



White Paper

May 12, 2009

## Product Movement Tracking System for Real-Time Terminal Operations

*Application of Varec's FuelsManager software to track petroleum product receipts, identify physical discrepancies, and provide data for daily close-out and reconciliation of physical product stocks at a bulk liquid petroleum terminal.*

# Contents

- Contents..... 2**
- Executive Summary ..... 3**
- Understanding the Source of Physical Discrepancies ..... 4**
  - Moving Product via Pipeline ..... 4
  - Marketing Terminals ..... 4
  - Transmix..... 4
  - Co-Mingled Product ..... 5
  - Controlling and Measuring Pipeline Batches ..... 5
  - An Acceptable Level of Discrepancy ..... 6
  - Final Receipt..... 6
  - Balancing Stocks Daily..... 6
- A Terminal’s Requirement for Tracking Product Receipts ..... 8**
  - Real-Time communication between the system and all connected devices ..... 8
  - Industry standard calculations..... 9
  - Manual hand gauged data ..... 9
  - Track various product movement types ..... 9
  - Automatically capture data based on the status of field devices..... 10
  - Intuitive user interface ..... 10
  - Alarms ..... 11
  - Reporting and trending tools..... 11
  - Interface to corporate level planning systems ..... 12
- Conclusion..... 13**
- Credits..... 14**
  - About Varec ..... 14
  - References ..... 14
- Copyright ..... 15**



## Executive Summary

Within the U.S., approximately 68% of all petroleum products are transported via the nation's pipeline infrastructure, while 27% is transported via ship or barge, and 5% by truck or rail car<sup>1</sup>. Product is transported to refineries, petrochemical plants and marketing terminals, which either process the product or distribute the product to the end user. Whenever a liquid product is moved from one location to another, a change in the measured amount is inevitable; this change is recorded as a physical discrepancy and is more often than not a loss of product. The company that transports the product provides a report on the actual amount transferred. The company that receives the product is often left to account for the physical discrepancy. Given the amount of product moved by pipeline across the U.S., this paper will concentrate on pipeline shipments to marketing terminals, but the same principles apply to shipments and receipts to all petroleum facilities via truck, railcar, ship or barge.

## Understanding the Source of Physical Discrepancies

### Moving Product via Pipeline

Pipeline transportation is by far the safest and most cost effective form of liquid transportation. Pipeline companies charge (or fill) a pipeline with batches of different petroleum products in sequence, which are then moved through the pipeline at a rate typically anywhere between 3 and 18 feet per second. The batch may be transported across state or even international borders. Each pipeline company establishes its own requirements for batch size based on a variety of factors, including pipeline size, flow rate and destination requirements. A typical batch size is between 30,000 and 100,000 barrels.



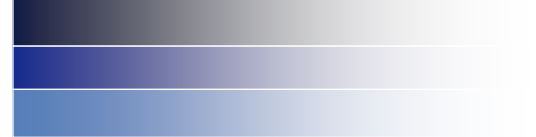
*U.S. oil and gas pipeline structure<sup>2</sup>*

### Marketing Terminals

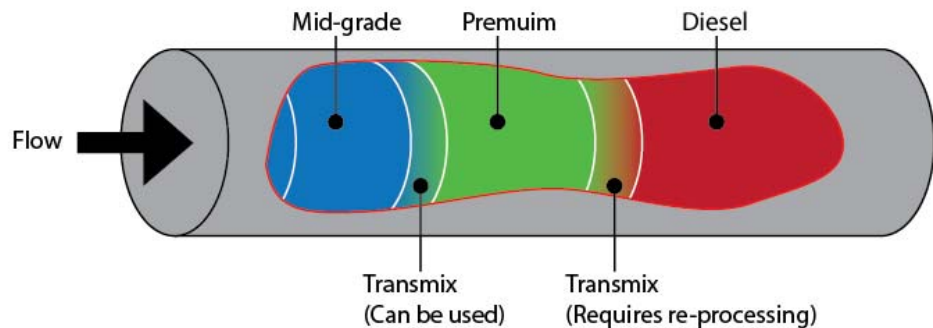
Terminals are usually located along the main pipeline or along smaller distribution pipelines and are often clustered in the same location. Terminals request product from a pipeline company based on their requirements and available storage capacity.

