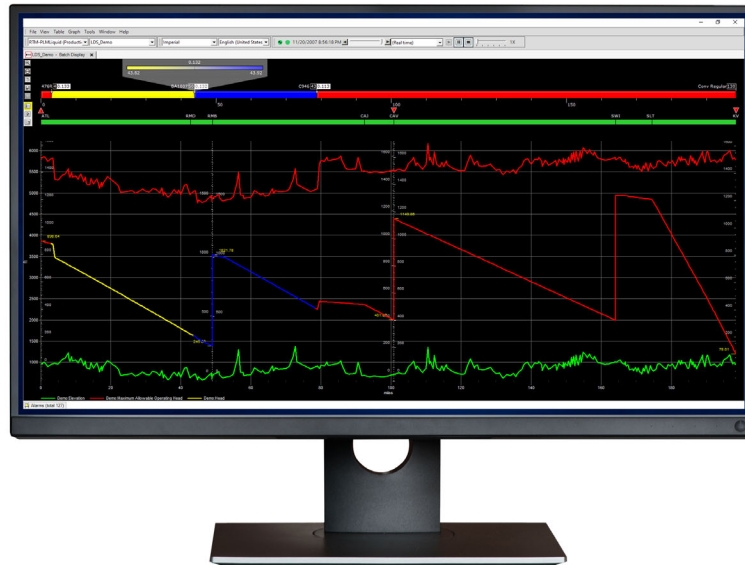


PipelineManager™ Software Suite for Leak Detection

Real-Time Simulation Software for Gas and Liquids Energy Pipelines



Emerson's PipelineManager Software Suite contextualizes real-time data and displays critical insights in visual detail to enhance situational awareness, leading to informed decisions that mitigate risk and improve safety.

Operate with Confidence

- Safely optimize pipeline throughput
- Minimize operator fatigue by reducing false alarms
- Automate future event notifications

Reliably Detect Leaks

- Accurately apply the optimal leak and/or theft detection system using RTTM or statistical methods
- Evaluate and fine tune the sensitivity and accuracy of your leak detection system with Emerson's Advanced Leak Detection Performance Analyzer (LDPA™)

Facilitate Compliance

- Comply with API RP 1130 and API RP 1175
- Comply with PHMSA's "Mega Rule" and PIPES Act of 2020
- Comply with TRFL, CSA, and many others

Manage More Products

- Prepare your operations for the energy transition with technology that reliably monitors a wider mix of products, including:
 - Common natural gas blends
 - CO₂, H₂, and renewable oil
 - Liquids, including crudes, refined products, biofuels, and more

Get Instant Insights into Daily Operations

Accurately plan for safe pipeline operations. Emerson's advanced PipelineManager™ Software suite allows you to simulate the flow of product in the pipeline using real-time data, resulting in fast and accurate identification and localization of ruptures and smaller leaks within your pipeline system. Your staff will be empowered to rapidly make informed decisions across your entire pipeline based on the consolidation and assimilation of reliable data from multiple sources, including flow and pressure data from your existing SCADA, DCS, RTU, or PLC system. Our agile software solutions will also ensure you can enhance the efficiency of your operations as additional products, including hydrogen and CO₂, are introduced into your pipeline system.

PipelineManager Software for RTTM

Comprehensive Pipeline Monitoring using Real-Time Transient Modeling (RTTM)

Contextualize data and provide your staff with enhanced visualization of current operations. Our comprehensive pipeline management solution brings together a computational pipeline monitoring (CPM) system with advanced RTTM capabilities, allowing for detailed models of pumps, compressors, piping, valves, tanks, heaters, coolers, control system logic and more. Users can easily track products, fluid composition, ownership, pigs, scrapers, and other activities down the line.

PipelineManager: A Complete Software Suite for Leak Detection		
Technology	What Is It?	Where to Best Apply It?
PipelineManager Software for RTTM for Comprehensive Pipeline Monitoring	A robust and highly detailed real-time transient model (RTTM) of the pipeline network that uses hydraulic profiles for sensitive, accurate, robust, and reliable leak detection. The software suite also handles batch tracking, automated forecasting, facility planning, operator training, and more.	Complex, longer length gas and liquids pipeline systems and where needed to meet heightened expectation of performance.
PipelineManager Software for Analytical Leak Detection for Targeted Pipelines	An easy-to-deploy and maintain machine learning solution for less instrumented, shorter length pipelines that applies machine learning methods to increase sensitivity, reliability, and robustness.	Less-instrumented or shorter length pipelines, including: <ul style="list-style-type: none"> ■ Non-transmission Pipelines ■ Gathering Systems ■ Chemical Feedstock Lines ■ Supercritical Phase Lines ■ Inter-terminal Lines ■ Produced Water Lines
PipelineManager Software for Rupture Detection for High-Risk Areas	Real-time statistical pattern recognition to detect rupture signals in under 2 minutes, checking for deviations in flow and pressure measurements to ensure a rupture will be detected whether the pipeline operation is using pressure or flow control, and/or is shut-in or slack. The highly reliable software minimizes false alarms.	Pipelines in remote operations, including: <ul style="list-style-type: none"> ■ Transmission Pipelines ■ Gathering Pipelines ■ Feeder Pipelines ■ Regulated and Unregulated Systems

