Oil Refinery Offsites
Automation opportunities to improve profitability

Challenges facing refineries
Efficient operation and management

Today, the gasoline and diesel blending business on a typical refinery has a turnover in billions of US dollars per year. Tight oil refining margins together with tighter product quality specifications, are causing refiners increased difficulty in producing on-specification gasoline, diesel and fuel oil at minimum cost.

Refiners are under pressure to increase refining margin by reducing inventory and reducing product quality giveaway whilst producing more grades to tighter product and environmental specifications. This results in reduced feasible blending space (see page 4).

While many refineries run their process units approaching the optimum, they then give away a significant part of the profit in the product blending.

The operation and management of the offsites is of critical importance to the economics and profitability of a refinery.

Economic benefits result from improved planning and scheduling, coupled with tighter control and increased operations confidence and flexibility.

Significant improvements to the operation and management of the offsites can be achieved through refinery offsites automation, often with a payback of less than one year.

Improvements include tighter control of product quality and decreasing storage inventory through selling the excess product, thereby decreasing capital and interest required to fund excess inventory. The number of storage tanks can be reduced, thereby lowering maintenance costs and avoiding the building of new tanks.

Typical offsite operations
Offsites operations involve the following tasks and oil movements:
– Crude receipt and storage.
– Process unit feeds, including crude blending.
– Process unit rundowns.
– Intermediate product storage.
– Component storage.
– Gasoline, diesel, fuel oil and bunker fuel blending.
– Storage of final products.
– Tank-to-tank transfers.
– Dispatch and loading of final products to ships, pipeline, road trucks and rail wagons.

In addition, other regular tasks include managing the inventory of each tank, drain water, mix, circulate and settle tanks, operating the pumps and valves, managing the custody transfer and bills of lading, collecting samples, approving lab results, etc.

Onsite processing

Offsite processing
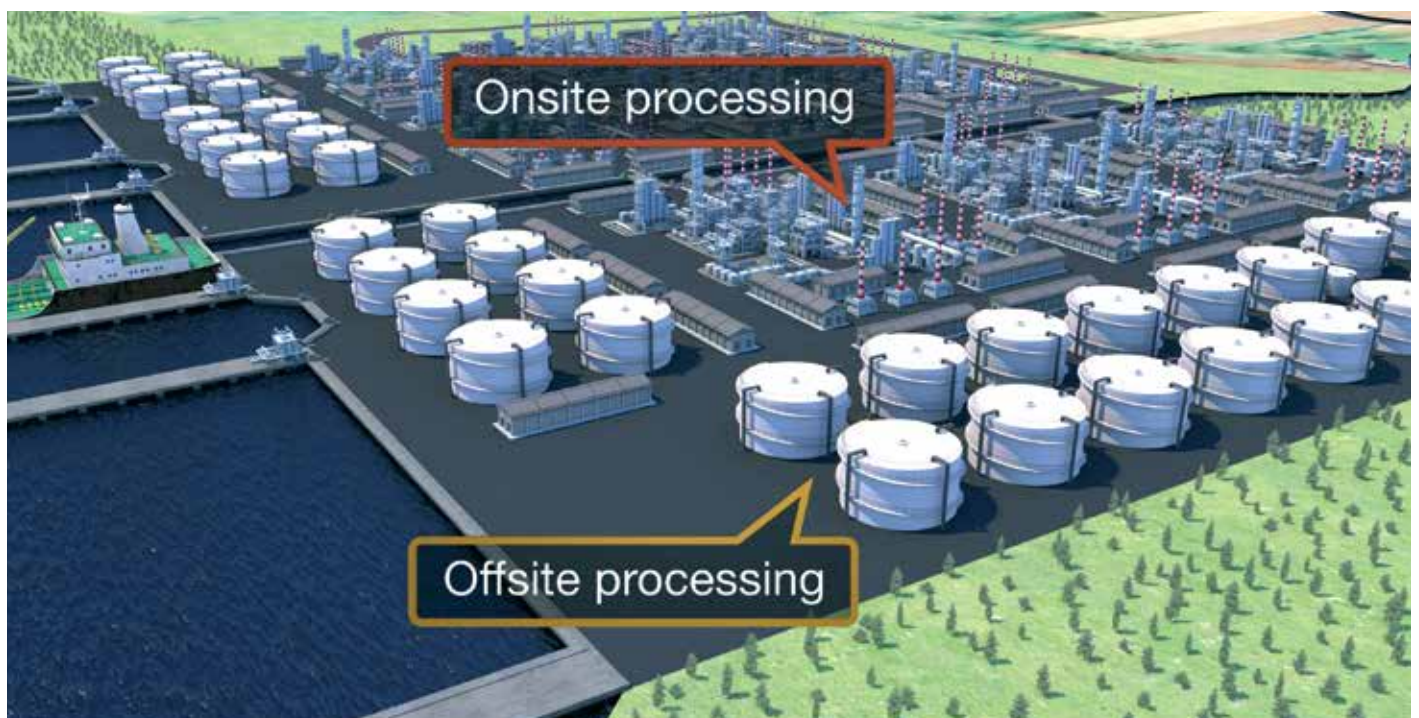
Benefits of offsites automation

