

SimRef - Monthly Plan

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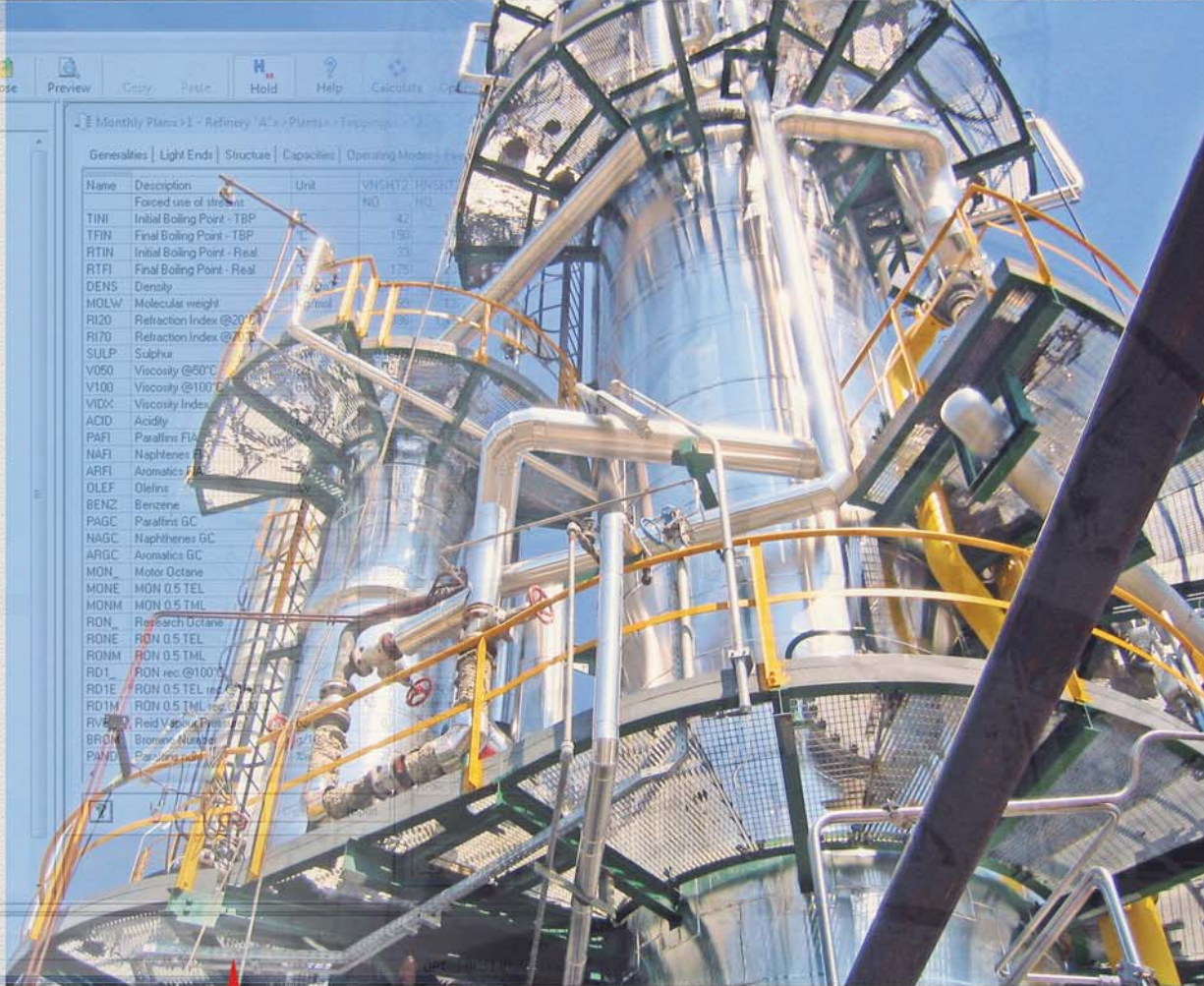
Simulation

Monthly Plan

1 - Refinery "A"

- Crude oil tanks
- Products
- Stream Tanks
- Handlings
- Schedule
- Plants
- Connections
- Products
- Economics
  - Crude oils
  - Imports
  - Products
  - Hydrogens
  - Utilities
  - Emissions
  - Fixed Costs
  - Exchanges
  - Investments
- Boards

Ready



 **ROMETHEUS**

# COMPANY

Prometheus is an independent consulting company that has served the oil industry since 1986. It provides products and services for refinery management that improve profitability, refinery operations, and marketing decisions.

The company was founded by Dr. Alberto Ferrucci, former CEO of an Italian primary private oil group.

It provides industrial consulting services for the energy sector: oil refinery surveys, energy saving measures, conceptual process design, and technical assistance to improve capacity, quality, and profitability.

Moreover, Prometheus offers a Decision Support System (DSS) specifically designed to ease the direct use of its optimisation models by refinery managers. Prometheus combines its experience in refinery management with its proven software packages to deliver customised solutions tailored to specific needs.