Device-driven data from flowmeters, pressure sensors, temperature gauges, and other instruments can be integrated to construct a complete and accurate real-time view of pipeline operations. Our VisualPipeline GUI organizes the data from multiple sources into intuitive charts, tables, graphs, maps, network views, and reports to help rapidly upskill staff and streamline processes.

Technology Advantage: RTTM

Emerson's real-time transient model is the core of our high-performance leak detection system for both gas and liquids pipelines, and hydraulic profiles are a key aspect. PipelineManager Software for RTTM provides a sophisticated physics and mathematical model or digital twin of a pipeline. It uses computational algorithms that account for real-time changes based on measurements from instruments in the field to simulate what is occurring within the pipeline.

The hydraulic profiles application provides high-resolution real-time pipeline hydraulic data based on actual pressures, temperature, flow rate and line pack. Operators can identify bottlenecks and pressure excursions that cause gas breakout and liquid dropout.

They can also assess simple instrument performance. This information is used to promote overall system efficiency and reduce maintenance requirements for the pipeline, its equipment, and its instrumentation.

The spacing of calculation nodes for pressure and flow calculations is configurable and varies based on the specific pipeline network. If elevation data with finer resolution than the model's calculated node spacing is available, the software uses pressure and hydraulic gradients at intermediate locations. The software interpolates pressure values of adjacent calculation nodes to account for the proper product density and elevation.

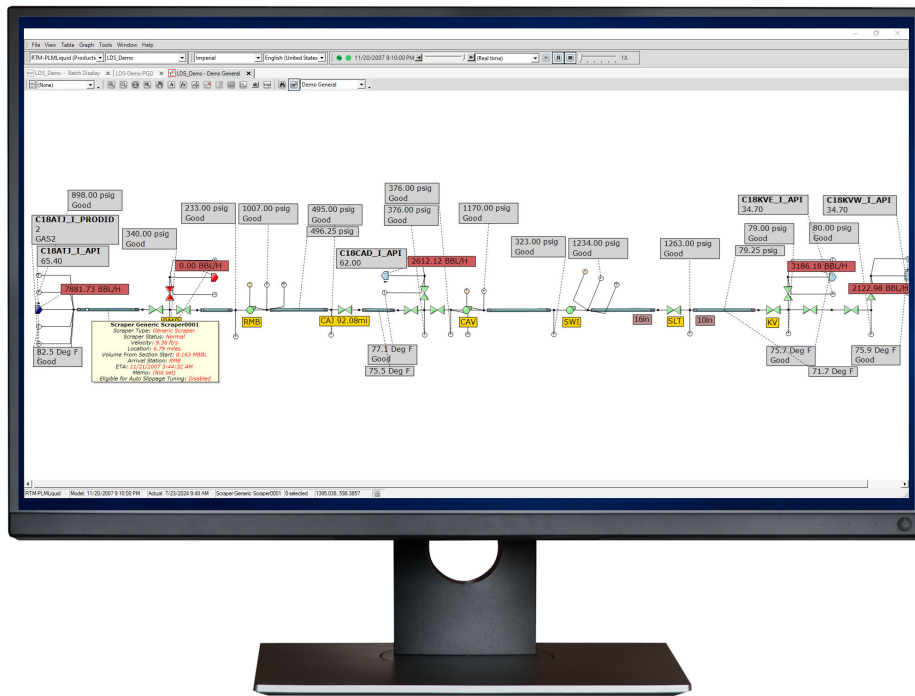


Figure 1: Emerson's intuitive VisualPipeline™ GUI provides a clear view into your daily operations and helps you visualize and analyze data in charts, graphs, dashboards, and schematics.