Typical business benefits

– Optimized blend recipes and reduced product quality
  giveaway thus reducing total blend cost.
– Reduced margin between legal sales and control target
  product specifications thus reducing total blend cost.
– Import of lower quality components and export of higher
  quality components leading to increased production and
  reducing total blend cost.
– Reduced blend corrections and reblends thereby avoiding
  use of expensive components.
– Just-in-time blending resulting in reduced demurrage costs
  and risk of stock-out and improved ability to respond
  to short term product sale opportunities and schedule
  disruptions.
– Blending direct to jetty and ship, reducing cost of inventory.
– Scheduling automation of oil movements, reporting and
  monitoring of actual quantities.
– Improved automation sequences thereby increasing
  operator efficiency and reducing contamination of products.
– Improved oil loss accounting, using better quality real-time
  data for material balances.

Achieving significant improvement in refinery profitability

The problem

Consider a simplified blender, with just three components – reformate, cat cracked gasoline and isomerate – which are rundown from the process units into running component tanks. How do we blend these components to produce 'just on-specification' gasoline at the optimum minimum cost?

The range of feasible recipes - known as the 'feasible solution space' - lies within the three-dimensional space bounded by the 0 and 100 percent limits for each component (see figure below).

Product quality specifications for each property impose constraints on the recipe. For example:
– The octane number specification constrains the maximum amount of cat cracked gasoline in the blend.
– The RVP specification constrains the maximum amount of the isomerate.
– The aromatics specification constrains the maximum amount of the reformate.

Other product quality and environmental specifications also constrain the recipe, which further reduces the feasible solution space. The refiner must consider the constraints imposed by the availability of each component and then consider the constraints imposed by the blender equipment.

In reality the refiner has to manage 10 to 15 components, typically 12 to 18 product quality specifications and up to another 20 equipment constraints.

The solution

Without online blend recipe optimization there is usually significant product quality giveaway for several of the key product quality specifications compared to the sales targets. The cost to the business of the product quality giveaway is highly dependent on the technology deployed and how well it is used.

The optimum minimum cost recipe will be right up against more than one constraint. How close do your operators dare go, without risking off-specification product? The size of the operators' safety margin is of course dependent on their confidence level.