Monthly Plan - Refinery - Economics - Products

Product	Period	Price	Min Qty	Max Qty	Sched Qty	Min Lot	MIP
GG/01 (G.Gale)	2-08 ott/14 ott 2008	\$/m3	m3	900.0 m3	m3	m3	NO
	3-15 ott/30 ott 2008	\$/m3	m3	2000.0 m3	m3	m3	NO
	1-01 ott/07 ott 2008	227.0 \$/m3	m3	600.0 m3	m3	m3	NO
GP/01 (G.Ric.Alp.)	2-08 ott/14 ott 2008	\$/m3	m3	600.0 m3	m3	m3	NO
	3-15 ott/30 ott 2008	\$/m3	m3	1300.0 m3	m3	m3	NO
	1-01 ott/07 ott 2008	222.0 \$/m3	m3	4000.0 m3	m3	m3	NO
G1/01 (G.Agric.)	2-08 ott/14 ott 2008	\$/m3	m3	4000.0 m3	m3	m3	NO
	3-15 ott/30 ott 2008	\$/m3	m3	9000.0 m3	m3	m3	NO
	1-01 ott/07 ott 2008	230.0 \$/m3	m3	1200.0 m3	m3	m3	NO
GE/01 (G.Aut.Exp.)	2-08 ott/14 ott 2008	\$/m3	m3	1200.0 m3	m3	m3	NO
	3-15 ott/30 ott 2008	\$/m3	m3	m3	m3	m3	NO
	1-01 ott/07 ott 2008	100.0 \$/ton	ton	ton	ton	ton	NO
BK/01 (BK.1.5)	2-08 ott/14 ott 2008	\$/ton	ton	ton	ton	ton	NO
	3-15 ott/30 ott 2008	\$/ton	ton	ton	ton	ton	NO
	1-01 ott/07 ott 2008	5.0 \$/ton	ton	ton	ton	ton	NO
O2/01 (O2.Funaces)	2-08 ott/14 ott 2008	\$/ton	ton	ton	ton	ton	NO
	3-15 ott/30 ott 2008	\$/ton	ton	ton	ton	ton	NO
	1-01 ott/07 ott 2008	90.0 \$/ton	ton	ton	ton	ton	NO
BF/01 (BF.3.5)	2-08 ott/14 ott 2008	\$/ton	ton	ton	ton	ton	NO
	3-15 ott/30 ott 2008	\$/ton	ton	ton	ton	ton	NO
	1-01 ott/07 ott 2008	110.0 \$/ton	ton	ton	ton	ton	NO
MZ/01 (F0.1.3)	2-08 ott/14 ott 2008	\$/ton	2000.0 ton	ton	ton	ton	NO
	3-15 ott/30 ott 2008	\$/ton	10000.0 ton	ton	ton	ton	NO
	1-01 ott/07 ott 2008	180.0 \$/ton	ton	ton	ton	ton	NO
BZ/01 (F0.0.35 %)	2-08 ott/14 ott 2008	180.0 \$/ton	ton	ton	4000.0 ton	ton	NO
	3-15 ott/30 ott 2008	180.0 \$/ton	ton	ton	ton	ton	NO
	1-01 ott/07 ott 2008	185.0 \$/ton	ton	ton	ton	ton	NO
LZ/01 (F0.0.30 %)	2-08 ott/14 ott 2008	185.0 \$/ton	ton	ton	ton	ton	NO
	3-15 ott/30 ott 2008	185.0 \$/ton	3000.0 ton	ton	ton	ton	NO
	1-01 ott/07 ott 2008	190.0 \$/ton	ton	ton	ton	5000.0 ton	YES
SZ/01 (F0.0.23 %)	2-08 ott/14 ott 2008	190.0 \$/ton	ton	ton	ton	5000.0 ton	YES
	3-15 ott/30 ott 2008	190.0 \$/ton	ton	ton	ton	5000.0 ton	YES
	1-01 ott/07 ott 2008	50.0 \$/ton	ton	ton	ton	ton	NO
Z0/01 (Sulphur)	2-08 ott/14 ott 2008	\$/ton	ton	ton	ton	ton	NO
	3-15 ott/30 ott 2008	\$/ton	ton	ton	ton	ton	NO

## Prometheus Decision Support System

Prometheus DSS is a user-friendly suite of applications for refinery planning and scheduling activities covering the entire supply chain from crude oil logistics to finished products distribution.

DSS seamlessly integrates operational research tools (linear, non-linear, and mixed integer optimisation), shortcut plant simulators, and reliable blending methods into the planning and scheduling process.

Even though each tool is designed to deploy a specific task of refinery operation, DSS applications are fully integrated and consistent with each other. This results from the common adoption of the same technical framework consisting of:

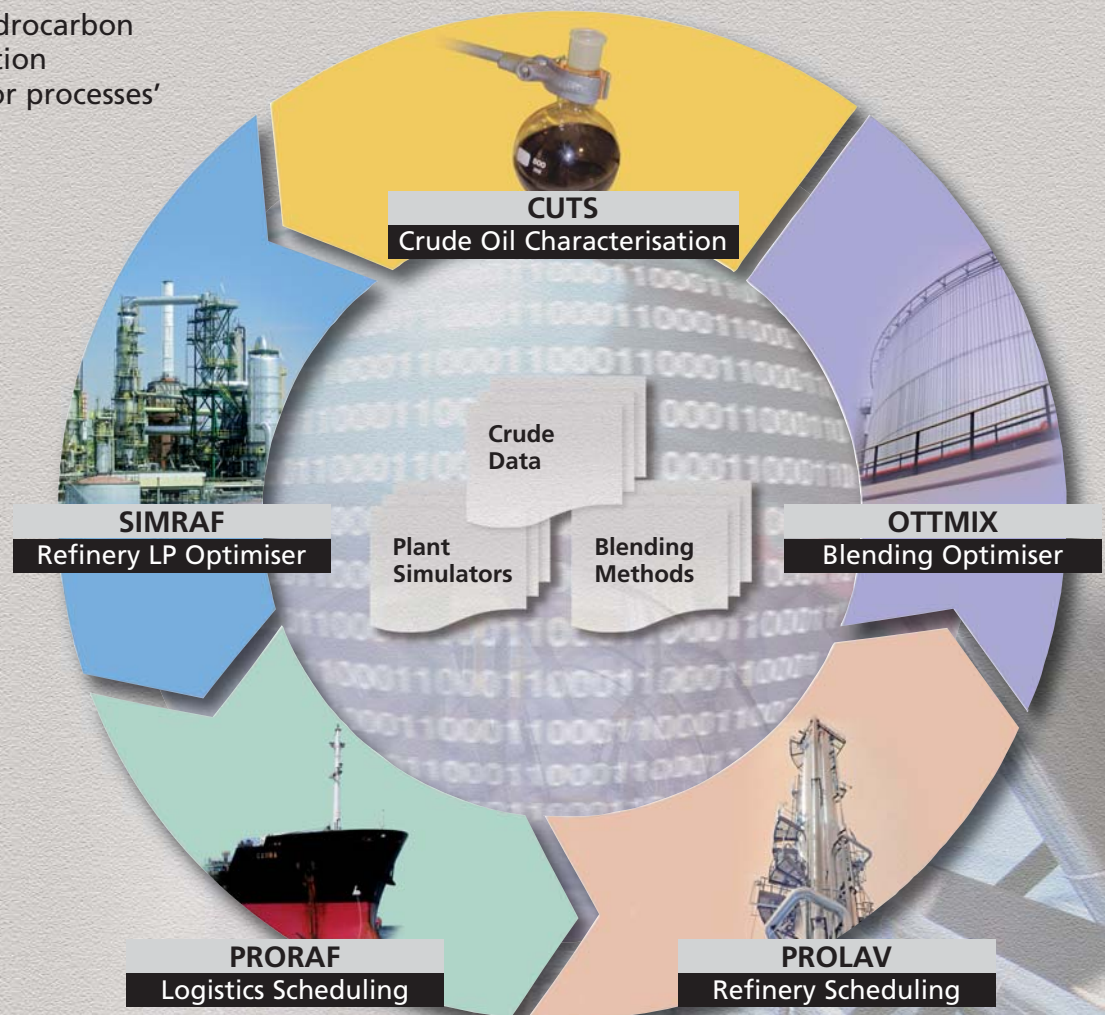
- Crude oil database for raw material characterisation
- Blending methods for hydrocarbon mixtures property prediction
- Plant simulators library for processes' performance calculation.

