Virtuoso®/LDS & Virtuoso®/RDM
Leak & Restriction Detection

Virtuoso® field-proven technology

Wood offers robust digital tools for the efficient design and management of oil and gas operations. Our technology is used for performing engineering studies, conducting simulations and operator training of integrated operations, including wells, pipelines and processing facilities. Wood's Virtuoso® package is a suite of tools, with 20+ yrs' successful track record of field performance. These tools are used to address the full range of issues for multiphase gathering, production, transportation and processing, as well as single-phase transmission and distribution.

Today, Virtuoso is used to help manage some of the world's key gas resources, supporting 10% of the global consumption of this vital commodity.

The Virtuoso suite is offered as both offline and online packages for Asset Performance Management (APM) purposes, providing vital monitoring and advisory functions and are routinely used to ensure operational integrity, production operations management & optimisation, performance assessment, planning & forecasting, field development analysis, data analysis and visualisation.

Multiphase and single-phase leak detection & location

Virtuoso®/LDS is Wood's real-time, on-line package for detecting and locating leaks in single-phase (i.e., oil or gas or aqueous phase) and more challenging multiphase pipelines. It utilises our field-proven Virtuoso platform for monitoring key operating parameters and provides valuable information on the performance of an asset. Virtuoso/LDS utilises multiple methods for computational pipeline monitoring (CPM), including:

- Rigorous real-time transient modeling (RTTM);
- Mass balance analysis;
- Comprehensive statistical signal trend and negative pressure wave analysis; and
- State-of-the-art dynamic leak "fingerprint" pattern-recognition algorithm (a **Virtuoso®/Analytics** component), to maximise leak sensitivity and reduce detection time, while minimising false/spurious alarms

Wood offers proven model-based technology, coupled with a proprietary Bayesian statistical inference analysis and comprehensive, high-speed, hybrid, "finger-print" dynamic pattern-recognition, to provide accelerated detection times and improved sensitivity. Each package is enhanced with our rigorous process and data analytics techiques.

Virtuoso's dynamic pattern-recognition technology is unique that it continuously examines hundreds of system parameters, specific to the pipeline and its operating conditions, to establish the true leak "finger print" on any given segment. It also handles automatic adjustment for longer-term variations in system bias and noise and accounts for all possible combinations of responses at available measurement points. This means that from "Day One" of deployment, the system is fully functional and has built-in knowledge of possible leak responses.

In addition, Virtuoso/LDS offers very flexible deployment options, including the use in "hybrid" detections systems, complemented by acoustic or fiber optic sensing methods.

LDS Field Case: reliable performance when it matters

A large natural gas supply and delivery system in Asia developed a leak in one of its subsea sections several years ago. This 650+km offshore network delivers natural gas to its cross-border customers. The use of leak detection technology is very challenging given the massive gas volume involved, compounded by a dynamic supply-demand cycle, and sparsity of available instrumentation/metering.

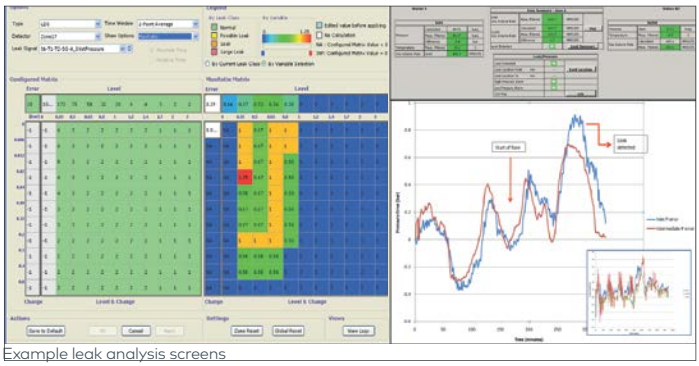
A Virtuoso-based pipeline management system (PMS) was deployed to check operational and commercial integrity and based on SCADA-metered conditions, declared a leak at one of its "legs", some 30-km from a subsea tie-in. Early detection and accurate leak location was instrumental in reducing environmental impact, ensuring safety, and minimising the downtime and gas supply curtailment. It declared the leak shortly after interpreting the minute deviations in metered conditions. Emergency procedures were then employed while the incident was assessed further. The accurate leak location helped narrow the search corridor and accelerated visual confirmation. Over 30+ days before repairs could start, Virtuoso maintained proper pipeline pressure to avoid seawater ingress in the damaged section and minimise gas supply disruption. It then helped maintain optimal operating conditions and gas delivery during the ensuing repair and commissioning phase.

Safeguarding for the inevitable

Despite the best efforts of the industry, leaks from pipelines do happen. Take the case of transporting fuel as an example. For such a case, pipelines would generally be regarded as a safer way to transport liquids, compared to land-based alternatives like trucks or by rail. One may say that the inherent risks of transporting by pipelines would be analogous to those of flying on a plane. While both are safer than by land, the analogy only extends so far. Planes are monitored and maintained regularly; and older equipment replaced. Whereas pipelines can stay buried or lay underwater for years/decades, carrying pressurised gas and liquids. It's inevitable that as they age, they are exposed to conditions, accidental damage, or acts of theft that could cause leaks.

Any product releases can be catastrophic, hence it's critical to ensure the integrity of assets not only like these pipelines but oil & gas gathering, production, transportation & processing facilities in general.

At Wood, we are engaged in addressing the various aspects of maintaining asset integrity, including: (a) prevention – by proper design/installation/construction, (b) detection - development & deployment of cutting edge technology; and (c) mitigation – monitoring/maintenance/inspection. This document focuses on the **detection aspect**.