Blend recipe feasible solution space for three components.
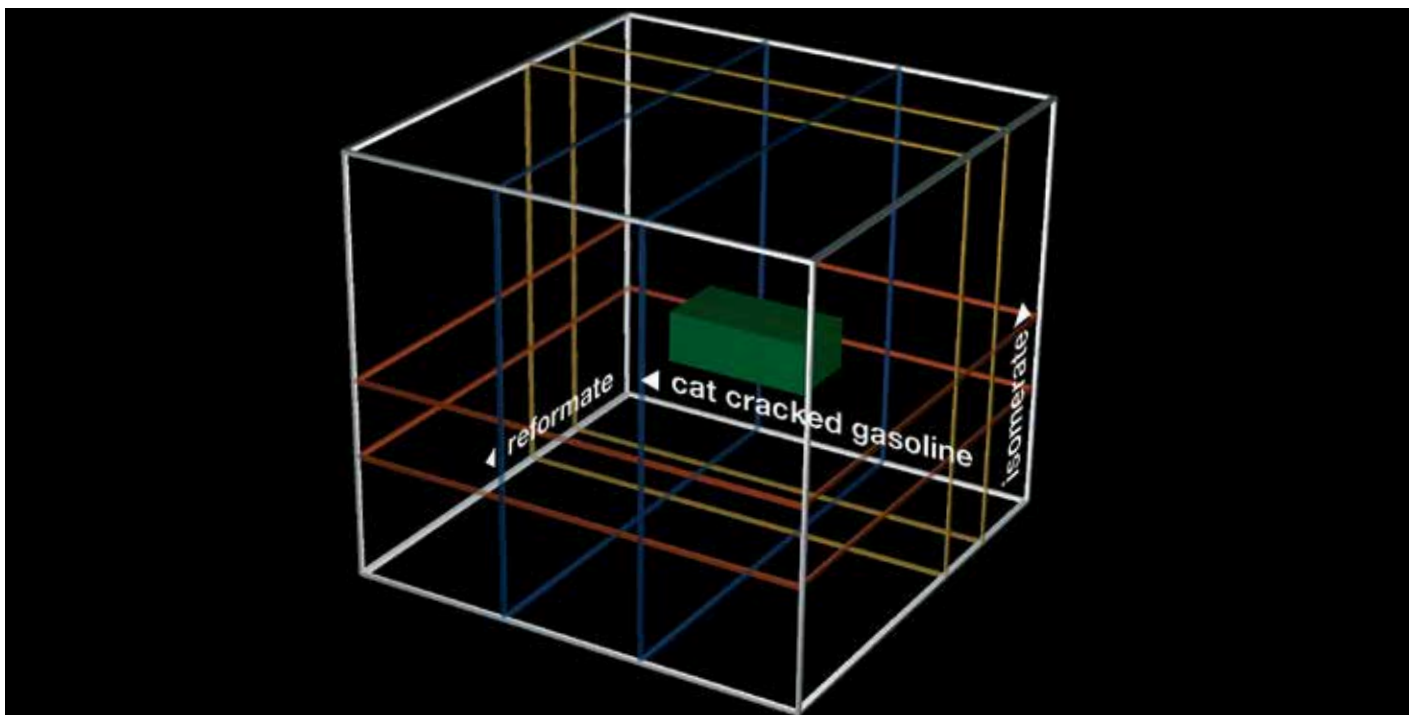
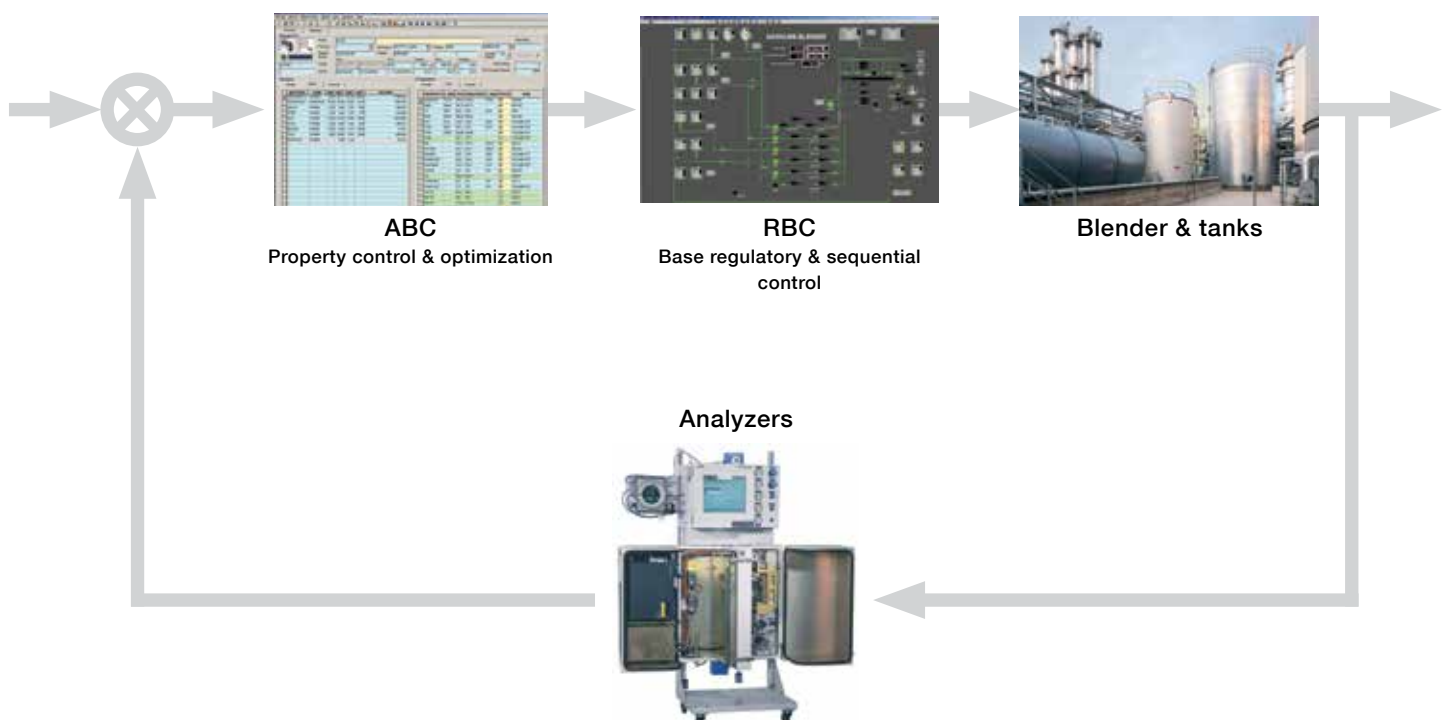# Refinery offsites automation suite

