED include the availability of new technical information, the design for higher flexibility, and accomplishment of more detailed engineering and lay out specs

Main Drivers for Change		
Driver	**Basis**	**Major Impact**
New information on existing units and technology	Physical inspections of some units Simulations with detailed data run when licensors were engaged	More precise data on material flows, units condition and utility needs showed additional requirements TR, based on licensors recommendations and other technical and economic analysis, decided to construct new units for the three units that were going to be revamped
FEED Design for Higher Flexibility	Considers process design margin recommended by licensors Considers variation in crude and stream qualities and operating flexibility Considers capacity margin for auxiliary equipment	Larger sites for process units and associated use of land, foundation, structures, construction, utilities, auxiliary equipment and interconnections

Key drivers for changes between conceptual engineering and FEED include the availability of new technical information, the design for higher flexibility, and accomplishment of more detailed engineering and lay out specs (cont.)

Main Drivers for Change

Driver	Basis	Major Impact
Crude Feedstock Mix & Carbon Content Change	Crude mix change from 24.2 API & 1.47% S to 23.3 API & 1.50% S Carbon content for Flexicoker feed changed from 27.3 to 32.4 % wt.	Larger Flexicoker unit Larger sulfur related units
EIA, marine/traffic, geotechnical studies	More information about context, regulations & environment conditions and construction requirements	+15,000 piling and foundations piers reinforcement +1.4 meters of soil added to site
Construction & Lay Out Safety Standards	FEED used Exxon DP15 standards and local regulations for spacing between units	Larger area required More relocations required Larger interconnection/interpiping required

Key drivers for changes between conceptual engineering and FEED include the availability of new technical information, the design for higher flexibility, and accomplishment of more detailed engineering and lay out specs (cont.)

Main Drivers for Change		
Driver	**Basis**	**Major Impact**
New units included in the scope	Scope of FEED added some units not included in the scope of the CE work. Some units were going to be developed by the refinery (i.e. Caustic Treatment Unit/Kero - TKT)	Additional units included in FEED, with larger related construction, equipment and utilities
Economic analysis based on detailed design	Some decisions were based on further economic analysis considered detailed design basis	Different cooling water system option selected. Atmospheric and Vacuum units replaced. New dock design.

Conceptual engineering study included the revamp of key units like FCC, atmospheric and vacuum distillation units, but all process units are new in the FEED. Crude mix has been adjusted to reflect lower availability of local crude

Major Changes Between CE and FEED

	CE	FEED	ADL View on Change
New vs. Revamp Units	Crude and FCC- revamp. Two Vacuum towers - one revamp, one new Rest of process units new	Major revamp for crude unit and all others are new process units	Although revamps are common in the industry, safety & insurance requirements, future flexibility and age of the units drove the changes. No objections from ADL.
Crude Quality and Carbon Content	All the process units, utilities and general facilities designed for crude mix of 64% Napo and 36% Talara/Petrobras light. Mix 24.2 API & 1.47% S	Crude mix of 67% Napo and 33% Talara. Mix 23.3 API & 1.5% S. Design basis for units varied – some worse case 27.3% CCR or 32.4% CCR (FCK), some feed +20% overdesign (FCC), etc.	Availability of local crude has been reviewed because of declining production and limited to 33% of the feed for design purposes Heavier and higher sulfur crude mix has direct implication on unit sizes and utility requirements. ADL supports the change.

FEED introduced significant changes in the sizes of the units related with the sulfur content of the crude and cetane quality of some streams and more feedstock flexibility.

Major Changes Between CE and FEED			
	CE	**FEED**	**ADL View on Change**
Process Units Size	WSA (AST)– Sulfuric Acid – 362 mt/d AM2-Amines Plant – 144 mt./hr. PHP- Hydrogen Plant -21 MMCFD FCK – 21 KBPSD	WSA (AST)– 560 mt/d – Sized for range of crude quality AM2 – 234 mt/hr –Sized for range of crude quality PHP- 30 MMCFD FCK – 22.6 KBPSD – Size set by PP for range of feeds	More sulfur removal and cetane improvement for diesel More hydrogen for cetane improvement and sulfur removal Design for more flexibility on feedstock drove the design of larger units No objections by ADL
Storage	Mostly conversions to new service 2 new LPG tanks	6 new crude tanks (4 by PetroPeru) 18 new product/feedstock tanks (13 by PetroPeru) 4 new intermediates tanks	FEED has new tanks for new products and to replace tanks demolished for site development FEED has less days of storage for crude CE used converted/ existing tanks for intermediates No objections from ADL.

New and larger units and the implications on power requirements, in addition to an overcapacity design for the pumping equipment, drives the need of a significant amount of additional power and electrical substations

Major Changes Between CE and FEED			
	CE	FEED	ADL View on Change
Utilities	**Power** – GE - 46 MW of gas turbines to meet refinery demand of 41 MW	**Power** – GE-100 MW of boilers/steam turbines to meet refinery demand of 85 MW	Higher power needs because of new units, larger units and new cooling water system ADL supports larger power needs, but recommend to continued value engineering efforts.
	Electric Distribution.- 1 new substation	**Electric Dist.** – 13 new substations	Substations to isolate individual units. Includes some units which were going to be revamped and are new in the FEED Includes individual substations for third party plants (i.e. Cogen) No objections by ADL

There were also changes in cooling water system, nitrogen plant size and number of torches of the FEED

Major Changes Between CE and FEED			
	CE	**FEED**	**ADL View on Change**
Utilities	**Cooling water** SWC Once through seawater cooling (50,000 gpm)	SWC – Once through seawater cooling (197,000 gpm) connected to closed loop(CWC) fresh water circulation (81,000 gpm)	Lower investment drove the change in the SWC system. No objections by ADL, but recommend to continue value engineering efforts, including the consideration of using a cooling tower for sea water
	Nitrogen –NIS- 1500 m³/hr. PSA unit	NIS – 3,500 m³/hr. cryogenic separation plant	Higher nitrogen demand driven by new units, larger units and better design info. No objections by ADL
	Flare – FB2- New ground flare	FB2- Three new vertical pipe flares (hydrocarbons, Flexigas, acid gas)	Licensor recommended the use an independent flare for Flexigas Different torches to be used (2) for hydrocarbons and acid gas No objections by ADL

Significant upgrade has been designed for the port considering increase in crude and products flow, marine and traffic studies, and the capacity for unloading construction supplies