Leak Detection: An Important Component of RTTM

Emerson’s RTTM provides the most sophisticated model of your pipeline, enabling you to achieve the best sensitivity, reliability, robustness, and accuracy for your leak detection as outlined in API RP 1130:

- Sensitivity refers to the system’s ability to quickly detect and pinpoint even small leaks.
- Robustness is the ability to detect a leak regardless of the pipeline’s condition: steady-state or transient, shut-in, slack, or supercritical.
- Reliability refers to the trustworthiness of the system’s alarms. An unreliable system results in too many false positive alarms with actual leak events being overlooked.
- Accuracy refers to the system’s ability to accurately determine the leak size and location.

The RTTM also conducts hydraulic monitoring for maximum allowable operating pressure (MAOP) alarms along with additional system alarms. Data is available at all calculation points along the pipeline, allowing the system to display information on a variety of profile plots in addition to MAOP. These additional plots include:

- Flow profile
- Pressure and head profile
- Density profile
- Composition profile
- Temperature profile
- Velocity profile
- Pipeline elevation profile
- Maximum allowable operating pressure (MAOP) profile.

Since the output of the hydraulic model is an exact representation of current pipeline conditions, it is easier to determine with specificity when an alarm is indicating an actual leak. Depending on requirements, the flexible RTTM can be scaled up to create a true digital twin or scaled down to calculate compensated mass balance.

	SENSITIVITY	ACCURACY		ROBUSTNESS	RELIABILITY
		LOCATION	VOLUME		
Real-time Transient Model	●	●	●	●	●
Compensated Mass Balance	●	●	●	●	●
Rarefaction Wave	●	●	●	●	●
Analytical / Statistical	●	●	●	●	●
Pressure / Flow Monitoring	●	●	●	●	●

● Best solution
 ● Solution available
 ● Not applicable for this technology

Figure 2: Emerson’s RTTM technology for leak detection ensures all four corners of API RP 1130 are met.

Monitor Leaks to Ruptures while Reducing False Alarms

Accurately detect pinhole leaks to ruptures with a single solution. PipelineManager Software for RTTM uses multiple technologies to provide you with a highly reliable, comprehensive leak detection tool. The software uses both model-based and non model-based methods to implement the correct technique based on assessments of your pipeline. An offline tool documents the actual reliability, sensitivity, and accuracy of the leak detection system regardless of the flowing condition. Our patented Advanced Leak Detection Performance Analyzer (LDPA) provides performance metrics and reports that create benchmarks. The software then uses these benchmarks to fine tune both the accuracy and sensitivity of your leak detection system, resulting in fewer false alarms. In addition, the software continuously monitors pipeline integrity and may indicate anomalies that can be correlated to a leak to further safeguard your pipeline system.

Model with Accuracy

Achieve greater profitability by lowering operational costs, optimizing pipeline throughput, and enhancing pipeline integrity monitoring. A highly accurate model of your pipeline will provide valuable insights to help you successfully meet these goals. To ensure the highest accuracy, transfer pressure, flow, and temperature measurements from your existing SCADA/DCS system into PipelineManager Software. Our Emerson engineers configure the software to ensure these measurements form an accurate basis of the model. The software uses a standard interface for safe and secure communications with your systems. This robust and highly detailed transient thermohydraulic model, also known as our Advanced Pipeline Leak and Theft Detection, notifies you when pipeline integrity has been compromised.