The key to refinery profitability is being able to plan, schedule and optimize the operations based on real-time information with feedback on what is currently happening and what has actually been done, in order to adjust the refinery operations. This is best achieved by all of the key cross-functional personnel using one single integrated system to ensure collaborative and cooperative working.

ABB's refinery offsites automation suite manages both the real-time blending and the oil movements, and is used by blend planners / schedulers, technical services / process engineers and by operators / supervisors in the control room.

Real time tasks are executed in a redundant DCS controller for high availability and safety.

ABB's refinery offsites automation suite comprises:
– The Advanced Blend Control (ABC) and Oil Movements Manager (OMM) Server suite of programmes and database specifically designed for refinery offsites automation. The database holds the configuration data and all relevant data for each blend and oil movement order.
– ABC Displays the graphical user interface client to the ABC / OMM Server.
– OPC Client for data transfer between ABC / OMM Server and the DCS.
– Laboratory Information Management System (LIMS) interface for automatic retrieval of latest laboratory test results.
– Planning and Scheduling Interface for import of blend and oil movement orders.
– Database utilities for archiving / restoring blend and oil movement orders and messages.

ABC
Property control & optimization

RBC
Base regulatory & sequential control

Blender & tanks

Analyzers

Advanced Blend Control (ABC)

ABB's Advanced Blend Control (ABC) is designed for blend planning, blend order definition and management with off-line optimization, off-line pre-blend optimization and on-line real-time optimization.

ABC allows the blend planner / scheduler to import, create, copy, modify and optimize blend orders. Once approved, the operator executes a blend order by downloading from ABC to the Regulatory Blend Control (RBC) in the DCS.

ABC continuously validates the analyzer feedback and monitors the predicted and cumulative product properties in the final product tank.

ABC uses the on-line analyzer feedback, available laboratory data for components and header samples, property blending algorithms, product and component prices, plus the equipment and inventory constraints to calculate the optimum recipe at each interval, for download to the RBC.