Major Changes Between CE and FEED

	CE	FEED	ADL View on Change
Port	New dock built south of existing dock by extending existing tug dock. New dock can unload 35 MDWT vessels on either side New dock has capacity for 21-30 million Bbls per month on either side The new dock can accommodate a 50 ton crane	New dock (MU2) built on south side of Talara Bay. MU2 will handle up to 52 MDWT vessels and 34 ft. draft. MU2 will be constructed from a temporary dock built to receive construction materials. Existing dock (MU1) will be refurbished and will handle ships up to 35 MDWT.	Refined products logistics (mainly directed to the local market) would continue on the 35 MDWT basis. MU2 – hybrid (first for receipt of equipment – 750 ton HDT and construction materials and later for shipment of products) Decisions supported by ADL

CE left final building definitions to the FEED phase. FEED proposes demolition and rebuilding of almost every building

Major Changes Between CE and FEED			
	CE	FEED	ADL View on Change
General facilities	Buildings – new 1,200 m^2 lab and 1,900 m^2 office No demolition program	Buildings – new total 65,084 m^2 consisting of Admin Buildings – 10,832 m^2 (Admin. , lab, guardhouse), Plant Buildings – 3,100 m^2 (control room, medical, lunch room), Maintenance- 7,940 m^2 (workshop, paint shop, maintenance office), Logistics – 15,200 m^2 (warehouse, receiving, hanger,), Stations – 24,052 m^2 (offices, water treatment, HVAC, docks), Other 3,960 m^2 List of 123 items to be demolished (buildings, guard houses, offices, warehouses, etc.)	CE left final buildings design for the FEED phase FEED includes relocation and demolition of almost all existing buildings Higher employee number base used for office space design ADL recommends to continue value engineering efforts.

FEED plot plan considers increased area needs because of new units, larger size of some units and plant spacing high standards

Major Changes Between CE and FEED			
	CE	**FEED**	**ADL View on Change**
Plot plan	Plot plan covers 199,154 m^3 No geotechnical study available and no soil stabilization plan	Plot plan covers 307,924 m^3. Increased area for: More process units, Large power generation, New, complex, cooling water system and waste treatment systems, More space between units, Large area for unit sites like sulfuric acid Haldor Topsoe - 52 m x 62 m FEED - 118 m x 124 m Soil Stabilization plan: approx. 15,000 piles needed to stabilize soil under plant. 1.4 m of new soil under new units to avoid contact with contaminated soil.	Construction of new process units and tanks require extra space Larger size of unit sites requires more space Larger space for some units than indicated by the licensors Exxon DP-15 standards and local regulations for plant spacing were used Two axis North-South and East-West forces demolition of some buildings/facilities ADL recommends to continue value engineering efforts now or during EPC

CE based on crude blend with 64% Napo, FEED blend has 67% Napo and 0.9 API lower gravity.

Critical Design Aspects - Crude Oil Feed	
Conceptual Engineering	**FEED**
■ 64% Napo crude - 18.8 API ■ 13.7% Petrotech crude - 37.2 API ■ 14.4% Petrobras crude – 33.2 API ■ 7.9% Other crudes (Talara) 34.2 API ■ Crude mix quality – 24.2 API & 1.47 %S	■ 67% Napo crude – 18.4 API ■ 33% Talara composite – 34.2 API ■ Crude mix quality – 23.3 API & 1.50%S

FEED production design converts a higher percentage of heavy hydrocarbons, producing a slightly higher portion of medium distillates and gasoline. Coke production has been significantly decreased

Critical Design Aspects – Production Mix

Product	Unit	CE	% in WT	FEED	% in WT	ADL View on Change
GLP	BPSD	9,296	6%	4,900	4%	The FEED has higher carbon content of the crude oil, and heavier and higher sulfur content crude mix as the feedstock. FEED design adds complexity and severity to convert a higher percentage of heavy hydrocarbons. This implies a larger portion of sulfur to be removed from lighter streams with higher capacities needed at sulfur related units like Amine, Hydrogen and Sulfuric Acid.
Butane	-		0%	1,660	1%	
Gasoline	BPSD	20,371	19%	21,400	21%	
Turbo	BPSD	8,632	9%	6,157	6%	
Diesel	BPSD	41,980	43%	43,700	48%	
High Sulfur Residuals	BPSD	7,522	11%	8,900	11%	
Asphalt	BPSD	3,885	5%	500	4%	
Sulfuric Acid	TN/D	362	3%	560	5%	
Coke	TN/D	514	4%	126	1%	

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

Critical Design Aspects – Units Capacity (BPSD)

Unit	CE	FEED
Catalytic Cracking Unit – FCC	25,000	25,000
FlexiCoker – FCK	21,000	22,600
Atmospheric Distillation Unit – DP1	95,000	95,000
Naphtha Hydrotreating Unit – HTN	13,300	13,300
FCC Gasoline Hydrotreating Unit – HTF	9,500	9,500
Sulfuric Acid Plant – WSA	362 TPD	560 TPD
Diesel Hydro treating Unit – HTD	41,000	41,000
Amine Plant – AM2	144 mt/hr.	234 mt/hr.
Catalytic Reformer – RCA	9,500	9,500
Vacuum Distillation Unit – DV3	22,00(Revamp) + 35,000 (New)	52,700
Gas Recovery II – RG2	-	72,586
LPG Treatment – TGL	-	8,230
Sour Water Treatment Disposal II – WS2	-	123 m3/h + 47.5 m3/h
Caustic Kero/Jet Treatment – TKT	-	8,800
Exhausted Soda Plant – OX/SCG	-	4 m^3/hr.
Cooling Water Closed System – CWC	Brief assessment	According to requirements of new and existing units
Maritime facilities/ Sea Water Inlet & Outlet		
Flare System/Torch – FB2		
Crude Product Storage – TKS		
Sanitary Treatment – SA2		
Buildings		
Interconnections – INT		
Nitrogen Plant – NIS	1,500 m^3 /hr.	3,500 m^3 /hr.
Auxiliary Services		
Hydrogen Unit – PHP	21 MMSCFD	30 MMSCFD
Cogeneration Plant – GE	46 MW	100 MW