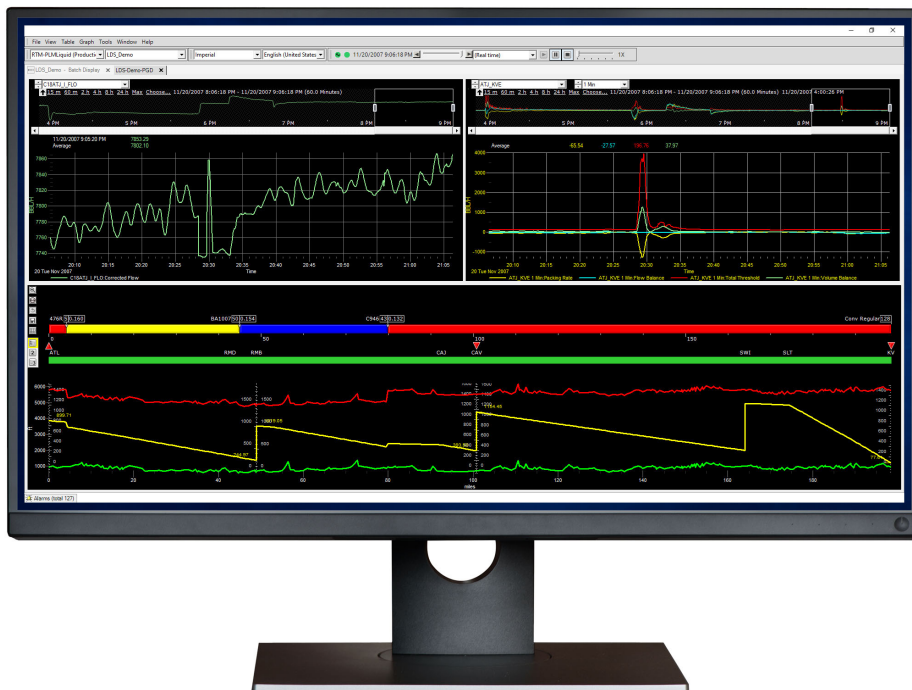


Figure 3: A composite view of hydraulic profiles, leak detection information, and trends.

Streamline Reporting and Auditing

Easily generate audit reports to comply with regulatory authority requests. PipelineManager Software for RTTM provides up-to-date data to comply with every international regulatory body, meeting requirements for both API RP 1130 regarding sensitivity, reliability, robustness, and accuracy of leak detection as well as API RP 1175 for control room management. Requirements for several international standards, including TRFL and CSA, can also be quickly fulfilled.

PipelineManager Software for Analytical Leak Detection

Targeted Area Monitoring using Machine Learning

Emerson’s PipelineManager Software for Analytical Leak Detection is a robust, easy-to-deploy, low maintenance leak detection solution for pipelines with limited instrumentation, including non-transmission pipelines, shorter length crude gathering systems, chemical feedstock lines, inter-terminal lines, and produced water pipelines. The cost-effective application uses machine learning to rapidly identify leaks while maintaining robust and reliable protection.

It seamlessly integrates with your primary control room applications as well as our PipelineManager Software for RTTM and PipelineManager Software for Rupture Detection to streamline compliance with API RP 1130, API RP 1175, and many other national and international regulations. Your staff will have the tools to mitigate risk and make the right decisions at the right time to protect lives, the environment, and your assets against the damaging effects of loss of containment.

Technology Advantage: Analytics with Enriched Statistical Inference

Improve the sensitivity, reliability, and robustness of your leak detection with machine learning. Our PipelineManager Software for Analytical Leak Detection uses analytics with enriched statistical inference to provide accurate leak detection for pipeline assets that cannot be monitored as easily using a traditional real-time transient model (RTTM) solution. Our best-in-class mathematical techniques use statistical analysis to improve sensitivity while delivering superior reliability and robustness.

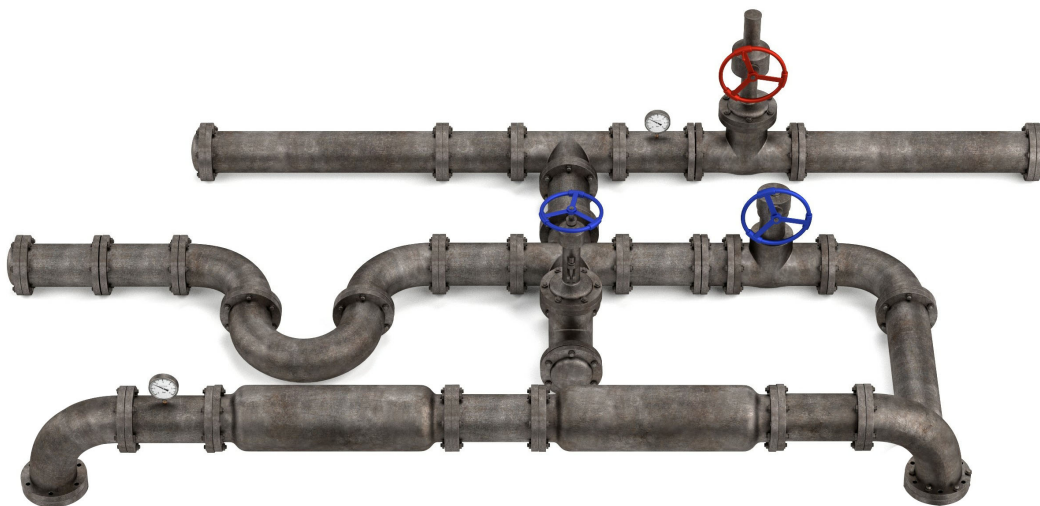


Figure 4: While many of the most sensitive leak detection systems require the highest quality pipeline instrumentation (i.e., valves, meters, etc.), PipelineManager Software for RTTM consistently delivers the most accurate results possible with the instrumentation already in place.