Highlights
– Blends gasoline, diesel, fuel oil / bunker fuel, and crude.
– Re-optimizes blend recipe at each analyser output update.
– Allows independent biases for each property and for each bias type.
– Allows optimization of blend target volume and blend flow rate to relax constraints.
– Allows reuse of previous blend order biases in next blend order for each product.
– Automates pre-blend line-up, component tank swings and destination product tank swings.
– Manages the varying component qualities and dynamic constraints.
– Handles:
  – Tank heel quantities and qualities.
  – In-line blenders, rundown blenders and pooled component blenders.
  – Rundown blender wild-flows to single / multiple blenders with / without escape route.
  – Tank and rundown stream component sources, plus tank, ship and pipeline product destinations.
  – Component and destination line-fills in heel correction and tank quality integration.
  – Additives.
  – Component rundown flow rates for component inventory.
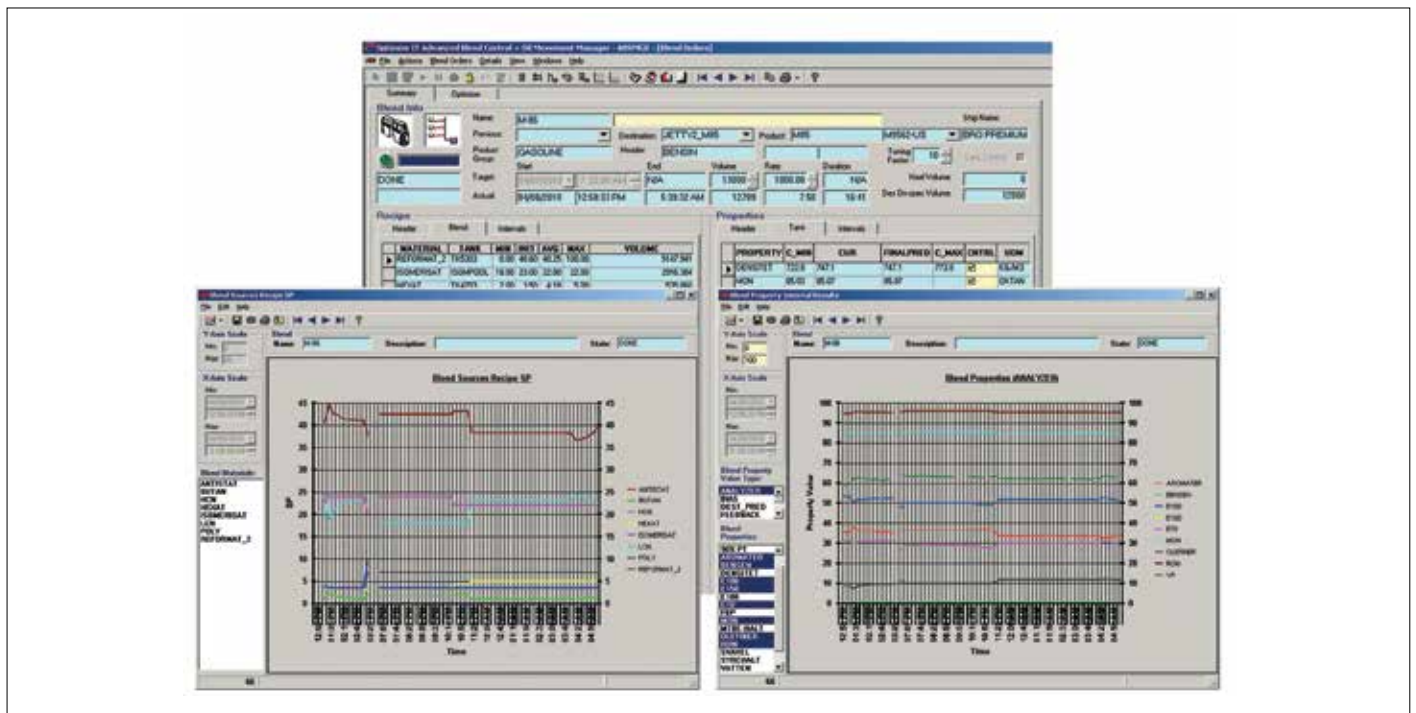
Regulatory Blend Control (RBC)

ABB's Regulatory Blend Control (RBC) is designed to manage the equipment and the sequences necessary to safely and reliably run a blend order to produce a batch of product.

RBC controls the blend operation including the recipe (blend component flow ratios and totals) and the total blend flow rate. RBC monitors the blend source and destination line-ups, and the sequences and equipment, to ensure correct and safe operation.

RBC is a DCS application built from a standard design of controller function blocks / control modules, sequential control programming and operator display templates.