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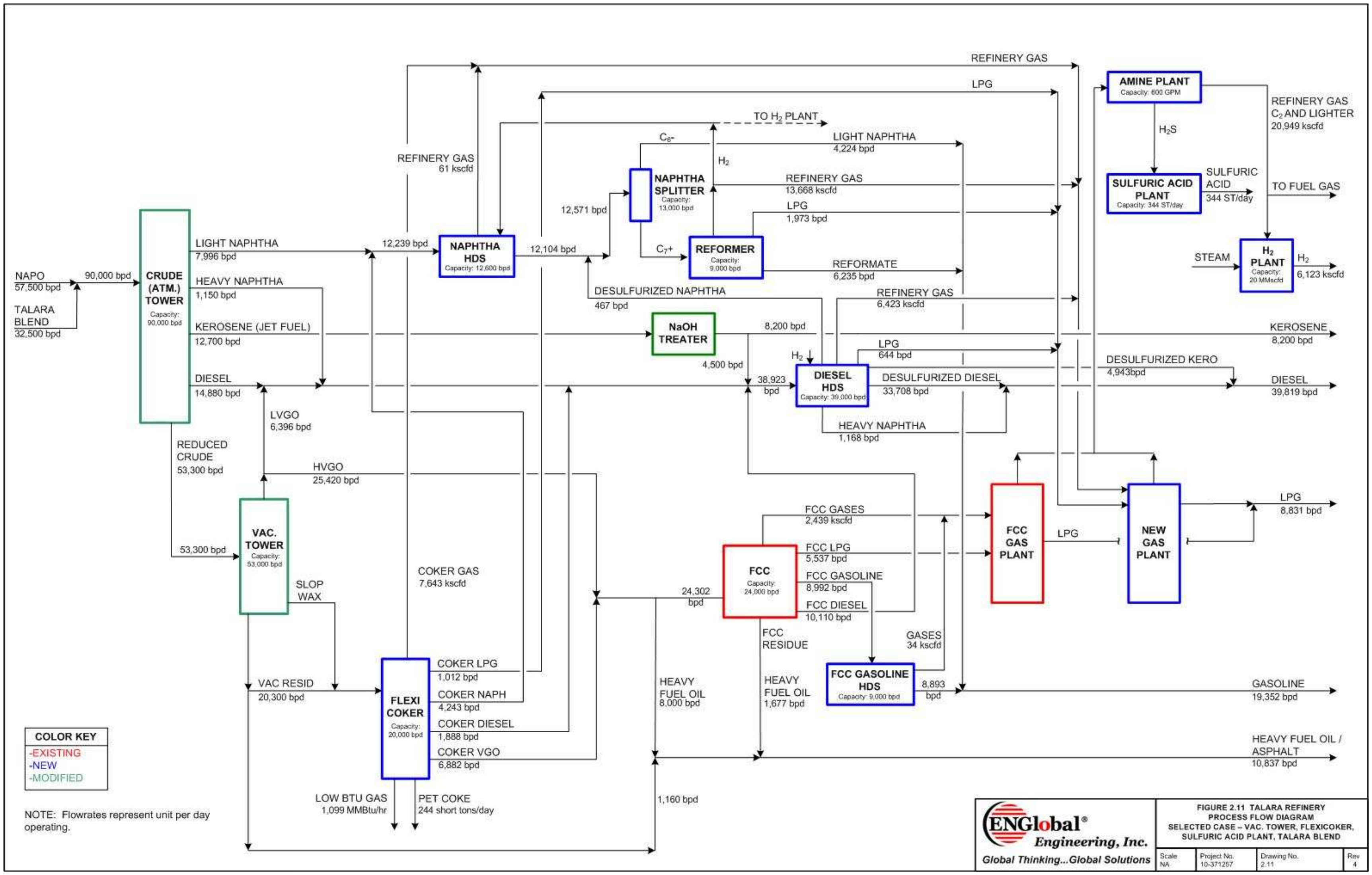
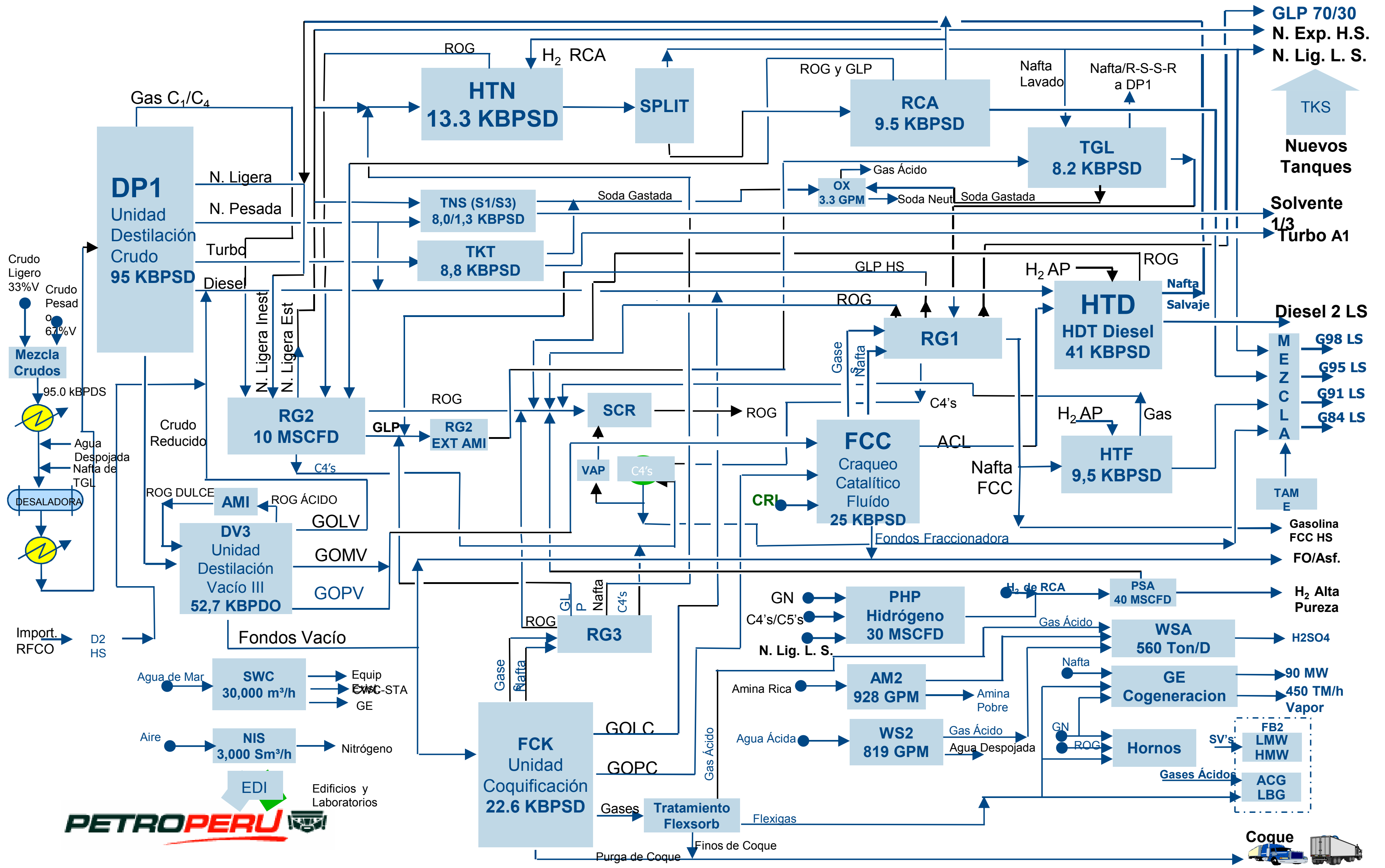
CE's Overall Refinery Block Flow Diagram