## Plant Simulators Library

Developed by internal research and validated through field data, shortcut plant simulators give users the flexibility of fine-tuning the refinery models using few parameters to reproduce the actual performance of their refinery units.

The following refining processes are currently available in plant simulators library:

- CDU and other Distillation processes
- Desulphurisation and Hydrotreatment
- Naphtha Reforming
- Fluid Catalytic Cracking
- Hydrocracking
- Visbreaking
- Thermal Cracking
- Delayed Coking
- Lube Solvent Extraction
- Catalytic Dewaxing



# CUTS



## Introduction

CUTS is the Prometheus software for building and managing crude oil databases.

Irrespective of the original source, form, and consistency of the input assay, once each crude oil is entered into CUTS, they are converted into a library of congruent data and can be queried for all the properties of any fraction.

Unlike other applications, which work only with crude assay data, CUTS characterises every crude oil as a mix of pure components (C5 minus) and "pseudo-components" (C6 plus), which cover the entire crude boiling range. Each pseudo component envelops pure components boiling in a narrow range of 10°C.

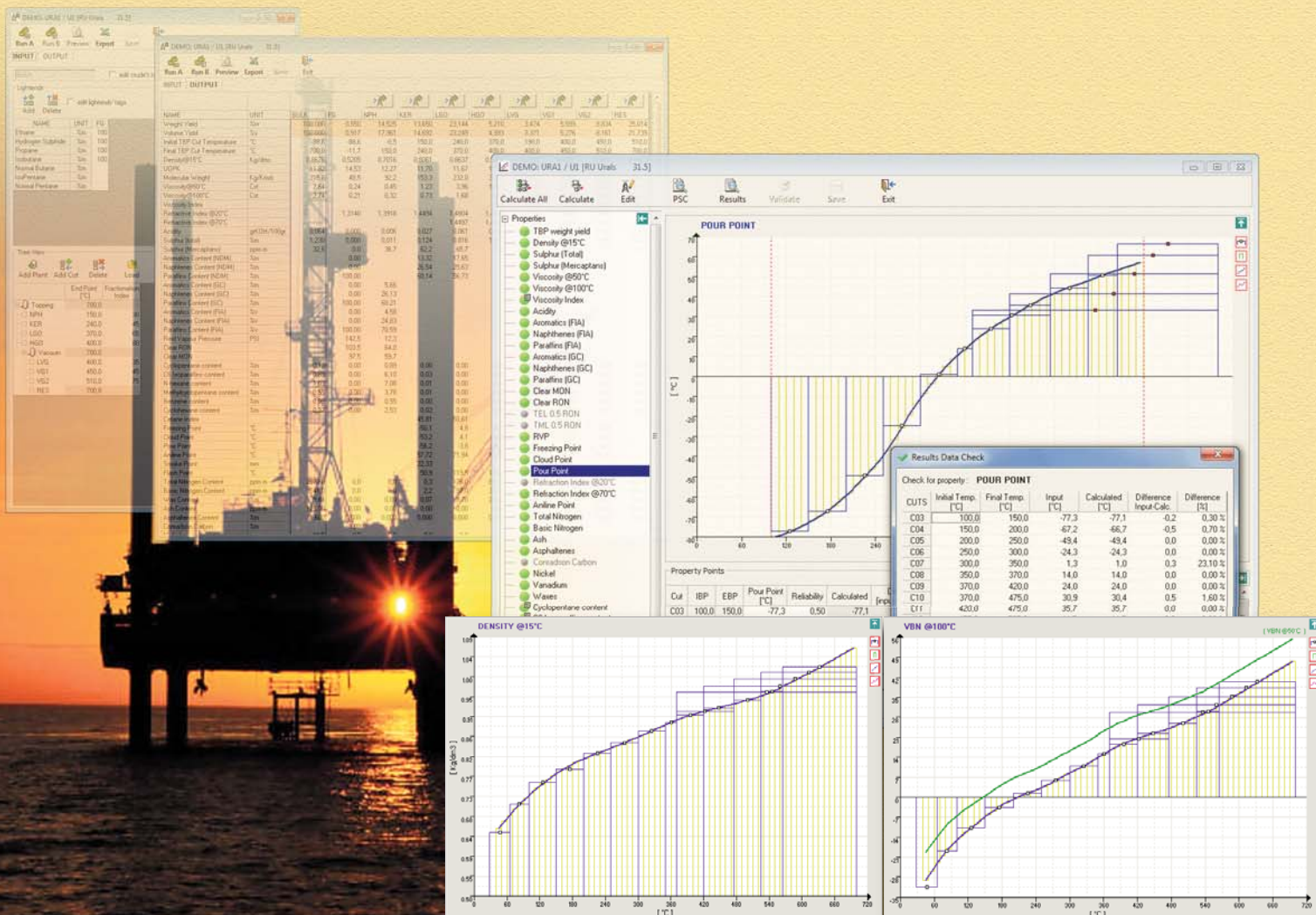
CUTS accurately predicts the values of properties, such as, Viscosity, Cold Properties, and Octane, that are not easy to correlate with main thermodynamic variables.

## Assay Data Elaboration

Creating a distribution curve by multidimensional regression on assay data, CUTS calculates the values of appropriate quality characteristics for each component.