### Transmix

A pipeline is typically always full of product. Whatever product was last sent through the pipe remains there until the next batch is started. There is no physical separation of different product batches and, therefore, some mixing occurs at the interface between batches. As the



batch is received, the interface of the two batches, commonly called the transmix, is typically diverted by the terminal and placed in re-processing tanks. In some cases, the transmix can be mixed with the main product batch and the overall product specification can still be met or the transmix may be sold as lower grade product. Measuring the amount of transmix accurately and diverting the transmix is a common source that adds to the discrepancy.



*Batches of petroleum product transported through a pipeline showing transmix*

### Co-Mingled Product

If multiple terminals have the same specification standards for petroleum products, for example premium grade gasoline, a pipeline company will co-mingle transport in the same batch. This allows the pipeline company to make more efficient use of the pipeline while allowing a terminal to receive smaller amounts of a normal sized batch. The batch will then be scheduled, transported and delivered to the individual terminals by the pipeline company. Dividing batches between terminals is an additional source of discrepancy in the amount of product received due to methods used to control batches during transportation and measure batches at delivery.

### Controlling and Measuring Pipeline Batches

Product can be controlled and measured at various points along its journey. Due to the length of a pipeline, many of the pumps' valves and compressors that control product movement are operated remotely. There may be small delays in action that may cause more or less product to be included in a batch.

When measuring the batch, an initial manual gauge is typically taken of the storage tank(s) that feed the pipeline. The flow and pressure may be measured at stages along the pipeline. The flow and pressure are usually monitored again at the distribution point (the terminal) by the pipeline company. The



terminal itself may also record the receipt of the product using a meter, automatic tank gauge or through manual gauging of the tank. Every meter, instrument or manual reading will provide different values based on the accuracy, repeatability, calibration and ambient conditions.

### **An Acceptable Level of Discrepancy**

Every company involved in the process understands that discrepancies will take place, whether they come from instrumentation readings, co-mingled product batches, transmix or control delays. In an ideal world, they will not come from product loss or leaks. Pipeline leak detection is an entirely separate subject that is important, but it's not the focus of this paper. The challenge for terminal managers is to identify any movement discrepancy quickly and agree on the amount with the pipeline company.

### **Final Receipt**

The pipeline company provides a final receipt to the terminal company for the amount of product delivered. This rarely matches the amount recorded by the terminal, assuming that the terminal even records the receipt. Many terminals have acceptable standards for discrepancies in the range of 1-2% of the overall batch size. If the batch size is 50,000 barrels, a 1% discrepancy is 21,000 gallons. At \$1.00 per gallon, a weekly delivery of this size over the course of a year has a potential loss of over one million dollars.

### **Balancing Stocks Daily**

Currently, many terminal companies managing multiple terminals would like to account (consolidate physical vs. book inventories) for the product they own on a daily basis. To do this, they rely on the individual terminal

managers to provide accurate daily accounts and a 'close-out' of all physical inventories. However, depending on the flow rate and size of batch, a product may be received during the close-out period and even over the course of multiple days.