FEED's Overall Refinery Block Flow Diagram



FEED tankage for crude oil is lower than CE and storage for products is larger, but the main change is that the FEED has 2 new tanks for crude, 5 new tanks for products and 4 new tanks for intermediate products

Critical Design Aspects – 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	

The CE study was done under a strict CAPEX constraint that impacted the design of the configuration and led to maximizing the use of existing equipment and infrastructure

Design Philosophy

Conceptual Engineering	FEED	ADL View on Change
▪ Guideline provided to ADL by Petroperu in 2007: Spend the minimum investment capital to make the Talara refinery profitable using a heavier crude mix. ▪ Using this basis the optimal configuration which included a hydrocracker was discarded by Petroperu ▪ Based on these guidelines ADL's conceptual study recommended a design that gave preference to the revamp of existing units, limited flexibility for different crudes, used existing tankage versus new tankage when possible, and a compact plot plan	▪ Take a long view on the refinery's needs : - Be able to process a range of crudes - Consider the potential for future expansions - Upgrade the utilities and general facilities to meet current and potential needs - Facilitate the handling of specialty products and receipts - Ample plot plan spacing and new buildings - Consider current regulations and standards	▪ FEED design provides flexibility for operations, crude selection and product output. ▪ These factors were considered at CE, but discarded because of strict CAPEX constraints ▪ Full cycle economics of CE study design were suboptimal

Agenda

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

Process Units – Major Changes			
Unit	**CE**	**FEED**	**Major Change**
Atmospheric Distillation Unit – DP1	95,000	95,000	New fractionator, stripper & condenser, instead of revamp
Vacuum Distillation Unit – DV3	22,00(Revamp) + 35,000 (New)	52,700	New instead of revamp
Catalytic Cracking Unit – FCC	25,000	25,000	New instead of revamp
FlexiCoker – FCK	21,000	22,600	7.6 % larger
FCC Gasoline Hydrotreating Unit – HTF	9,500	9,500	No major change
Naphtha Hydrotreating Unit – HTN BPSD	13,300	13,300	No major change
Diesel Hydro treating Unit – HTD	41,000	41,000	No major change
Catalytic Reformer – RCA	9,500	9,500	No major change
Gas Recovery – RG1 and RG2	-	-	Similar size
LPG Treatment – TGL	-	8,230	No included in CE
Amine Plant – AM2	144 mt/hr.	234 mt/hr.	Larger
Hydrogen Unit – PHP	21 MMSCFD	30 MMSCFD	Larger
Sulfuric Acid Plant – WSA	362 TPD	560 TPD	Larger

Internal corrosion and the need to enlarge the diameter of the tower makes the FEED option of a new fractionator for atmospheric distillation the best choice

Atmospheric Distillation Unit – DP1	
Conceptual Engineering	**FEED**
■ Revamp existing unit to 95,000 BPSD ■ Based on RefSym simulation needed changes are increase lower section from 5 to 10ft dia., new trays in mid section, and new heat exchangers and pumps. ■ Use existing desalter and feed furnace.	■ New 95,000 BPSD fractionator and stripper, & new condenser ■ Use feed furnace and existing desalter with new heat exchangers before and after desalter.

Rational for change:

- Internal inspection showed corrosion in top of tower.
- Foundation repairs needed to meet seismic design code.
- Extensive unit downtime for construction and economic impact will be higher than expected and supports the decision of replacing the tower
- FEED contractor did not want to guarantee old unit's performance

ADL view:

- Internal corrosion , foundation issues, need for increased diameter in lower tower section and economic impact of shutdown supports the FEED option. No objections by ADL

The FEED plan to construct a new unit that can handle all the flow makes sense given the condition of the old unit (DV2)

Vaccum Distillation Unit – DV3	
Conceptual Engineering	**FEED**
■ Keep existing unit, (DV1) changing the capacity to 22.000 BPSD. ■ Add a new unit DV3, capacity 35.000 BPSD. ■ Dismantling of DV2 was included.	■ 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.

Rational for change:

- Engineering study showed that the condition of the old vacuum units and unit space limitations did not justify revamping
- Opportunity cost of stopping operations was also considered for the replacement decision of the tower

ADL view:

- ADL agrees with FEED for a new Vacuum Tower with capacity of 52,740 BPSD. Petroperu may consider to keep DV1 for potential parallel operation

A detailed engineering study supported the FEED recommendation of a new FCC unit, keeping only a few pieces of equipment of the old unit

Fluid Catalytic Cracking Unit – FCC	
Conceptual Engineering	**FEED**
■ Keep existing unit . ■ Revamp capacity to 25.000 BPSD ■ Replace or increase capacity of wet gas compressor and air blower capacity. Riser modification	■ 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 ■ Design cases: Lt Feed (VGO), Hvy. Feed (80 VGO/20ATB); Max distillate, Max LPG ■ New main fractionator and debutanizer columns

Rational for change:

- The new unit was selected due to plant obsolescence and the length of plant shutdown and its economic impact.

ADL view:

- FCC revamps are common, even for old units, due to the complexity of the unit and the high cost of new units.
- Detailed engineering showed many new components needed for 25,000 BPD, making new unit attractive
- Keeping major equipment in revamp and taking capacity loss would save money, but cut gasoline output
- No objections from ADL

The FEED unit equipment has been sized at about 7% larger than in the CE to handle a range of feedstocks

FlexiCoker – FCK

Conceptual Engineering	FEED
■ New Flexicoking unit using EMRE technology ■ Capacity: 21,000 BPSD ■ Feed % CCR of: 28.3 CCR: Conradson Carbon Residue	■ New Flexicoking unit using EMRE technology ■ Capacity: 22,600 BPSD ■ Two feed cases: 27.3% CCR (Blend case) and 32.4% CCR (Heavy case) ■ The Blend case sets the equipment sizes for the liquid products recovery & Heavy case sets the sizes for the coker gas recovery, reactor, heaters and gasifier

Rational for change:

- Petroperu MJS suggest the capacity of 22.6 BPSD
- Add flexibility for a range of feedstocks

ADL view:

- The FEED design allows for a range of feedstocks and two operating cases. No objections from ADL

The FCC gasoline hydrotreater is the same size in both CE and FEED

FCC Gasoline Hydrotreating Unit – HTF

Conceptual Engineering	FEED
■ New unit ■ Capacity: 9500 BPSD	■ New unit ■ Capacity: 9500 BPSD

Rational for change:

- No change

ADL view:

- The unit is the same in both cases.