The software distributes properties of the original assay, finding the best fit between the natural curve shape and the input data. The algorithm is designed to calculate consistent values for contiguous pseudo components, while special operating parameters are available to harmonise the shape of the resulting curve, if necessary.

CUTS also provides proper user calibration and checks the reliability of the input data: If the original assay is consistent, fraction and global balances will be always satisfied, otherwise inconsistent input data will be highlighted. The curves are always validated by comparison with original input values.



## Field Data Elaboration

Besides the conventional crude assay data (yields from crude oil's TBP distillation and quality of TBP fractions), CUTS can handle data from production characterising feedstocks from the yields and the quality of units' effluents.

Distillation data (D86, D1160, D2887), yields, and qualities of the effluents are elaborated to build the TBP distillation of the feedstock and to characterise the related pseudo-components.

## Estimation of unknown oils

CUTS implements an innovative data mining algorithm to estimate the quality of unknown crude oils starting from available data; the system exploits the hidden relations intrinsically contained in a characterisation database.

Available information (for example distillation test, density, sulphur) is fed to the algorithm as well as to the reference database to be considered. The elaboration identifies the set of consistent data that most likely represents the unknown crude oil.

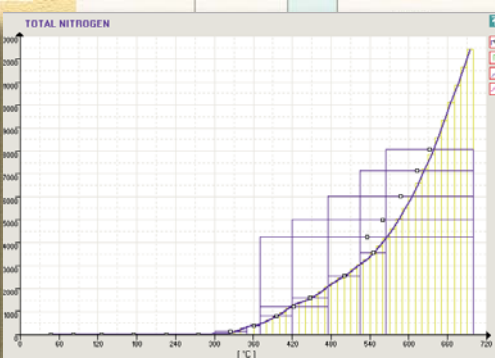
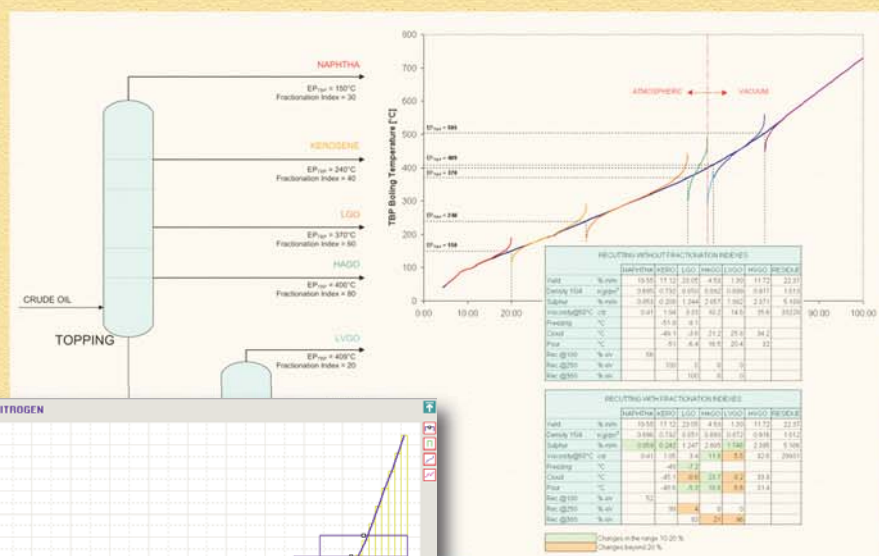
## Tasks

The reliability of property distribution curves is extremely important when using crude oil data in simulation models because it reduces error amplification. CUTS curves can be reliably used in process plant simulations. Prometheus scheduling and planning applications use them to predict yields and quality produced by both distillation and conversion plants.

The narrow cuts characterisation permits reliable re-cutting of crude assay to any requested format. Since the CUTS database relies on pseudo-components, the program blends their properties with appropriate methods to obtain the quality of any fraction.

CUTS is also able to elaborate a new crude blend, mixing any number of crude oils from the database. After completing the calculations, the resulting mixture can be saved and treated just like any other crude oil.

Distributed oil data encourages the use of shortcut methods for process plant performance calculation. The CUTS crude oil database format allows the embedding of shortcut plant simulators into the Planning and Scheduling models to improve flexibility and reliability.



# SIMRAF



## Introduction

SIMRAF is a technical and economic simulator for the linear programming optimisation of the oil refining industry.

Medium and long-term planning, evaluation of new raw materials and products, feasibility studies, and investments are some of the challenges that managers of a modern refinery have to face every day.

The availability of a reliable computer model is crucial to calculate the economic impact of thousands of technical and marketing variables affecting refinery results.

SIMRAF has been designed to be used readily by managers who do not have time to study complicated operating manuals. Prometheus believes that a planning tool is really useful when it can be directly operated by people who are responsible for making decisions, and who have the hands-on experience to validate the computer results.

The program gives oil companies a clear competitive advantage: the coupling of LP and plant simulation technologies allows fast and accurate analyses of refineries profitability considering alternative marketing scenarios and operating conditions.

## Tasks

SIMRAF helps to develop the best refinery plan, forecasting the impact of alternative business decisions in dynamic markets and various environmental and regulatory scenarios.

Program features apply to:

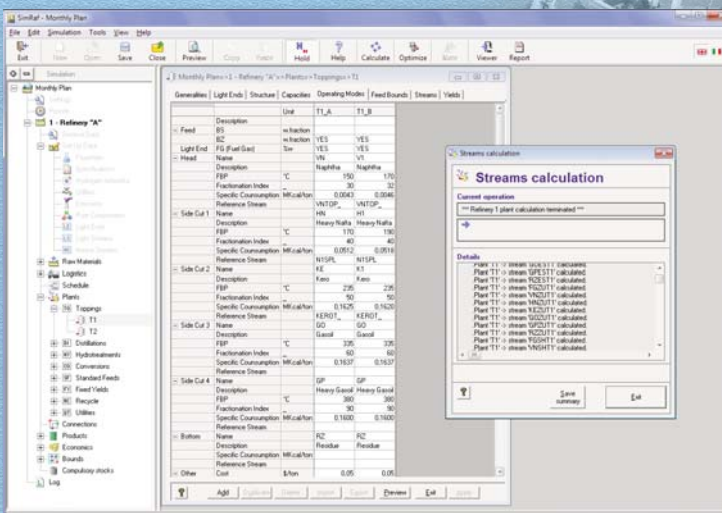
- Long and medium term planning
- Optimised short term scheduling
- Feedstock selection
- New products evaluation
- Detection of best process conditions
- Production de-bottlenecking
- Investment feasibility studies.