Most terminal managers would like to know how much product has actually been transferred and the discrepancy at the close-out period or at any point in the process. To do this, they may be able to take an automatic or manual tank gauge reading and estimate the discrepancy. As they are performing the procedure, the



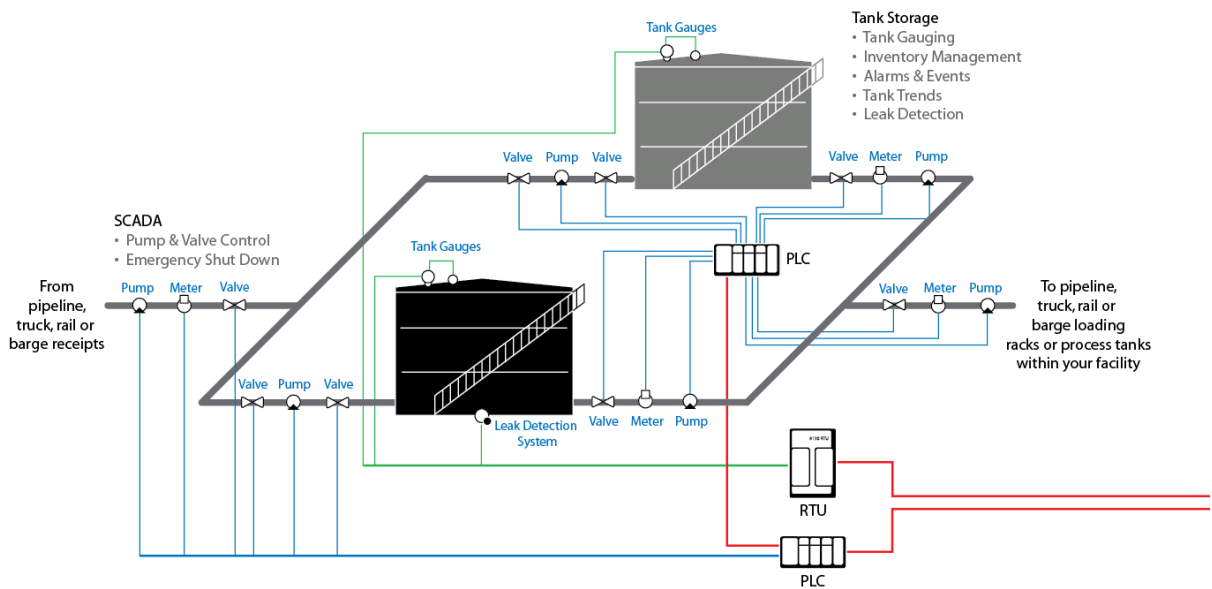
receipt continues; the time it takes to measure and manually calculate the discrepancy means managers are always behind received amounts. To resolve this problem, many terminals request a temporary shutdown of the receipt for their daily close-out. The daily close-out period is often at midnight, which also means staffing the terminal for the required procedures at that time.

## A Terminal's Requirement for Tracking Product Receipts

A terminal operator has very little control over product receipts and there are many factors that can affect the actual amount of product received compared to the amount requested or invoiced. We will now look at how Varec is able to utilize FuelsManager's product movement tracking system to accurately measure the physical receipt at any given moment, again at final receipt and how it is able to automatically provide daily close-out data that can potentially be given to a corporate accounting department to assist with the consolidation of physical vs. book inventories.

### Real-Time communication between the system and all connected devices

For a marketing terminal receiving product from a pipeline company, this may mean connecting the system to the pipeline meter and any tank gauging equipment or meters that provide inventory data for the receipt tanks. If an existing system is already providing this data or a new system can be plugged into existing field wiring, it will save on additional costs of connecting or wiring your facility. FuelsManager utilizes live communications with all connected devices so the operator sees real-time measurement that can be clearly identified with an exact time, such as at the end of a movement.



FuelsManager can be configured for the movement path based on the facility's piping, tankage and equipment. It can account for the specific tankage and the inventory volumes within your pipeline before, during and after receipt.

It is also possible to connect FuelsManager to densitometers that measure any change in density of the product as it is received. This would be useful when the operator would like to divert any transmix to separate tankage at specific density values. FuelsManager can alert the operator of the change in density and record the amounts of product diverted. These amounts could then be recorded and accounted.

FuelsManager also has the ability to compute pipeline leaks by monitoring the movement from both ends of the pipeline and monitoring the data as the receipt or shipment is in progress. Again, this is another topic that will not be covered in detail in this paper.