Deploy Rapidly

Minimal instrumentation requirements, simpler configuration, and a small application footprint even when failover is required allow for rapid deployment. With our Analytical Leak Detection Application, you can extend or reduce configurations during a live incremental rollout to provide leak detection coverage when pipeline asset information becomes available, assets are deployed, or assets are retired without having to re-initialize any running configurations.

Minimize False Alarms

Achieve real-time monitoring and alarming for system upset conditions, including leak detection and location. Our Analytical Leak Detection Application uses reinforcement training to discover optimal configurations while reducing false alarms by analyzing historical data. This machine learning capability ensures the application can be trained to automatically sound an alarm for any system upset condition, providing real-time surveillance to maintain maximum pipeline uptime.

Comply with Ease

Meet and exceed the requirements of your stakeholders, insurers, regulators, and the public. Our Analytical Leak Detection Application is a statistical solution that provides many advantages, including:

- Greater sensitivity, reliability, robustness, and accuracy as outlined by API RP 1130
- Fast to deploy
- Cost-effective
- Flexible
- Robust against instrumentation challenges, particularly on pipelines where RTTM is less optimal.

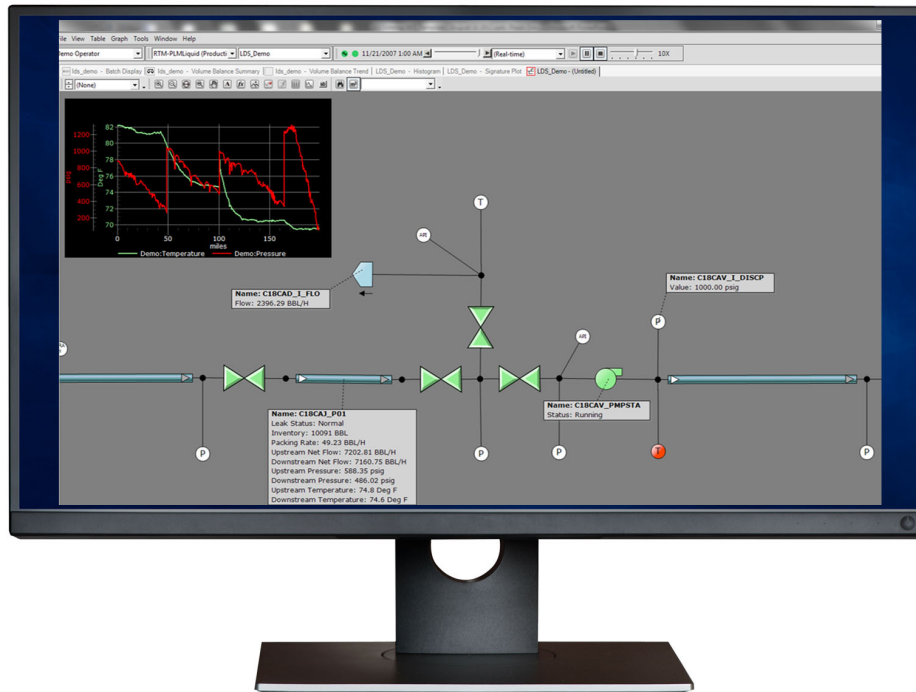


Figure 5: PipelineManager Software helps prevent incidents and safeguards your pipelines from exceeding safety limits for pressure with MAOP monitoring.

Our Analytical Leak Detection Application provides reliable event logs and reports to help you comply with specific leak detection requirements stated by TRFL, CSA, and other national and international standards and practices as well as change management recommendations stated in API RP 1175.

Integrate with Greater Flexibility

Configure and deploy our Analytical Leak Detection Application directly to your control system (i.e., SCADA or DCS) quickly with only a list of tags and a small number of parameters. An industry-standard protocol receives live data during deployment, ensuring rapid commissioning of the application into your system. Every alarm and important piece of data is transferred to your SCADA system for display and analysis.

PipelineManager Software for Rupture Detection

Targeted Area Monitoring

Whether your pipeline operation is using pressure or flow control and/or is shut-in or slack, Emerson's PipelineManager Software for Rupture Detection provides a reliable layer of defense to limit costly financial and environmental impacts. Users can detect rupture signals in less than 2 minutes and respond rapidly to mitigate them. Our application monitors your pressure and flow sensors in real time under all pipeline flowing conditions using accurate, up-to-the-minute data. This real-time statistical pattern recognition method enhances the long-term operational reliability of remote transmission pipelines such as gathering pipelines, feeder pipelines, and both regulated and unregulated systems of liquid pipelines. Your staff will adapt to and report on changing pipeline conditions with greater accuracy, leading to confident and rapid remediation of large incidents.