Highlights

– Performs source and destination equipment line-up and sequencing based on selected component and product tanks and line-ups.
– Allows start, pause, re-start of the blend on request by the user.
– Monitors equipment during blend and takes action (alarm, warning, blend pause) if an equipment failure or malfunction is detected.
– Calculates flow controller setpoints which:
  – Maintain flow ratios to match the recipe.
  – Maintain the total flow rate at the recipe target flow rate.
  – Ramp flows up at start and ramp flows down at end of blend.
  – Pause and resume blend.
  – Pace components when required.
– Integrates individual component blended volumes from their flow rate measurements.
– Integrates total blended volume from calculated total
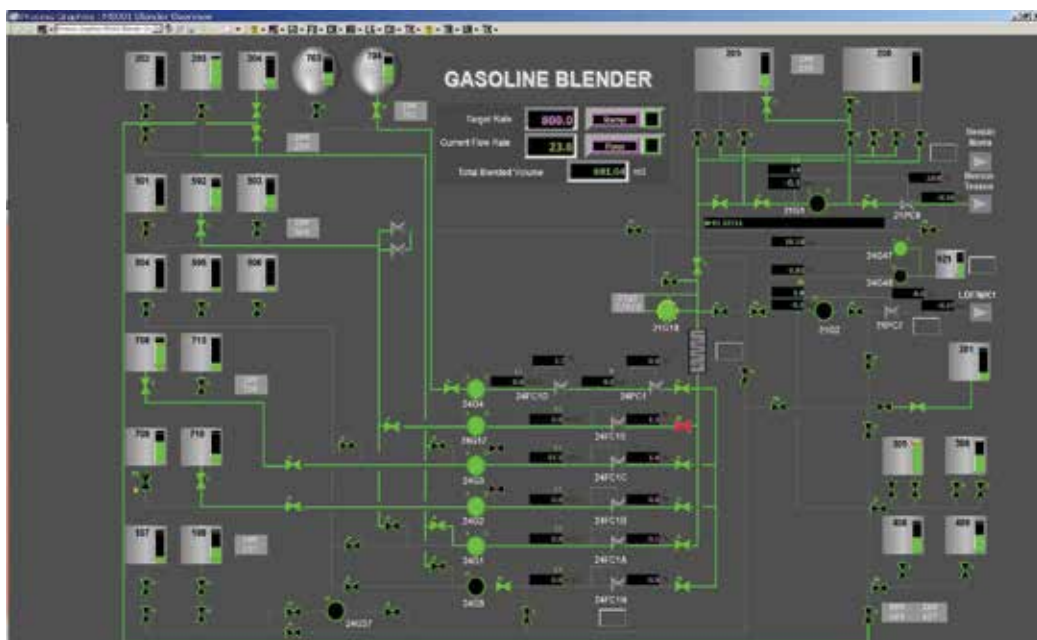
Oil Movement Manager and Executor

Oil Movement Manager (OMM)

ABB's Oil Movement Manager (OMM) is designed for oil movement planning, oil movement order management, oil movement line-up and oil movement order monitoring and reporting. OMM allows the offsites planner / scheduler to import, create, modify and monitor oil movement orders. Once approved, the operator executes an oil movement order by downloading it to the Oil Movement Executor (OME) in the DCS.

OMM monitors the progress of the oil movement, and terminates the movement when complete and starts the next order, based on the swing criteria.

A significant advantage of OMM is that the destination properties are calculated based on the tank heel and source properties, and is updated by laboratory results from the LIMS system interface.

The offsites operators also have to dispatch the product, and these 'oil movements' are dependent on the blend order being completed and the product quality being certified. OMM is therefore integrated in the same system and database as ABC.

Highlights
– Manages batch oil movement orders.
– Manages perpetual oil movement orders.
– Manages source and destination line-ups.
– Monitors and reports oil movements.
– Tracks tank and tank heel quantities and qualities.
– Manages laboratory data for oil movements.

Oil Movement Executor (OME)

ABB's Oil Movement Executor (OME) is designed to manage the equipment and sequences necessary to safely and reliably execute an oil movement order.

OME controls the physical oil movement operation including the source and destination line-ups, sequences and equipment to ensure correct and safe operation.

OME is a DCS application built from a standard design of controller function blocks / control modules, sequential control programming and operator display templates.