#### **Industry standard calculations**

FuelsManager calculates physical volumes using industry standard calculation methods, such as ASTM, API, JIS, etc., from the available measurements in real-time. Almost all terminals in the U.S. measure and transfer product based on volumes, which means integrating product temperature, tank strapping and tank shell corrections into calculations. FuelsManager also handles all mass based measurements for the international bulk terminal market.

#### **Manual hand gauged data**

In many cases, terminals are required to rely on manual measurement of a tank's content for calculation of final receipt volumes. FuelsManager allows the operator to manually input hand gauged values for any tank. It then performs all calculations and provides comparisons to automatically captured data values.

#### **Track various product movement types**

The same measurement, recording and reporting principles that apply to receipts also apply to other off property or internal product movements. FuelsManager can handle nearly any conceivable type of movement performed at your facility, such as transfers, shipments, blends, charges, run downs, etc.

### Automatically capture data based on the status of field devices

In many facilities, an operator is required to initiate a movement by manually opening a valve or starting a pump from the field. Movement data would not be recorded if a system requires the operator to return to the control room and initiate recording. FuelsManager allows for, but does not require manual intervention to record movement data. It can be configured to automatically record data based on a known set of conditions in the field, usually based on pump and valve status, thus drastically reducing the impact of human error.

FuelsManager records inventory data and allows the operator to utilize this data to populate unknown values given a date and time. If the status of field devices can not be used as an initiator and the start of a movement was missed, historical values from inventory records can be used. For example, if a movement record was started an hour later than the actual product movement, the operator can tell the system to use the data recorded an hour earlier. If they are unsure of the movement start time, the operator can use trending tools to find the measurements last recorded before flow was detected.

*FuelsManager's SQL databases can be queried by connected systems for any recorded data. This data can then be utilized by other users or systems to generate reports specific to their business functions.*



### Intuitive user interface

In many locations, a single operator has responsibility for scheduling, coordinating and reporting movements, while different operators may be responsible for all other day-to-day inventory concerns. Both sets of users require information displayed on data and/or graphical SCADA displays that represent their unique function. FuelsManager provides clear, concise movement displays of aggregated receipt data that are separate to other inventory or control displays. Data can be grouped and organized based on the priority of the information at any given moment, such as movement path, date, product, etc. For example, an operator may only want to see “all receipts of premium gasoline” only.



*Once a movement lineup has been configured in FuelsManager, it can be re-used again at any point in the future, .i.e commonly performed movements only have to configured once.*

### Alarms

Along with many general operator alarm and event management tools, FuelsManager is able to provide specific alarms or warnings for a movement coordinator, such as tank status, overfill prevention or unintentional product blending. It is also able to calculate an estimated completion time. This is performed in real-time and can be configured to provide advanced warnings of alarm limits or movement completion based on observed data. For example, an operator may want to be alerted when there is “1 hour before the receipt is completed”.

### Reporting and trending tools

FuelsManager records physical and movement data in databases that can be utilized for reports and trends. It also records close-out data at a desired time for both databases. For movements, this provides an instant close-out snapshot of all active movements. Combine that with close-out records of the physical data and you have all you need for daily reconciliation **with no down time for close-out**. Reports can be printed, output electronically or even delivered via e-mail to other individuals or departments in standard formats, such as Microsoft Excel, Microsoft Word, CSV and PDF. FuelsManager can also be configured to automatically print standard movement tickets upon completion of a movement or on demand.