Figure 6: Easily deploy Emerson's PipelineManager Software for Analytical Leak Detection into your complex control room environment to enable faster, more confident decision making.

Technology Advantage: Bayesian Inference Statistical Modeling

Our PipelineManager Software for Rupture Detection uses a Bayesian inference statistical model to test whether observed pressure measurements are normal or abnormal given the prevailing flow conditions. Improbable pressures are analyzed and fed into a pattern recognition algorithm, with the data enabling users to determine if the pattern is normal or if there is a rupture when large flow and/or pressure changes occur. Flow-pressure patterns are monitored, with the software looking for a pressure decrease coupled with a flow increase. Users can also monitor an increasing pressure drop by identifying pressure decrease patterns at multiple nearby locations to ensure a comprehensive approach to rupture detection. The application self-trains using machine learning and rapidly recognizes the unique characteristics of your pipeline operation, ensuring expedited implementation with less user intervention.

Limit False Alarms

Inconsistent data results in frequent false positive alarms, leading to complacency and inaction in the control room. Our PipelineManager Software for Rupture Detection reliably processes and manages data to eliminate nuisance alarms and minimize operator fatigue. The software invites a specific response to every alarm to ensure any rupture is quickly detected. The application also provides complete alarm rationalization and documentation that seamlessly integrates into your control room management plan to comply with API RP 1167.

Ack	Level	Filter Type	Model Time	Network	Version	From	Message	Needs Ack
	Normal	Leak	11/24/2007 12:20 PM	LDS_Demo	RTM	Model	DETAIL LEAK CLEARED: ATJ_KVE in 3 Hour period, 1209 s, at 8.7 miles in C18ATJ_P	False
	Normal	Leak	11/24/2007 12:20 PM	LDS_Demo	RTM	Model	SYSTEM LEAK CLEARED, duration 1209 seconds	False
	Normal	Leak	11/24/2007 12:20 PM	LDS_Demo	RTM	Model	LEAK CLEARED: ATJ_KVE, duration 1209 seconds	False
	Alarm	Leak	11/24/2007 12:15 PM	LDS_Demo	RTM	Model	*ONGOING LEAK* C18ATJ_P01 6.6 miles 37.7 bph Period: 3 Hour	True
	General Alarm	Sensor	11/24/2007 12:11 PM	LDS_Demo	RTM	Model	Sensor (Acc) C18KVE_I_ACC ROC,New: 6.2 Old: 561448.4	False
	Alarm	Leak	11/24/2007 12:00 PM	LDS_Demo	RTM	Model	*LEAK DETAIL* ATJ_KVE: 3 Hour, 40.1 bph at 4.0 miles in C18ATJ_P01	True
	Alarm	Leak	11/24/2007 12:00 PM	LDS_Demo	RTM	Model	*LEAK* ATJ_KVE: 40.1 bph at 4.0 miles	True
	Alarm	Leak	11/24/2007 12:00 PM	LDS_Demo	RTM	Model	*SYSTEM LEAK* ATJ_KVE: 40.1 bph at 4.0 miles	True
	Normal	Leak	11/24/2007 11:03 AM	LDS_Demo	RTM	Model	DETAIL LEAK CLEARED: ATJ_KVE in 30 Min period, 540 s, at 174.5 miles in C18SWI_	False
	Normal	Leak	11/24/2007 11:03 AM	LDS_Demo	RTM	Model	SYSTEM LEAK CLEARED, duration 540 seconds	False
	Normal	Leak	11/24/2007 11:03 AM	LDS_Demo	RTM	Model	LEAK CLEARED: ATJ_KVE, duration 540 seconds	False
	Alarm	Leak	11/24/2007 10:54 AM	LDS_Demo	RTM	Model	*LEAK DETAIL* ATJ_KVE: 30 Min, 45.7 bph at 10.3 miles in C18ATJ_P01	True
	Alarm	Leak	11/24/2007 10:54 AM	LDS_Demo	RTM	Model	*LEAK* ATJ_KVE: 45.7 bph at 10.3 miles	True
	Alarm	Leak	11/24/2007 10:54 AM	LDS_Demo	RTM	Model	*SYSTEM LEAK* ATJ_KVE: 45.7 bph at 10.3 miles	True
	General Event	Batch	11/24/2007 10:43 AM	LDS_Demo	RTM	Model	Batch Conv Regular is 10 minutes away from SLT	False
	General Event	Batch	11/24/2007 10:42 AM	LDS_Demo	RTM	Model	Batch RFG Regular is 10 minutes away from SLT	False
	General Event	Batch	11/24/2007 10:25 AM	LDS_Demo	RTM	Model	Batch Conv Regular is 30 minutes away from SLT	False
	General Event	Batch	11/24/2007 10:23 AM	LDS_Demo	RTM	Model	Batch RFG Regular is 30 minutes away from SLT	False
	General Event	Batch	11/24/2007 8:26 AM	LDS_Demo	RTM	Model	Batch Low Sulfur Diesel is 10 minutes away from RMB	False
	General Event	Batch	11/24/2007 8:25 AM	LDS_Demo	RTM	Model	Batch RFG Regular is 10 minutes away from RMB	False

Figure 7: View alarms in real-time in an easy-to-understand format.