HTN FEED represents licensor/PP design basis and detailed design data of feedstock data

Naphtha Hidrotreater – HTN

Conceptual Engineering	FEED
■ New 13,300 BPSD unit using EMRE technology ■ Feed 969 ppm S and product <0.5 ppm S	■ New 13,300 BPSD using Axens technology ■ Considers two cases: Blend and Napo ■ Feed 2,973 ppm S and product <0.5 S

Rational for change:

- FEED based on improved feedstock information and licensor/PP design basis which has flexibility in feedstock quality

ADL view:

- FEED design based on latest design information and licensor/PP design basis. No objections by ADL

HTD FEED represents licensor/PP design basis and detailed design data of feedstock data

Diesel Hydro treating Unit – HTD

Conceptual Engineering	FEED
■ New 41,000 diesel HDS unit using EMRE technology ■ Cetane spec of 47 controls hydrogenation. Feed mix has cetane of 44. EMRE = ExxonMobil Research & Engineering	■ New 41,000 diesel HDS unit using Haldor Topsoe technology ■ Cetane spec of 47 controls hydrogenation. Feed mix has cetane of 42.1

Rational for change:

- FEED based on improved feedstock information and licensor/PP design basis which has flexibility in feedstock quality

ADL view:

- FEED design based on latest design information and licensor/PP design basis. No objections from ADL

Catalytic reformer is the same in the CE and FEED cases

Catalytic Reformer – RCA	
Conceptual Engineering	**FEED**
■ New 9,500 BPSD unit using EMRE technology ■ Semi-regenerative design with three reactors ■ Unit sized for design crude blend.	■ New 9,500 BPSD unit using Axens technology. ■ Semi-regenerative design with three reactors making either 98 or 100 RON reformate with <1.5% benzene ■ Design based on two feed cases: Blend case and Napo case

Rational for change:

- Units are basically the same

ADL view:

- Units are basically the same, with two octane cases. ADL agree with the FEED design.

The gas recovery unit of the CE and FEED are similar size, and able to recover natural gas liquids of the FCC

Gas Recovery Unit– RG1	
Conceptual Engineering	**FEED**
■ Recover NGLs from FCCU off gas and FCC gasoline hydrotreater. ■ Use existing C_3/C_4 splitter, condenser, receiver, feed preheater, and product cooler.	■ Recover NGLs from FCCU off gas. ■ Use existing C_3/C_4 splitter, condenser, receiver, feed preheater, and product cooler. ■ New debutanizer

Rational for change:

- Units are similar

ADL view:

- The two gas plants are similar

The gas recovery unit of the CE and FEED, are similar size, and able to recover natural gas liquids of the new process units.

Gas Recovery II – RG2	
Conceptual Engineering	**FEED**
■ New gas plant for light ends/saturated gases recovery from crude tower, naphtha HDS, reformer, flexicoker splitter, and diesel HDS	■ New gas plant for light ends recovery from crude tower, naphtha HDS, reformer, FCC gasoline hydrotreater, and diesel HDS. ■ Flexicoker has its own/captive RG unit

Rational for change:

- Unit needed to process collection of diverse streams from different new units

ADL view:

- ADL supports the FEED decision

The larger amine plant in the FEED reflects licensor/PP detailed design basis including more conversion, and flexibility oversizing to meet variability in crude choices

Amine Plant – AM2	
Conceptual Engineering	**FEED**
■ Treat H_2S from Flexicoker OH, Diesel HDS, Naphtha HDS, FCC Gas Plant. Amine type:DEA ■ Design based on treating 2,695 scfm of H_2S with 630 gpm (144 mt/hr.) of amine solution. ■ Open art Crosstex technology used because it is skid mounted (low cost).	■ Treat H_2S 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

Rational for change:

- CE amines unit sized for crude blend
- FEED amines sized for licensor/PP design basis which has more conversion and sizing to meet variability in crude choices

ADL view:

- Skid mounted units not practical at FEED sulfur levels, The larger size in the FEED reflects PP desire for flexibility to meet variable crude choices. No objections from ADL

The new detailed hydrogen balance for the FEED design supports the need of a larger hydrogen production plant

Hydrogen Unit – PHP

Conceptual Engineering	FEED
■ New 21 MMscfd (23,442 m³/hr.) plant using Haldor Topsoe technology ■ Reformer hydrogen is fed to the H_2 plant PSA for cleanup and added to the plant output ■ Plant can use butane, naphtha, natural gas, or refinery fuel gas for feedstock	■ New 30 MMscfd (33,489 m³/hr.) hydrogen plant using Haldor Topsoe technology ■ Reformer hydrogen is fed to the H_2 plant PSA for cleanup and added to the plant output ■ Feedstock for hydrogen plant is light naphtha and refinery fuel gas or natural gas

Rational for change:

- The hydrogen required for treating diesel to meet the cetane and sulfur content specified by Haldor Topsoe was higher than the one obtained from the licensor in the CE.
- Licensor used a higher feed cetane and sulfur species were not available at the CE phase

ADL view:

- The larger hydrogen plant in the FEED study is needed. No objections from ADL

Caustic Kero/Jet treatment unit was to be part of Talara refinery projects and after the CE was done the project was moved to the modernization project and included in the FEED

Caustic Kero/Jet Treatment – TKT

Conceptual Engineering	FEED
■ Caustic Kero/Jet treatment was a separate PetroPeru project	■ Caustic Kero/Jet treatment project moved to Talara Expansion ■ Capacity: 8,800 BPD

Rational for change:

- Project moved to Talara Expansion after CE study, to assure proper design for new crudes and new instrumentation

ADL view:

- FEED needs to integrate this units to the global modernization project. No objections from ADL

LPG treatment was not part of the CE study and has been included in the FEED because of the quality of the LPG to be produced

LPG Treatment – TGL	
Conceptual Engineering	**FEED**
■ Not considered	■ An amine pretreatment process designed by TR and a new caustic treatment unit with a capacity of 8230 BPSD which uses Axens technology, were added. ■ New Sulfrex unit using extractive technology to remove mercaptans, H_2S, and COS

Rational for change:

- The reason to include the unit was to assure LPG under specification when running high sulfur crudes. Unit has been added to remove sulfur compounds from LPG using an Axens technology with circulation and regeneration of soda, reducing volume needs of caustic soda and also reducing sulfides at effluents

ADL view:

- FEED TGL unit is needed. No objections from ADL

Caustic naphtha treatment unit was to be part of Talara refinery projects and after the CE was done the project was moved to the modernization project and included in the FEED

Caustic Naphtha Treatment – TNS	
Conceptual Engineering	**FEED**
■ Caustic treatment of naphtha was a separate PetroPeru project	■ New 9.600 BPSD unit ■ Designed to remove mercaptans. sulfur, and acid from the naphtha.

