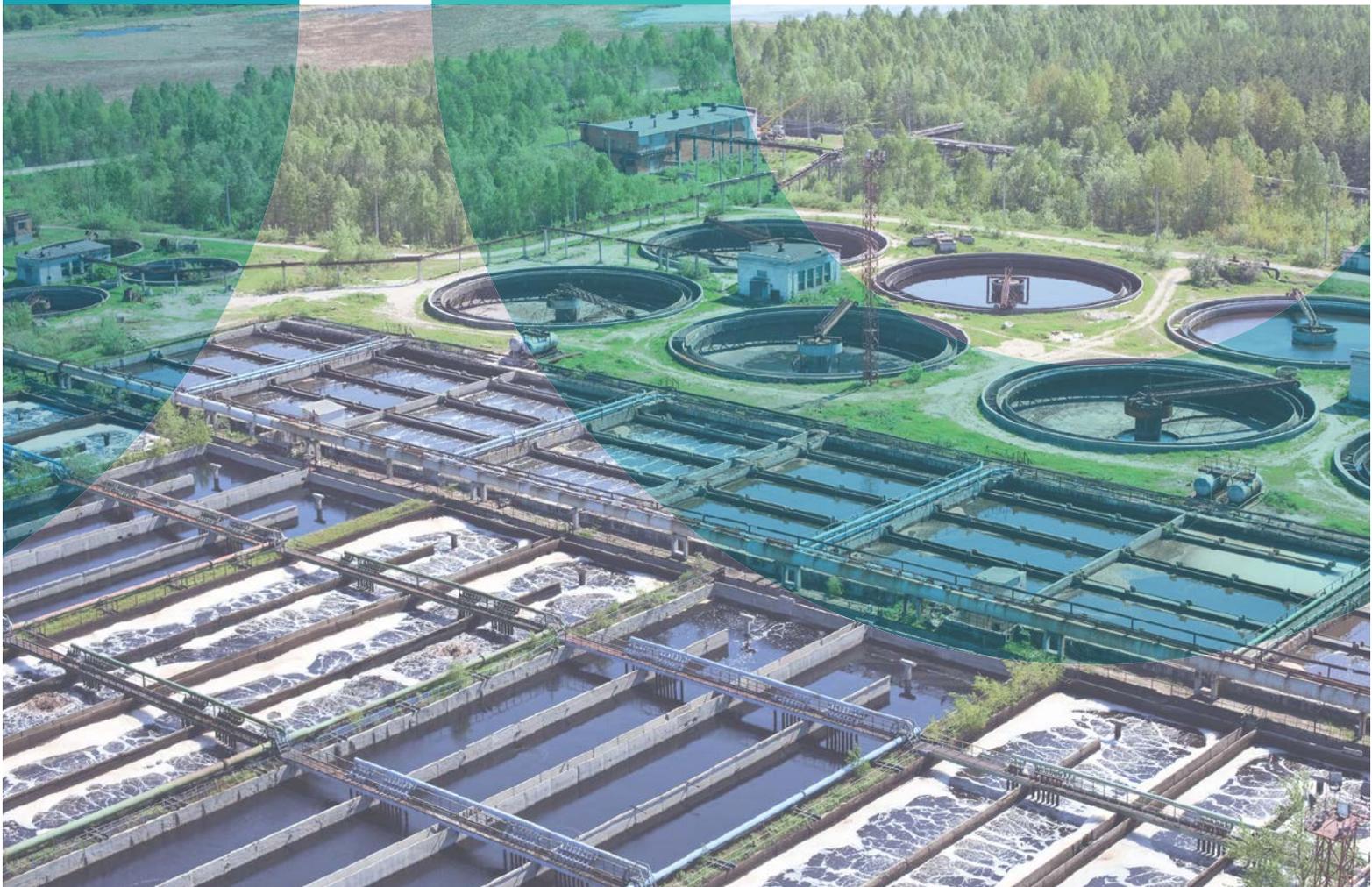


wood.

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





Virtuoso® field-proven technology

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

Today, Virtuoso is used to help manage some of the world's key resources, supporting 30% of the global LNG production.

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.

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 operations. 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

techniques.

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 "fingerprint" 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.

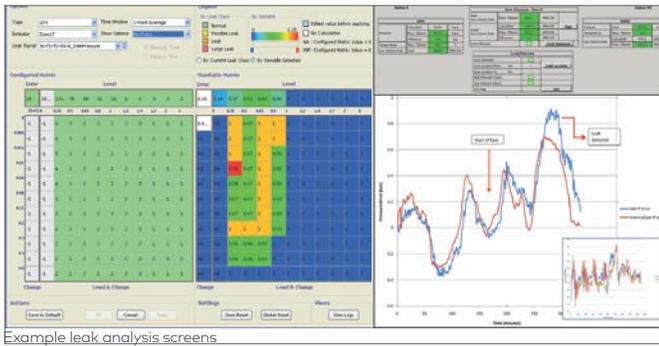
Partial restriction or full blockage detection Virtuoso®/RDM (restriction detection) is a

Safeguarding for the inevitable

Despite the best efforts of the industry, leaks 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 brochure focuses on the **detection aspect**.



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 solids build-up or accumulation, stuck objects as well as a number of related issues.

Just like the old adage, “an ounce of prevention is better than a pound of cure”, the same applies to potential hydraulic issues. Timely application of mitigation measures can be the difference between getting back to normal in short order or completely obstructing fluid flow.

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,

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 able to detect 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 accounts for associated heat transfer effects, where applicable
- Configurable for simple pipelines to complex networks
- Accommodates all fluid types and product blends
- High sensitivities to fluid release and performs accurate imbalance calculations on flow meters
- Provides users with valuable real time information/profiles (e.g., temperature, pressure, holdup, velocity, composition, etc., where applicable)

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 operations can it be used on?

A: Various operations, including production and gathering, export, long-distance transmission and distribution operations, including water, sour service and chemicals.

Q: What conditions will it handle and remain accurate?

A: Our systems are robust and can 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: Depending on the operations, flow and pressure at both ends and an inlet temperature.

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 different 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.

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.

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



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.

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