## Input

Model data are set through a user friendly interface conceived for refinery managers and designed to be easily customised.

The software simulates complex downstream systems, setting operative and marketing constraints such as:

- Raw material supply
- Products specifications and demand
- Plant capacity and performance
- Processing scheme and operating modes
- Crude supply and products shipping schedule
- Inventories and logistics
- Production and distribution losses
- Environmental constraints
- Economics



## Shortcut Simulators

SIMRAF provides "shortcut plant simulators" embedded into the application environment to support the calculation of main refining processes.

Shortcut models, tuned with actual plant data, predict yields and qualities of output streams with good accuracy. Their availability in an LP modelling environment:

- Simplifies model building
- Eases the integration of processes into the refinery scheme
- Facilitates the evaluation of alternative operating modes
- Expedites the development of feasibility studies on plant investments and revamps
- Minimises data entry mistakes and inconsistencies thanks to the reduced number of input parameters
- Generates a database with yields and qualities for any process unit when fed with each feedstock, useful for matrix generation; these results can be accessed and modified before running a matrix generation process
- Weight, volume, and quality balances are automatically closed around any unit.

## Linear Programming

Operating the program does not require a deep understanding of linear programming techniques. Nevertheless, expert users can consult and evaluate matrix and solution files which are always available.

- The generation process is designed to produce "dense" matrices (high number of non-zero values) and make them easier to handle for the solver
- Linear indices are applied to model quality specification constraints depending on property blending behaviour
- Advanced inspection tools are available to identify the constraints causing infeasibilities
- Recursive methods and mixed-integer technology are integrated to handle nonlinearities
- The innovative pooling algorithm does not need initial estimates.

## Advanced Features

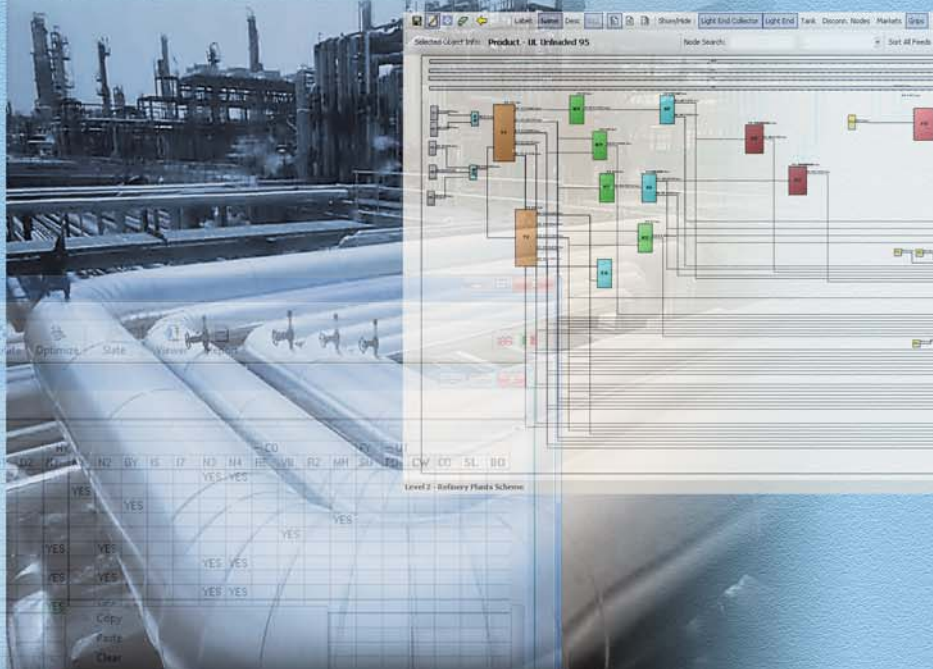
- Multi-period options extend the simulation over time permitting accurate planning of mid term refinery operations
- Multi-refinery options permit the optimisation of a group of refineries sharing raw materials and products markets
- Scheduling options turn the multi-period model into a multi-stage advanced optimisation accounting for logistic constraints and crude supply / product shipping schedule. The system optimises the blending of the intermediates resulting from the processing in sequence of each tank's crude mixes.

## Solution Analysis and Reports

SIMRAF provides solution analysis and complete reporting tools. Solution results, can be produced in Microsoft™ Excel format

- Economics (production balances, operative costs, swaps)
- Process (processing options, utility networks, internal consumption, material balance, handling, emissions)
- Solution inspection (hidden constraints, range analyses, shadow values)
- Production (finished products quality and composition)

Detailed reports are available for each period and for each refinery managed in the simulation.



# PROLAV



## Introduction

PROLAV is the solution for short term scheduling of refinery processing and production.

The challenge for the refinery's short term scheduling manager is to find the best operating program considering current supply, logistical, and processing constraints. PROLAV offers a "comprehensive and sophisticated model" which simulates the processing of a sequence of crude oil tanks feeding refinery plants. A user-friendly interface simplifies the detailed scheduling of refinery operations.

PROLAV can be used stand-alone or in combination with PRORAF, the crude logistics scheduler, to evaluate the composition of refinery crude oil tanks.

PROLAV also can be used to finalise the results obtained from the SIMRAF optimised scheduling model.

## Customisation

To reproduce the real operations effectively, the application can be calibrated to specific refinery schemes to provide the necessary operating flexibility.

The program is developed within the Microsoft™ Excel environment and it can be integrated into any system or customer proprietary software solution. Results are easily exported and can be easily reused in any further analysis.

## Tasks

PROLAV models the entire refinery scheme including crude oil supply, plant processing, intermediate streams tanks, and finished product blending. PROLAV can be applied to:

- Finalise plant operating modes (capacity, severity, feed composition) that best fit production targets and constraints
- Calculate plants and production material balances
- Predict the impact of alternative operating decisions on the evolution of intermediate product tanks' status
- Produce the necessary technical reports and documentation including plant operating conditions and expected production
- Control utility consumption and losses
- Control intermediate and finished products inventories
- Simulate the processing of a sequence of tanks to control the evolution of operative variables
- Inspect the differences between simulated targets and actual results.