Highlights
– Performs source and destination equipment line-up and sequencing.
– Allows start, pause, re-start commands on request by the operator.
– Monitors equipment during oil movement and takes action (alarm, warning, pause) if an equipment failure or malfunction is detected.
– Integrates movement volumes from the change in source and destination tank levels and flow rate measurements.
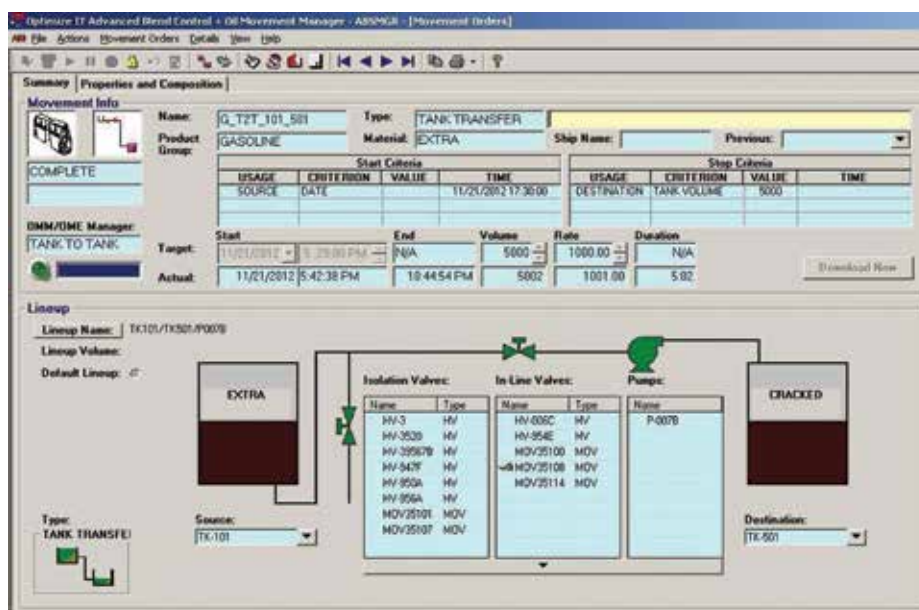
Co-operative and collaborative working

ABC and OMM are used by the operations manager / supervisor and operators, as well as by the blend schedulers, refinery schedulers and planners.

They can create, manage and optimize blend and oil movement orders offline in advance to meet the production and lifting schedule. They can see the results of the previous blend and oil movement orders, as well as the current active orders as they progress, and feed back the results into the refinery schedule.

This is hugely important to the business profitability and greatly facilitates cooperative and collaborative working by all personnel, using the same data and system.
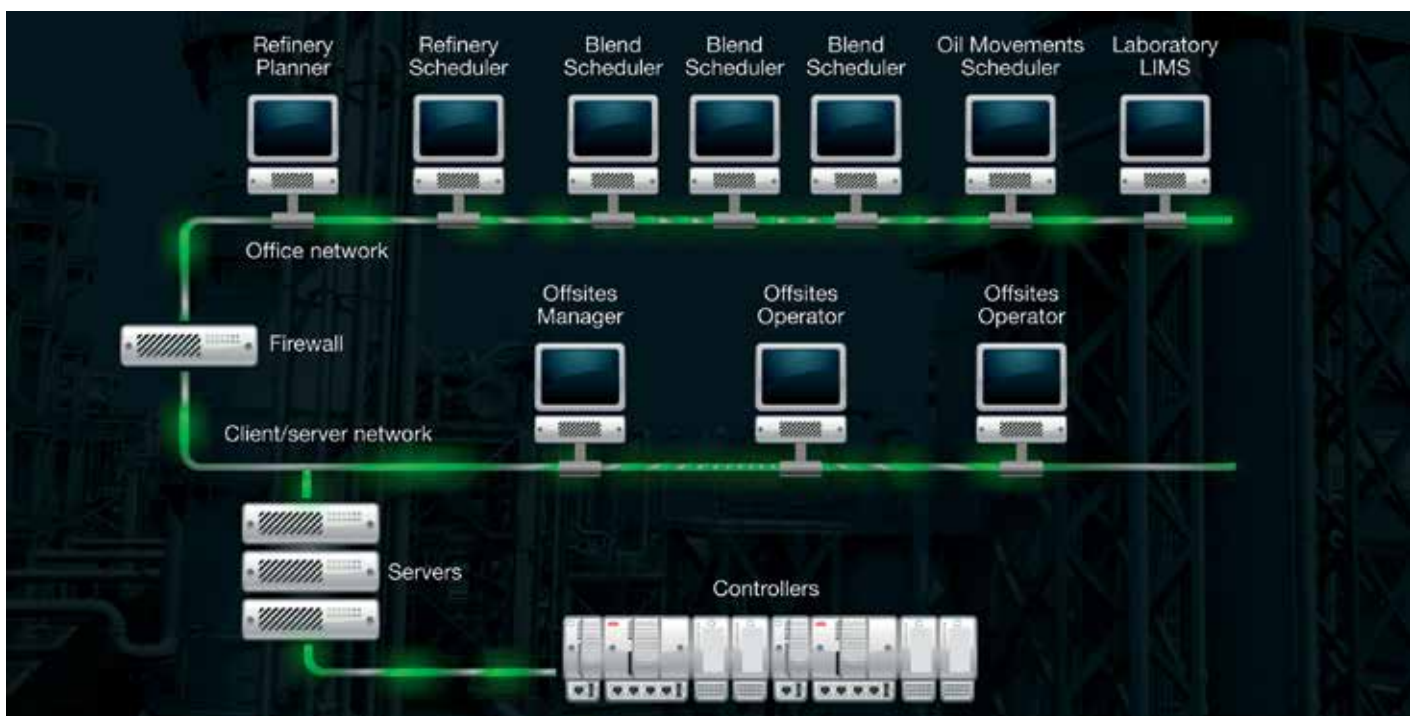
Deploying ABB offsites automation
Should your refinery use the ABB offsites automation suite?