Rational for change:

- Unit moved to Talara Expansion project

ADL view:

- FEED needs to integrate this units to the global modernization project. No objections from ADL

Agenda

Some of the auxiliary units of the FEED were not included in the scope of the CE.

Auxiliary Units – Major Changes			
Unit	**CE**	**FEED**	**Major Change**
Sulfuric Acid Plant – WSA	362 TPD	560 TPD	Larger
Sour Water Treatment Disposal II – WS2	-	123 m^3/h + 47.5 m^3//h	……….
Caustic soda plant -CAF	-	Makes 15% & 40% Caustic	Not included in CE
Exhausted Soda Plant – OX/SCG	-	4 m^3/hr.	Not included in CE.
Flare System/Torch – FB2		According to requirements of new and existing units	3 instead of one
Sanitary Treatment – SA2			Replacement for larger cap.

Sulfuric Acid FEED is designed to match the load from the Amines unit and Flexigas coming from the Flexicoker

Sulfuric Acid Unit - AST	
Conceptual Engineering	**FEED**
■ New 362 mt/d (98% sulfuric acid) plant ■ Haldor Topsoe Wet Sulfuric Acid (WSA) technology used. ■ Unit sized for design crude blend ■ Three 36,000 bbl. sulfuric acid storage tanks included	■ New 560 mt/d plant (98% sulfuric acid) plant ■ Haldor Topsoe Wet Sulfuric Acid technology used. ■ Two new 82,000 bbl. storage tanks for sulfuric acid

Rational for change:

- FEED sulfuric plant size exceeds the normal H_2S load and is oversized to match the amine system and to meet peak demand. TR initially identified the need of 460 mt/d TR calculated the 560 mt/d size requirement after consultation with major licensors. Careful capacity design has been used given the criticality of the unit to the environmental compliance of the plant

ADL view:

- FEED is designed to match the load from the Amines unit and Flexigas Unit. No objections from ADL

Detailed design for units of the FEED showed that a unit is needed to mix caustic of various concentrations

Caustic Soda Facilities– CAF	
Conceptual Engineering	**FEED**
■ Not considered	■ Unit mixes caustic soda ■ 2 mixers for 15% and 40% dilution ■ Electrical heater ■ 6 Caustic soda pumps

Rational for change:

- Detailed design identified a need to mix caustic soda of various concentrations
- This was due to moving into the scope of the FEED new caustic treatment units, not present at CE phase

ADL view:

- Unit facilitates mixing various concentrations of caustic soda needed in the refinery. No objections from ADL

FEED study flare system incorporates an individual torch for low BTU gas from the flexicoker and two separate ones for hydrocarbons and acid gas following licensors recommendations

Flare System/Torch – FB2

Conceptual Engineering	FEED

■ Keep existing unit and add new ground flare with steam assist and knockout drum for new units
■ Low-cost alternative .
	■ New vertical pipe systems.
	■ Three independent flares of the same height
	  ■ Hydrocarbons 721,191 kg/hr.
	  ■ Low BTU Gas-FCK 222,440 kg/hr.
	  ■ Acid Gas 44,450 kg/hr.

Rational for change:

- The current system is not appropriate for international and national laws and regulations. (height and size)
- The type of torch must be elevated (not ground flare) according to EMRE experience
- The Flexicoker and acid gases (from DEA & WSA) require independent flares
- Heavy and light molecular weight hydrocarbons require separate headers and knockout drums in order to separate condensates, but use a common flare stack.

ADL view:

- FEED captures latest standards and design details. No objections from ADL

Spent Caustic plant use to be part of Talara refinery projects and after the CE was done, was moved to be part of the modernization project and included in the FEED

Spent Caustic Plant – OX/SCG	
Conceptual Engineering	**FEED**
■ Spent caustic is treated with acid, allowing oil/water to separate. pH of the water is adjusted to meet environmental standard, then discharged.	■ Plant uses spent caustic to neutralize out of specification and waste acid ■ Capacity to treat H_2SO_4: 3 m^3/hr of acid.

Rational for change:

- Detailed engineering defined the caustic/ H_2SO_4 size and treater design

ADL view:

- FEED plant eliminates caustic/acid waste streams. No objections to FEED design from ADL

Oily water treatment FEED design has different capacities and slightly different configuration

Oily Water Treatment	
Conceptual Engineering	**FEED**
■ New plant for Industrial effluents treatment ■ Demolish existing API oil separator unit ■ Tank Farm & Desalter Water: Centrifuge to separate oil and water. Send water to the revamped CPI separator and then to a Dissolved Air Flotation (DAF) separator before discharging. Both CPI & DAF will be covered.	■ New plant for industrial effluents treatment ■ Capacity: 400 m^3/hr ■ Demolition of existing oil/water separator ■ At least 2 API and 2 DAF units included ■ Tank for DQO oxidation and a sludge thickener

Rational for change:

- Larger use of fresh water in the FEED design requires more oily water treatment

ADL view:

- Overall FEED design for oily water treatment . No objections from ADL

The FEED design for Sanitary Treatment replaces the existing process with a new unit considering larger quantity of effluents

Sanitary Treatment – SA2	
Conceptual Engineering	**FEED**
■ Keep existing system. ■ Installation of new sanitary treatment for new buildings not included	■ A new sanitary effluents treatment plant with capacity of 20 m^3/hr.

Rational for change:

- Larger capacity for larger buildings and manpower estimation
- A new sanitary water treatment system needed to be installed to achieve the quality standards of national and international laws

ADL view:

- The FEED design is more comprehensive and meets environmental standards. No objections from ADL

Sour Water Treatment and Disposal plant was to be part of Talara refinery projects and was moved to be part of the modernization project after the CE and included in the FEED

Sour Water Treatment/Disposal II – WS2	
Conceptual Engineering	**FEED**
■ Not considered	■ The sour water treater takes sour water containing ammonia, H_2S, and CO_2 and treats the stream with caustic soda. ■ Capacity of the unit is 196 m^3/hr.