Mitigate Risk

Expedite response to mitigate the impact of a pipeline rupture. If a breach occurs, a rupture detection system must accurately and reliably recognize a large incident to ensure your pipeline controllers can take confident action to rapidly remediate the situation. Our PipelineManager Software for Rupture Detection can be trained to alarm on ruptures that occur during pump trips, flow starts, and any other operation that can disable other detection systems or cause the systems to generate false alarms.

Comply with Regulations

Emerson's PipelineManager Software for Rupture Detection complies with PHMSA's "Mega Rule," API RP 1130, 1149, 1167 and 1175, CSA Z662, and other local government regulations.

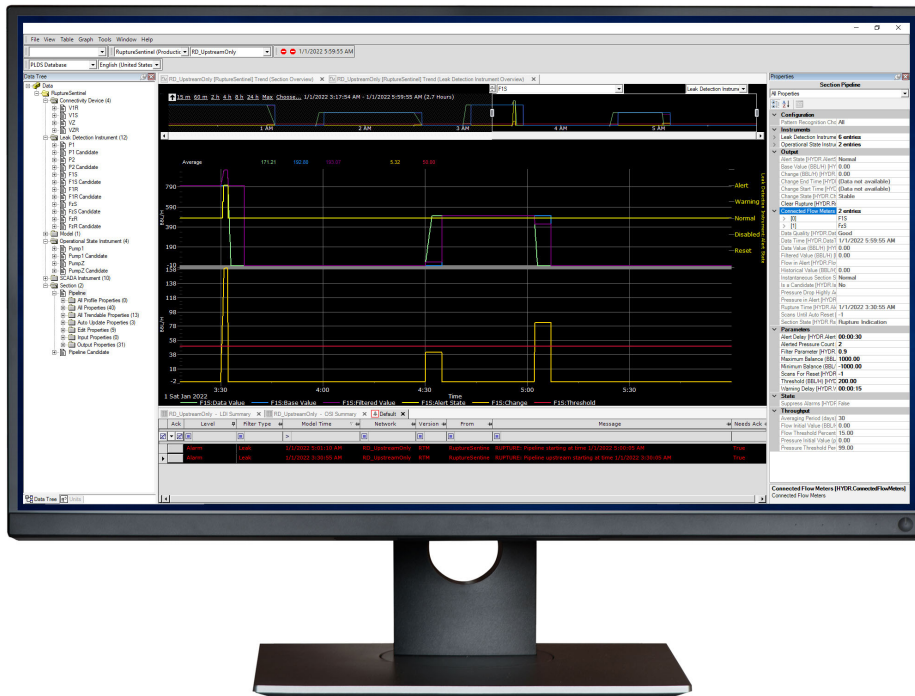


Figure 8: Eliminate nuisance alarms for rapid detection of large petrochemical pipeline releases with Emerson's PipelineManager Software for Rupture Detection.

Expedite Start Up

Our PipelineManager Software for Rupture Detection self-trains and determines parameters by analyzing your archived SCADA data. The software's adaptive tuner analyzes your data both with and without historical leaks. It learns to recognize your normal operations, distinguishing normal from abnormal conditions to improve sensitivity without sacrificing reliability. Historical data is used in an offline tuning environment to learn from the widest possible exposure to your pipeline operations in real time, resulting in minimal implementation time.

Establish Sensitivity

Automatically calculate thresholds based on the performance of your pipeline network displays. With our PipelineManager Software for Rupture Detection, you can set the preferred sensitivity (e.g., 20% of flow) and the software will calculate the appropriate flow thresholds based on observed throughput over the last month. Pressure deviation thresholds are calculated by the application based on the historical performance of your pressure meters. Following examination of the calculated thresholds, your staff can develop a fully auditable change management-compatible form. In addition, our PipelineManager Software for Rupture Detection can easily scale to meet changing pipeline requirements.