Example leak analysis screens

Partial restriction or full blockage detection

Virtuoso®/RDM (restriction detection) is a specialised module used for detecting the onset or build-up of restrictions or blockages in flow paths. It monitors and alarms for cases of partial flow restrictions up to complete blockages. Partial restriction detection functionality is particularly important, as these types of situations can rapidly occur or may build up over time and could have serious consequences on flow performance if left unchecked. These issues can be associated with hydrate formation, wax deposition, gel formation, asphaltene instability, solids accumulation, stuck pigs, dropped objects as well as a number of related issues.

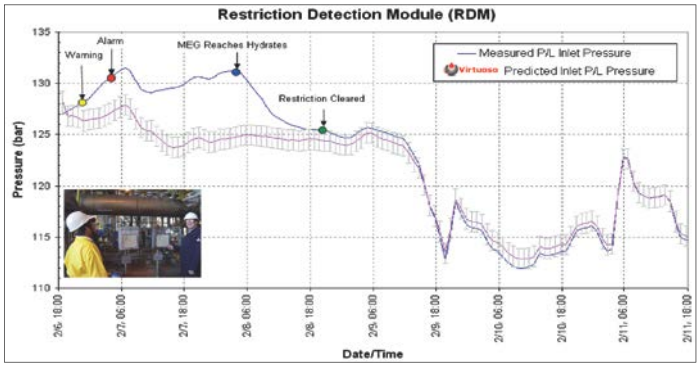
Just like the old adage, "prevention is better than a pound of cure", the same applies to flow assurance issues. Timely application of inhibitors can be the difference between getting back to normal in short order or completely obstructing fluid flow, as in the case of a hydrate blockage.

Virtuoso/RDM takes into account the same measured and calculated parameters used by Virtuoso and then employs an enhanced version of our dynamic pattern-recognition technology, to extend the functionality to handle the myriad of unique site-specific patterns, germane to the operating conditions, and those associated with restrictions build-up. RDM has been successfully deployed in several assets globally for many years now and is a mainstay in our client's arsenal in handling their operational challenges.

RDM Field Case: Virtuoso saves the day

For several clients' massive offshore gas gathering assets, it is imperative for operations to have unimpeded gas flow feeding mega LNG trains. These trains are designed for continuous service and unplanned shut-downs are costly.

One such asset was close to experiencing such an event during one harsh winter cycle that blanketed the ME region. Virtuoso had been installed on this asset for several years now, to monitor and advise on all aspects of its operational integrity. On that unusually cold February, operators were alerted that a restriction was beginning to be "observed". Virtuoso flagged a possible hydrate blockage forming in a trunkline. Early detection helped minimise risks and it advised them that inhibitor injection was required and at what dosage. Timely response was critical and they were able to abate the issue, as can be seen in subsequent response in the P/L pressure profile. Shutdown was avoided.



Pressure profile tracking during hydrate blockage event

To learn more about what Wood can offer, please visit us at www.woodplc.com/IntelligentOps, or contact us at IntelligentOps@woodplc.com.

Virtuoso/LDS Beneficial Functionalities

- User-friendly, rigorous model that handles single-phase, slack-line and multiphase operations
- Incorporates comprehensive dynamic "finger-print" pattern-recognition technology
- Fully operational and detecting leaks from "Day One"
- Provides accurate leak location and leak rate
- Accommodates full range of operating conditions, and handles transient operations, including shut-in, and rigorously accounts for heat transfer effects
- Configurable for simple pipelines to complex networks
- Accommodates all fluid types and product blends
- High sensitivities to product release and performs accurate imbalance calculations on flow meters
- Provides users with valuable real time information/ profiles (i.e., temperature, pressure, liquid holdup, velocity, composition, etc.)

FAQs

Q: What are the main features of Wood's offering?
A: Multiple methods including RTTM, mass balance, statistical and negative pressure wave analysis, with "finger-print" pattern-recognition techniques and process analytics.

Q: What fluids can the Wood LDS system handle?
A: Our technology is very flexible and used for multiphase (i.e., 3-phase, 2-phase, including presence of a solid phase, and single-phase (i.e., gas or liquid, including water).

Q: What type of pipeline operations can it be used on?
A: Various operations, including production and gathering, export, long-distance transmission and complex distribution operations, including sour service and chemical injection.

Q: What conditions will it handle and remain accurate?
A: Our systems are very robust and can readily handle steady-state and transient operations, including shut-in, full rupture as well as conditions that result in phase transition.

Q: What instrumentations is commonly used?
A: Flow and pressure at both ends and an inlet temperaure.

Q: What performance is expected?
A: Detection response in minutes and leak sizes from 0.5% of flow are achievable, depending on the flow conditions and available instrumentation.

Q: How does the system minimise false alarms?
A: Our systems are designed with advanced filtering techniques to detect if field instrumentation or data has gone bad or if any system bias has drifted.

Q: What are the challenges in any LDS implementation?
A: One common issue would be metering inaccuracies. At Wood, we have a team of metering and allocation specialists who help improve our Clients' metering system performance.

Q: What else can Wood offer?
A: Wood is a **solutions provider**. We have domain expertise in oil & gas operations and can deploy hybrid solutions that include complementary technologies like fiber-optic and acoustic. Wood is also one of the largest hardware independent automation and control system integrator.

Wood is a global leader delivering technical, engineering and project services across the entire asset life cycle. We operate in more than 60 countries, employing about 60,000 people. We provide performance-driven solutions from development to decommissioning for a broad range of industries including all energy sectors, process and refining, power and utilities, mining and manufacturing.