Technology

PROLAV uses Prometheus plant simulation technology based on shortcut models to replicate the refinery distillation and conversion unit performance. Plant simulators predict yields and quality of output streams and are resolved in sequence following the refinery processing scheme.

Internal recycling, plant refills from auxiliary tanks, as well as any other process peculiarities also can be accounted for and implemented. Plant simulators use crude oil data produced by Prometheus CUTS software. The model can be linked to the refinery information system to retrieve inventory status at the beginning of the simulation.

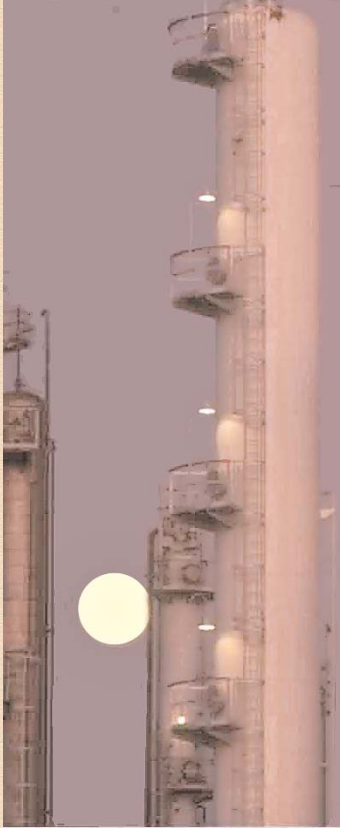
Interface

The interface is engineered to permit the control of the simulation from a single worksheet. Plant output streams and intermediate tanks status are instantly updated.

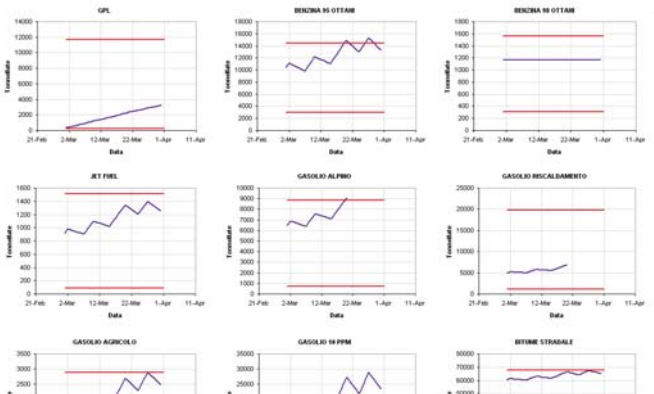
In modelling the process, utilities consumption and generation are calculated, accounting for material balances for service networks such as hydrogen and fuel gas.

The solution includes state of the art blending methods for every property. Users can modify the recipe for each product with one eye to quality give away and another to the availability of intermediate streams in refinery tanks.

For each processing run, detailed plant, utilities, and blending balances are automatically reported.



109 del 3/20/2012		Material Balance														
Product	Topology	Substrating	Process	HEC H2O	Internal Cooling	H2S1	H2S2	H2S3	H2S4	H2S5	Hydrogen	Pressure	Distillation	Isopent. Hydrogen	Isopent. Propan	TOTAL
Crudo de Base	8117.4	3056.0	1294.1	950.0	1100.0	1864.2	700.0	1153.7	206.0	265.0						11114
Base H2O	41.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	31.3						152.9
Crudo Tot	8117.4	3056.0	1294.1	950.0	1100.0	1864.2	700.0	1153.7	306.4	296.3						11266.9
HEC H2O	8.0	5.2		8.0					1.4							22.6
H2	0.1	14.4		-14.7					-14.8	14.0						6.0
Cl	15.0	11.0		-11.7					-11.7	-0.0						110.0
Cl2	25.7	9.7		-10.7					-10.7	-0.0						200.0
H2S	777.4	66.1		-66.8					-66.8	0.0						982.0
Water (00-100)	1241.8			-1241.8												1241.8
Water Striping	396.0			-396.0												396.0
Water Striping	2650.8			-2650.8												2650.8
Water Striping	136.4			-136.4												136.4
Gasoline Hydroblending	2052.0			-2052.0												2052.0
Gasoline Hydroblending	2052.0			-2052.0												2052.0
Isopent. Hydrogen	476.9			-476.9												476.9
Isopent. Propan	206.3			-206.3												206.3
HEC H2O	8.0			-8.0												8.0
Water (00-100)	1413.1			-1413.1												1413.1
Water Thermal	86.8			-86.8												86.8
Gasoline Thermal	179.1			-179.1												179.1
HEC H2O + Baseoil Thermal	0.0			-0.0												0.0
Isopent. Hydrogen	485.1			-485.1												485.1
Gasoline Hydroblending	541.1			-541.1												541.1
HEC H2O + Baseoil Thermal	395.7			-395.7												395.7
Isopent. Propan	43.9			-43.9												43.9
Water (00-100)	301.0			-301.0												301.0
Water Striping	81.4			-81.4												81.4
Water Striping	950.8			-950.8												950.8
Water Striping	164.0			-164.0												164.0
HEC H2O + Baseoil Thermal	58.7			-58.7												58.7
Water (00-100)	81.1			-81.1												81.1
Water Striping	14.5			-14.5												14.5
Cl	25.7			-25.7												25.7
Cl2	25.7			-25.7												25.7
Crudo Tot	78.7	43.5	10.0	21.0	16.1	6.8	7.8	0.0	5.0	0.4						413.3



# PRORAF



## Introduction

PRORAF is an event driven scheduling program developed to manage crude oil supply logistics.

The simulation of supply events improves the management of refinery assets preventing unsustainable crude oil mixtures.

The composition of refinery crude oil tanks depends on tank history and on the supply sequence to the logistic structure.

PRORAF is able to represent the logistic scheme to highlight the constraints that may arise from the supply and processing schedule.

Within the simulation environment, PRORAF uses specific objects to represent tanks, tank farms, and pipelines accounting for tanks geometric and operative information as pumping rates, time for water drainage, homogenising, and fiscal control.