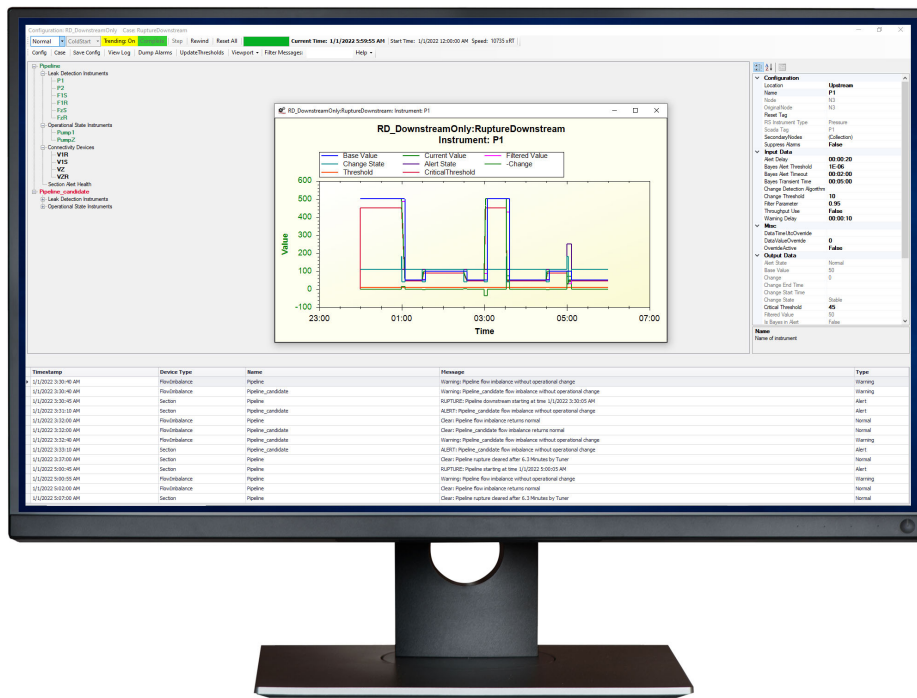
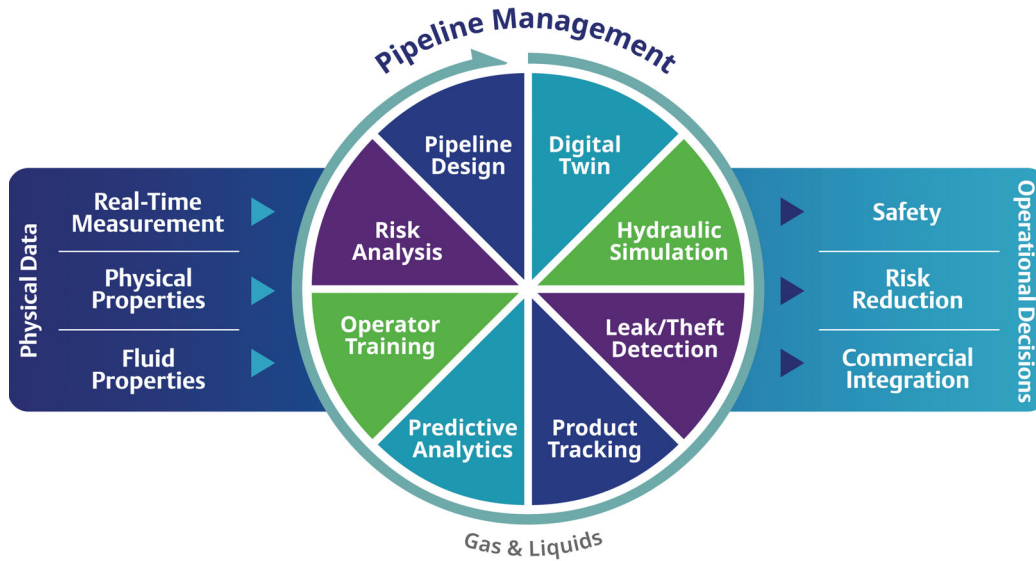


Figure 9: Increase the accuracy and reliability of rupture detection using pattern recognition and statistical analysis.

Agile Software Solutions for an Evolving Industry

Pipelines will continue to play a critical role in the future of energy transportation. Companies transporting hydrogen and CO₂ will likely use existing natural gas pipeline infrastructures. Carbon capture and sequestration programs will also rely on existing gas pipelines for transport. Emerson's software is built for the energy transition and will continue facilitating the transport of all products, including hydrogen, along the energy value chain as the transition to a low-carbon economy continues.



Streamline opportunities and overcome limitations by meeting commercial and operational objectives and regulatory requirements with our agile, field-proven software portfolio for gas and liquids pipelines.

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