Rational for change:

- Moved to the Talara Expansion project after the CE

ADL view:

- The sour water unit in the FEED will be required to meet effluent standards. No objections from ADL

Agenda

The larger cogeneration in the FEED study is a natural outcome of design changes and more complex refinery in the FEED study

Cogeneration Plant – GE	
Conceptual Engineering	**FEED**
■ 46 MW gas turbine operating on refinery gas and natural gas ■ Covers refinery power needs of 44 MW	■ Three steam boilers (one spare, two operating) driving two steam turbine generators (50MW each) and making high pressure(42.2 kg/cm^2) and medium pressure (12.6 kg/cm^2) steam. ■ Boilers use Flexigas supplemented with fuel gas and natural gas. ■ Covers refinery power needs of 85 MW

Rational for change:

- The big increase in power required in the FEED arises from more process units, a larger more complex cooling water system, and offsites/auxiliary equipment

ADL view:

- The larger power requirement (and requisite cogen plant) is a natural outcome of the more complex plant that has emerged in the FEED study. No objections from ADL

The larger nitrogen plant in the FEED study is consistent with more detailed estimate of need and the larger FEED refinery.

Nitrogen Plant – NIS	
Conceptual Engineering	**FEED**
■ 1,500 m^3/hr. packaged PSA unit	■ 3,500 m^3/hr. cryogenic separation plant

Rational for change:

- Increased number of units
- More detailed analysis and information from licensors of nitrogen requirements

ADL view:

- The larger nitrogen plant in the FEED study results from more units and a more detailed definition of demand for nitrogen. No objections from ADL

Both the CE and FEED plan to use the existing boilers and modify the distribution system to handle the new units.

Steam Generation System – SGV

Conceptual Engineering	FEED

■ New deareator
■ Modification of existing systems for new requirements
	■ Modification of distribution system to handle new units
	■ New deareator with capacity of 461.6 mt/hr
	■ New Pumps:
	  ■ Very high pressure: 2 x107 m^3/hr (to cogen)
	  ■ High pressure: 2 x 224 m^3/hr
	  ■ Medium pressure : 2 x 126 m^3/hr
	  ■ Low pressure: 2 x 4.1 m^3/hr

Rational for change:

- More detailed design of pump requirements and feed water collection/storage

ADL view:

- Changes between CE and FEED are not major. No objections from ADL

FEED system is more complex, but evaluated to be cheaper than CE's once through system.

Cooling Water Closed System – CWC

Conceptual Engineering	FEED
■ Once through sea water flow of 50.000 gpm ■ Pacific Ocean inlet and outlet. Return water is aerated to get sea water to <0.1 ppm chlorine. and temp. increase at 100 m expected to be 2.5 °C at 100 m. after mixing ■ Individual exchanges are monitored for process leaks and can be isolated with return water sent to wastewater collection.	■ New system ■ Sea water intake off Punta Gallosa has two towers and two parallel pipelines delivering 196,958 gpm ■ Seawater exchanged with closed sweet water cooling system circulating 80,863 gpm. Turbidity meters at exchanges isolate process leaks for segregation. ■ Temperature rise after mixing is < 3 °C at 100 m from outlet. Larger heat load requires lower temperature on return seawater to meet max maximum.

Rational for change:

- Economic analysis by TR.
- Larger cooling water needs because of better information from licensors, new and larger units , more boiler feed water needs for power generation and other configuration changes. Some units to continue to be cooled by sea water, because of licensors recommendation
- Adoption of stricter sew discharge standards (Max Δt 3°C for sea water discharge for a 100 m distance of outlet)

ADL view:

- FEED system designed for major duty and is more complex, and was selected because it showed a lower investment than once through option. ADL recommend to continue value engineering before or during EPC

Design of the sea water inlet and outlet are similar for the CE and the FEED, except the flow in the FEED system is almost 4 times that of the CE

Sea Water Inlet & Outlet – SWI & SWO

Conceptual Engineering	FEED
■ New deep Pacific Ocean intake with design intake velocity of 0.15 m/sec (EPA guideline). ■ Inlet covered with heavy duty slotted screen with openings <5mm. Jellyfish fence included. ■ Return is moved from Bay to Pacific Ocean. ■ Once through sea water cooling flow of 50.000 gpm	■ 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 .

Rational for change:

- FEED considered a marine and wave simulation study
- Flow of the FEED is almost 4 times that of the CE because of larger water needs, impacting on pipes and pumping capacities

ADL view:

- Design of the two systems is similar, except that the volume for the FEED is almost 4 times greater than the CE. ADL recommend to continue value engineering before or during EPC

FEED design requires more desalinated and demineralized water, mainly because the need of fresh water for the cooling water system and additional boiler feed water for cogeneration

Demineralizing Plant – DM2/ Desalination Plant – OR2	
Conceptual Engineering	**FEED**
■ Expand existing seawater desalination plant to 2,200 m^3/d. ■ Continue to outsource the desalination plant to PRIDESA.	■ New plants (desalination and demineralization) to produce: • Desalinated water demand of 16,000 m^3/d to a maximum of 20,000 m^3 /d using reverse osmosis. • Demineralized water of 10.602 m^3/d using deionization

Rational for change:

- More detailed design and more units using desalinated/demineralized water in the FEED.

ADL view:

- Larger plants are needed to meet the increased demand for sweet water in FEED design. No objections from ADL

Capacity of the air systems in the FEED and CE are the same, but the FEED uses three compressors.

Air System Unit – PAR	
Conceptual Engineering	**FEED**
■ New 12,500 scfm (21,240 m^3/hr.) compressor (2755bhp) operating at 125 psig.	■ Three new compressors delivering 7,910 m^3/hr each operating at 125 psi. ■ One unit needed for normal operation, three units may be needed at peak demand.

Rational for change:

- Three units instead of one to provide flexibility

ADL view:

- Three units can follow load better than one large unit. No objections from ADL

Decision in FEED to send flexigas to cogeneration plant, using other fuel sources for process units

Refinery Fuel System – SCR	
Conceptual Engineering	**FEED**
■ Flexigas is used in the CO boiler and process heaters ■ Refinery fuel gas used in gas turbines for electric power, as a partial feed to the hydrogen plant, and as an auxiliary feed with Flexigas ■ Butanes are vaporized and added to refinery fuel gas	■ Flexigas and some RFG feed cogen boilers ■ Butane supplements RFG via two butane/LPG vaporizers ■ Butanes/C_5s and naphtha feed hydrogen plant. ■ Process heaters use refinery fuel gas and natural gas

Rational for change:

- Decision made in FEED to send Flexigas to cogen plant, because difficulties found by licensors and TR in burning Flexigas in process furnaces. This decision implies additional fuel requirements to meet total demand for the refinery process units.