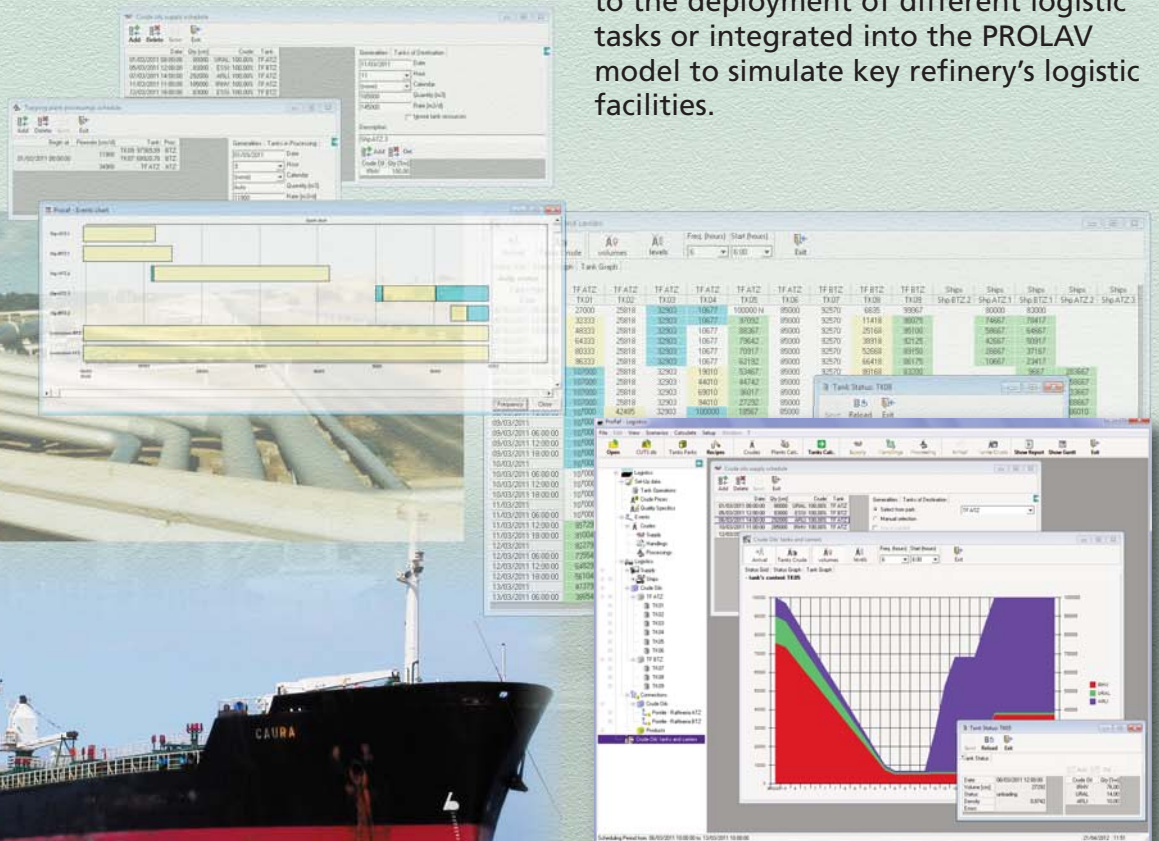
## Technology

Considering the scheduled events (supply, handling, and processing) and the logistic constraints (volume, pumping rates, connections, assets availability) the simulator calculates the hourly evolution of each tank status, returning volume and composition for each tank to be processed.

Each event scheduled for the period generates a list of service requests for the objects (tanks, pipelines) represented in the logistic structure. The PRORAF calculation engine manages the service requests (accounting for priorities and given inputs) to terminate each event as soon as possible.

The simulation checks the feasibility of the supply program highlighting the logistics bottlenecks and constraints that need to be managed to prevent operational problems.

Even though this technology has been used mainly for the simulation of Crude Oil supply logistics, it could be applied to the deployment of different logistic tasks or integrated into the PROLAV model to simulate key refinery's logistic facilities.





## Introduction

OTTMIX is the linear programming optimiser dedicated to refinery blending operations.

The software calculates the best way to produce finished products from intermediate refinery stocks, accounting for:

- Market prices
- Intermediates stock quality and quantity
- Product specifications
- Production targets.

OTTMIX enables refinery blending managers to reduce quality "give away" using the most convenient available components.

The reliability of OTTMIX's results, confirmed by laboratory tests, provides managers with confidence in the solutions suggested reducing the costs related to safety margins.

## Blending Calculation

OTTMIX uses consolidated methods and linear indices to calculate blends. The software is flexible and customisable to specific user needs and market requirements:

- Both typical and user-defined properties are supported
- Use of additives is simulated; susceptibility curves may be set for each product
- Composition constraints on blending recipe can be specified
- The elaboration accounts for the contribution of residual stocks in destination tanks
- Multi-period simulation permits the scheduling of operations on a weekly or monthly basis.

## Optimisation and Report

Running the OTTMIX optimisation routine solves the blending problem and elaborates the solution while delivering intuitive reports that can be easily exported to Microsoft™ Excel.

The report shows optimal product recipes, clearly highlights the constraints limiting profits, and displays related marginal values (economic incentives to relax the constraint.)