The answer is YES, if the answer to these questions is YES.
– Capacity > 50,000 bpd crude?
– Refinery > very low complexity?
– Components > 2 per product (gasoline, diesel, fuel oil, bunkering)?
– Products > 1 grade per product?
– Buy or sell components > 2 times per year?
– Degrees of freedom > 2?
– Product quality giveaway > ASTM repeatability?
– Reblends and correction blends > 1 per month?
– Inventory total (products + components) > 15 days?
– Insufficient number of tanks?

Business economic benefits are captured by reducing the inventory of components and products, and reducing product quality giveaway; as well as avoiding reblends and correction blends, eliminating demurrage, etc.

You can quickly estimate the cost of product quality giveaway, based on RVP and ON. If you have ON giveaway, can you sell some of the product at premium instead of at regular gasoline price? If you have RVP giveaway, can you add butane and sell more gasoline and less LPG?

You can run your refinery LP Planning tool to calculate the business economic benefits in more detail.

How much of this business economic benefit can you capture? This is highly dependent on the technology deployed and how well it is used. With the right investment and dedication, your refinery can reduce the ON giveaway to 0.03 ON and the RVP giveaway to 0.4 kPa.

Ask ABB to be your partner on this business improvement journey.

Examples of reduced quality giveaway

Reduced quality giveaway cost AKI ON

Gasoline prices
Regular US$ 2.80 Premium US$ 3.19/us gallon

Premium – Regular – US$ 3.19 – US$ 2.80 = US$ 0.39/usg
= US$ 16.38/bbl

Premium – Regular = 93 – 87 = 6 AKI ON

ON giveaway = US$ 16.38/6 = US$ 2.73/ON/bbl

Reduced quality giveaway cost AKI ON

Cost to refinery of 100,000 bpd gasoline
with 0.25 ON giveaway

100,000 x 365 x 2.73 x 0.25

= US$ 24.9 million/year

Reduced quality giveaway cost RVP

Gasoline prices
Regular US$ 2.80/us gallon = US$ 117.6/bbl
LPG sales price US$ 0.84/kg = US$ 82.5/bbl
Regular – LPG = US$ 35.1/bbl

Regular with 0.5 psi RVP giveaway would allow + 0.86%
n-butane to be added to increase RVP from 9.5 to 10 psi

Gasoline 100,000 bpd production increaed to 100,859 bpd
Sell 859 bpd of butane at Regular price

Reduced quality giveaway cost RVP

Cost to refinery of 100,000 bpd gasoline
with 0.5 psi RVP giveaway

859 x 365 x 35.1

= US$ 11 million/year

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