ADL view:

- We support the decision made in the FEED to send Flexigas to cogen plant. No objections from ADL

FEED tankage for crude oil is lower than CE and storage for products is larger, but the main change is that the FEED has 2 new tanks for crude, 5 new tanks for products and 4 new tanks for intermediate products

Critical Design Aspects – 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	

FEED and CE crude tank additions fit the need for their cases.

Crude Product Storage – TKS	
Conceptual Engineering	**FEED**
■ Provide 30 days of crude storage. ■ Convert 320,000 bbls. from gasoline to crude, no new tanks required.	■ Provide 15 days of crude storage. ■ Build 2 new crude tanks totaling 240,000 bbls ■ PetroPeru to build 4 new crude tanks totaling 380 MB

Rational for change:

- FEED study cut overall crude storage, but built new crude tanks to replace those demolished or shifted to usage other than crude.

ADL view:

- CE and FEED crude tank balances fit the need of their cases. No objections from ADL

Updated demand, Peruvian law, more relaxed attitude about investing in new tanks, and requirements for new products/feedstocks have contributed to a significant increase in the amount of tanks required for the FEED case

Intermediate and Product Storage- TKS

Conceptual Engineering	FEED
■ LPG - 2 new bullet tanks, 20,000 bbl each. ■ Intermediates – 8 tanks converted from other uses ■ Blending- 2 tanks converted from other uses	■ LPG - 3 new spheres, 20,000 bbl each, by PetroPeru ■ Gasoline – 2 new tanks to be built by PetroPeru ■ Jet – 1 tank to be built by PetroPeru ■ Diesel- 3 tanks to be build by PetroPeru ■ Bunker/Industrial – 2 new tanks to be built ■ Asphalt – 3 new tanks to be built by PetroPeru ■ Biodiesel – 1 new receiving tank by PetroPeru ■ Sulfuric Acid – 2 new tanks to be built

Rational for change:

- Since the CE study in 2007, PP has identified new requirements for tanks, decided to demolish old tanks, build new ones, and adjusted the need for product storage based on the actual demand growth and Peruvian law.

ADL view:

- Efforts at cost saving in CE study dictated the maximum reuse of existing tanks.
- FEED focused on covering needs for new products/feedstocks, eliminating tanks that interfered with the plot plan expansion, building new ones to cover storage requirements and addressing inventory required by Peruvian law. ADL recommend to continue value engineering before or during EPC

Biodiesel, TAME, diesel from Conchan, and naphtha for Iquitos are all new tank needs since CE in 2007

Intermediate and Product Storage con't- TKS

Conceptual Engineering	FEED
■ Freshwater – 1 new 30,000 bbl for fire fighting	■ TAME – 2 receiving tanks converted from other uses ■ Hi Sulfur Naphtha – 1 tank for shipment to Iquitos ■ Freshwater – 1 tank for firefighting ■ Intermediates – 4 new tanks (naphtha from RG-2, HI S diesel (inc. Conchan), VGO, cut material)

Rational for change:

- FEED added tanks to meet need for new products and feedstocks.

ADL view:

- CE used ethanol for gasoline octane not TAME
- No objections from ADL

Agenda

The new dock in the FEED study replaced a two sided extension of the current tug dock in the CE study.

Docks – MU1 & MU2	
Conceptual Engineering	**FEED**
■ New dock built south of existing dock by extending existing tug dock. ■ New dock can unload 35,000 DWT vessels on either side ■ New dock has capacity for 21-30 million bbls.. per month on either side ■ The new dock can accommodate a 50 ton crane	■ 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

Rational for change:

- The planned dock in the CE was replaced with a larger dock in the east side of the Bay

ADL view:

- The CE design is more compact and less expensive, but not detailed assessed against marine traffic studies.
- ADL recommend to continue value engineering now or during EPC

The demand for electricity increased in the FEED study due to the revised cooling water system and increased number of new units.

Electricity	
Conceptual Engineering	**FEED**
■ 1 new substation included ■ Energy requirements: 44 MW ■ Electricity energy requirements provided by gas turbines	■ 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 ■ 1500 km of cable needed

Rational for change:

- The increment of electricity demand is due to the increment of number of pumps and compressors with electric engine, air cooling, larger distances between units, shipping to the new pier and higher compression needs for hydrogen for the HTD

ADL view:

- FEED design, with new and larger units, and changes in utilities and facilities justify higher power use
- Part of the increase of the number of substations came from of new units and third party operations

The FEED plot plan is 55% greater than the CE driven by the design changes and larger unit sites.

Plot Plan	
Conceptual Engineering	**FEED**
■ Plot plan has area of 199,219 m^2 composed of 112,012 m^2 for process units, 38,139 m^2 for utilities and 49,003 m^2 for offsites.	■ Plot plan has area of 307,924 m^2 composed of 152,307 m^2 for process units, 45,760 m^2 for utilities, and 109,857 m^2 for offsites.

Rational for change:

- More and larger units, more space within and between units according to local regulations, more buildings, bigger power plant and more complex cooling system and waste treatment demands more area

ADL view

- Considering the project as a modernization and not a grass roots refinery, FEED would optimize plot area, and maintain units safety
- ADL recommend to continue value engineering before or during EPC

The FEED study contemplates adding 65,000 m^2 of new building that includes replacing nearly all of the current buildings and demolishing 123 structures of various types.

Buildings	
Conceptual Engineering	**FEED**
■ Buildings – new 1,200 m^2 lab and 1,900 m^2 office ■ No demolition program ■ CE left final design of building to the FEED phase	■ Buildings – new total 65,084 m^2 consisting of Admin Buildings – 10,832 m^2 (Admin. , lab, guardhouse), Plant Buildings – 3,100 m^2 (control room, medical, lunch room), Maintenance- 7,940 m^2 (workshop, paint shop, maint. office), Logistics – 15,200 m^2 (warehouse, receiving, hanger,), Stations – 24,052 m^3 (offices, water treatment, HVAC, docks), Other 3,960 m^3 ■ List of 123 items to be demolished (buildings, guard houses, offices, warehouses, etc)

Rational for change:

- FEED includes relocation and demolition of almost all existing buildings
- Higher employee number base used for office space design:

ADL view:

- Additional reviews on the demolition plans are recommended
- ADL recommend to continue value engineering before or during EPC