DESCRIPTION	Period 1 from 10/03/2008			Period 2 from 11/03/2008			Period 3 from 12/03/2008			Period 4 from 13/03/2008			Period 5 from 14/03/2008		
	IN/OUT	BLENDING	STOCK	IN/OUT	BLENDING	STOCK	IN/OUT	BLENDING	STOCK	IN/OUT	BLENDING	STOCK	IN/OUT	BLENDING	STOCK
Balance	138.1	106.1	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9
DRH Blw	23.5	0.3	185.2	23.5	344.3	244.4	23.5	367.9	24.9	-147.1	126.6	24.8			
H-Naphtha	67.2	2405.2	67.2	2405.2	292.4	67.2	2405.2	292.4	67.2	2405.2	193.0	67.2	2405.2	193.0	193.0
HTB	47.9	1228.1	47.9	510.3	717.9		717.9		381.4	284.4					
Iron	208.4	705	287.9	208.4	698.0	264.3	208.4	3749.7	372.3	372.6	384.4	372.3			
L-Naphtha	179.2	179.2	179.2	179.2	954.4	179.2	179.2	626.6			526.6				
DRH-C5	686.1	626.1	686.1	2208.9	3748.3	686.1	686.1	4437.8	764.7	2453.6	2742.5	764.7			
H-Naphtha	109.2	109.2	109.2	219.4	109.2		109.2	205.6	142.0		637.6	142.0			
TK 002 - H-Naphtha	1269.0	600.0		600.0			600.0				600.0				
TK 007 - H-Naphtha	460.0	234.0		234.0			234.0				234.0				
TK 002 - L-Naphtha	424.0	212.0		212.0			212.0				212.0				
TK 006 - Unsealhd	2024.0	1024.0	384.0	384.0	954.4		954.4				954.4				
TK 004 - Unsealhd	1621.1	820.9		820.9			820.9	3854.9	3804.4	767.9					
TK 005 - Unsealhd	3075.2	1544.4		1544.4			1544.4				1544.4				
TK 006 - Unsealhd	3134.6	1567.9		1567.9			1567.9				1567.9				
TK 001 - Unsealhd	1344.6	705.9		705.9			705.9				705.9				
Weight total	1391.7	13344.6	21019.1	2489.5	0.0	16446.0	1209.0	16702.0	2448.5	0.0	17447.6	1410.8			

**TK TK1 - G1 Batch1**

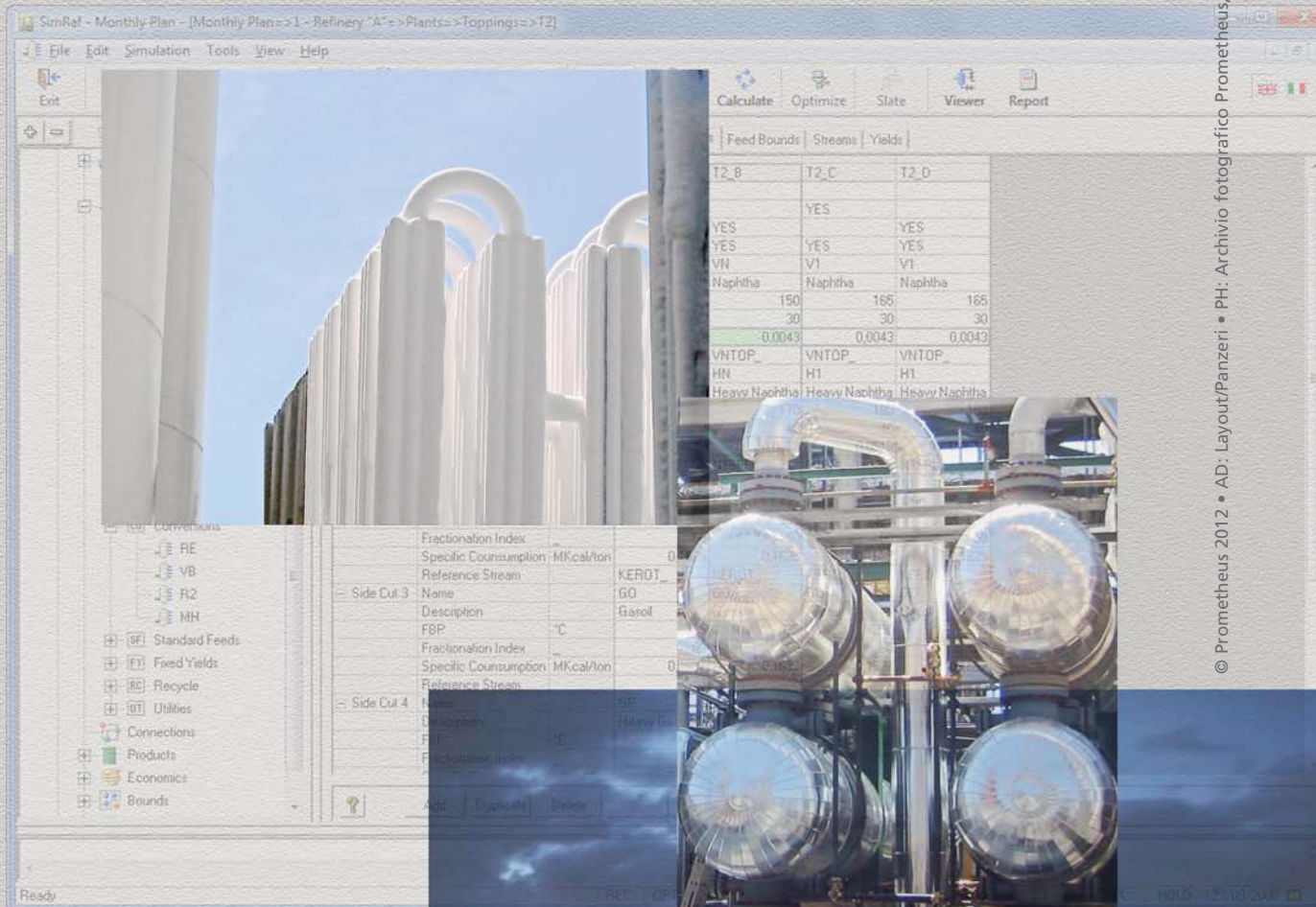
Qualities period '1' | Composition period '1'

INTERMEDIATE COMPONENT FROM CRUDES & PLANTS	VALUE E/ton	TK TK1 - Batch1 ton	E/ton
Toluene	541.4	319.9	
ULSPSG	408.2	6215.1	
Cyclohexane	750.6	568.9	
LI Aromatics	443.7	302.5	
White Spirit	348.1	102.1	
Total		7507.9	

**TK TK2 - G2 Batch2**

Qualities period '1' | Composition period '1'

PRODUCTS	TANK UNIT	TK2 Batch2	TK2 Batch2	TK2 Batch2
SPECIFICATIONS	UNIT	DELTA	QUALITY	DELTA
Density	kg/dm3	0.0100	0.7476	
Aromatic: FIA	%v	1.00	31.36	
Olefin:	%v	0.10	3.07	
Motor Octane		1.0	85.8	
Research Octane		0.1	95.2	
Pressure	Bar	0.010	0.616	3.8
		0.1	4.7	0.2
		1.0	28.4	
		1.0	40.0	1.6
		1.0	82.0	2.2



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