**Product Movement Report**  
*by Movement Type*

---

Product: GAS

Transfer

Movement Name:	T1 to T8	Movement Initiation Time:	08/12/2005 04:36:02PM		
Product:	GAS	Movement Type:	Transfer		
Order Number:	Prod Level	BSW Level	Temp	Net Vol	Xfer Net Vol
From:	Tank 1				
Opened:	08/12/2005 16:33	14-03-02	0-00-00	200.10	402,939.76
Closed:	08/12/2005 16:36	13-00-00	0-00-00	200.10	367,325.68
	Unit	ft <sup>3</sup> /100	ft <sup>3</sup> /100	°F	gal (US)
Discrepancy:					-35,614.08
					gal (US)
Discrepancy:					-14,264.13
					gal (US)

The terminal owner may be able to use reports generated by FuelsManager to recoup losses due to discrepancies in receipts from a pipeline company. Forms can be modified to meet the specific needs of each customer.

### Interface to corporate level planning systems

FuelsManager's product tracking system provides an application programming interface that allows a corporate system to download movement (bulk shipment) schedules. The product tracking system can automatically upload all close out and movement completion data as well. With or without this feature, a movement coordinator could schedule all receipts in advance. Terminal operators can then execute the scheduled movement and, using built-in filters, focus only on the tasks specific to that operator or control room.

A movement coordinator may import and configure all movement schedules for the current day, week or month.

Configuration by the operator is then not required and they can concentrate their attention to 'pending' movements for the day at hand.



## Conclusion

If your existing inventory management system is not able to fulfill the needs of tracking receipts and calculating discrepancies in real-time, you have limited options.

Many terminals now utilize software systems that interface to field instruments to provide physical inventory management and control, such as Varec's FuelsManager. Contact your inventory management software vendor - they may be able to provide an upgrade or plug-in to your existing software that provides the functionality needed for product movement tracking. This may be far more cost effective than physically connecting a new system to existing field wiring, or providing new or additional field wiring and instruments. However, be wary of custom software development disguised as released products or plug-in modules. Maintaining custom developed software may be more expensive due to configuration issues or compatibility problems, especially when upgrading the system in the future.

In the case of Varec's FuelsManager, a movement tracking system plug-in module is available that was originally developed in 1994 for complex movements within a petrochemical processing plant. Over the years, it has been refined to include specific functionality suitable for all bulk liquid petroleum facilities and has been field proven in many large refineries and terminals worldwide.

For the terminal manager or owner, Varec offers a complete support. We utilize the flexibility of FuelsManager and the movement tracking system to find a solution that suits their business operations. Our focus is to provide a seamless installation of a system that assists the customer with scheduling and coordinating product movements, as well as monitoring and identifying discrepancies. We work together at all levels of a company's structure, such as IT, corporate, and facility operations, to ensure the data required is distributed in the format needed so a close-out of movements and physical product stock can be performed quickly and automatically.

If you operate FuelsManager at one or more facilities or have a similar system from a different vendor, contact Varec to learn more about our capabilities and the functionality available in the latest release of FuelsManager and the movement tracking system.

## Credits

### **About Varec**

*Varec, Inc. delivers measurement, control and automation solutions and professional services for most major oil companies, defense organizations and airlines worldwide. Varec's FuelsManager® software applications and hardware products provide local level management and enterprise visibility of liquid petroleum assets at bulk storage facilities, marketing terminals, refineries, petrochemical plants and military fuel facilities.*

### **References**

1. Source: [www.API.com](http://www.API.com)
2. Source: <http://www.theodora.com>

## Copyright

***© Copyright 2009 Varec, Inc. All rights reserved. No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of Varec, Inc. The information contained herein may be changed without prior notice. Some software products marketed by Varec, Inc. and its distributors contain proprietary software components of other software vendors.***

***All other product and service names mentioned are the trademarks of their respective companies. Data contained in this document is for informational purposes only.***

***These materials are subject to change without notice. These materials are provided by Varec, Inc. for informational purposes only, without representation or warranty of any kind and Varec, Inc. shall not be liable for errors or omissions with respect to the materials. The only warranties for Varec, Inc. products and services are those that are set forth in the express warranty statements accompanying such products and services, if any. Nothing herein should be construed as constituting an additional warranty.***