Leak detection and localisation system
All rights reserved. It is prohibited to reproduce this documentation, or any part thereof, without the prior written authorisation of KROHNE Messtechnik GmbH.

Subject to change without notice.

Copyright 2013 by
KROHNE Messtechnik GmbH - Ludwig-Krohne-Str. 5 - 47058 Duisburg (Germany)
1 Safety instructions

1.1 Intended use
1.2 Safety instructions from the manufacturer
  1.2.1 Copyright and data protection
  1.2.2 Disclaimer
  1.2.3 Product liability and warranty
  1.2.4 Information concerning the documentation
  1.2.5 Warnings and symbols used
1.3 Safety instructions for the operator

2 Device description

2.1 Functionality
2.2 Hardware installation
2.3 Principle of Extended Real Time Transient Model [E-RTTM]
2.4 Leak localisation method

3 Operation

3.1 General safety notes
3.2 Start-up
3.3 Layout of user interface
  3.3.1 Status window
  3.3.2 Controls
  3.3.3 Operator windows
  3.3.4 Main Overview
  3.3.5 Pipeline Overview
  3.3.6 Trend
3.4 Detailed description of leak detection screens
  3.4.1 Leak information
  3.4.2 Events
  3.4.3 Alarm history
  3.4.4 Explanation [Legend]
3.5 Leak alarm handling
3.6 LDS system commands
  3.6.1 Stop and start the LDS
  3.6.2 Application alarm
3.7 Messages and error handling
  3.7.1 List of event messages
  3.7.2 List of alarm messages
  3.7.3 Troubleshooting
3.8 Expert functions on Operator Station
  3.8.1 User settings
  3.8.2 Default passwords
4 Service

4.1 Maintenance on the hardware ................................................................. 44
  4.1.1 Filters ............................................................................................. 44
  4.1.2 Mechanical damages ..................................................................... 44

4.2 Availability of services ......................................................................... 44

5 Notes ........................................................................................................ 45
1.1 Intended use

PipePatrol is a leak detection and localisation system for liquid and gas pipelines which operates in the stand-alone mode without any human interaction. It can be used during pumping, ramp-up, ramp-down, shut in and standstill conditions and allows continuous monitoring during all operating conditions. Additionally, functionalities are the batch tracking and the instrument error analysis.

1.2 Safety instructions from the manufacturer

1.2.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

The contents and works in this document are subject to copyright. Contributions from third parties are identified as such. Reproduction, processing, dissemination and any type of use beyond what is permitted under copyright requires written authorisation from the respective author and/or the manufacturer.

The manufacturer tries always to observe the copyrights of others, and to draw on works created in-house or works in the public domain.

The collection of personal data (such as names, street addresses or e-mail addresses) in the manufacturer’s documents is always on a voluntary basis whenever possible. Whenever feasible, it is always possible to make use of the offerings and services without providing any personal data.

We draw your attention to the fact that data transmission over the Internet (e.g. when communicating by e-mail) may involve gaps in security. It is not possible to protect such data completely against access by third parties.

We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.2.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect or incidental and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.
1.2.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation and operation of the devices (systems) will cause the warranty to be void. The respective “Standard Terms and Conditions” which form the basis for the sales contract shall also apply.

1.2.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of underneath icons.
1.2.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.

**DANGER!**
This information refers to the immediate danger when working with electricity.

**DANGER!**
This warning refers to the immediate danger of burns caused by heat or hot surfaces.

**DANGER!**
This warning refers to the immediate danger when using this device in a hazardous atmosphere.

**DANGER!**
These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator’s plant.

**WARNING!**
Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator’s plant.

**CAUTION!**
Disregarding these instructions can result in damage to the device or to parts of the operator’s plant.

**INFORMATION!**
These instructions contain important information for the handling of the device.

**LEGAL NOTICE!**
This note contains information on statutory directives and standards.

- **HANDLING**
  This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

- **RESULT**
  This symbol refers to all important consequences of the previous actions.

1.3 Safety instructions for the operator

**WARNING!**
In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel. This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.
2.1 Functionality

**INFORMATION!**
For detailed overview about the system architecture please refer to the "Functional Design Specification (FDS)" of the project.

The PipePatrol leak detection system (LDS) station will be configured to provide the following main features:

**Monitoring Station (LDS server)**
- Leak detection and localisation in pumping and standstill conditions
- Calculation of the leak rate
- Calculation of the leak location
- Remote maintenance via a remote access gateway (if connection is available)
- Alarming
- Data logging and event reporting
- Storing of reports and other data

**Operator Station (LDS client)**
- Visualisation of the running leak detection system
- Alarming (visual and acoustic)
- Trending
- Event logging
- Controlling & operating functions

2.2 Hardware installation

The Monitoring Station (MS) is completely installed before the start-up. No further installation is required.
2.3 Principle of Extended Real Time Transient Model (E-RTTM)

According to API 1130, leak detection systems can be categorised into external and internal systems. External systems include acoustic sensors and sensing cables that are placed alongside the pipeline. Due to the extremely high installation costs the use of external systems is usually restricted to high risk areas such as nature protection areas and near rivers. Internal systems are systems that perform leak detection based on measured parameters such as flow, pressure and temperature.

PipePatrol is an internal system based on E-RTTM [Extended Real Time Transient Model] and SMB [Statistical Mass Balance].

**E-RTTM**

E-RTTM is a combination of RTTM and leak pattern recognition by means of statistical analysis.

The fundamental principle is that RTTM is a series of algorithms that allow calculation of the flow, based solely on pressure and temperature readings at the inlet and outlet of the pipeline. To do this RTTM uses the conservation laws for mass, momentum and energy and the thermodynamic state equations for pressure and enthalpy.

When applying RTTM algorithms, the flow is not only measured by flowmeters but also calculated from pressure and temperature readings at the inlet and outlet. Subtracting the calculated flow from the measured flow gives the flow residual. Combining the two flow residuals gives the true flow residual (inlet minus outlet). The RTTM algorithms compensate for medium compressibility and line expansion.

**Leak pattern recognition**

Basically the leak pattern recognition algorithm constantly monitors whether the residual (difference between inlet and outlet flow after the transient effects have been compensated for by RTTM) exceed a predefined threshold. If this threshold is exceeded statistical analysis will be used to determine whether this is caused by a true leak or by a sensor drift.

**SMB**

SMB is a combination of compensated mass balance and leak pattern recognition by means of statistical analysis.

Compensated mass balance method is based on the equation of conservation of mass. The result of this equation is permanently passed to the leak pattern recognition, which analyses it statistically to avoid false alarms.
2.4 Leak localisation method

To identify the source of the leak accurately the following 3 localisation methods are combined in PipePatrol.

Gradient Intersection Method

![Gradient Intersection Method diagram]

Figure 2-1: Gradient Intersection Method

Under zero leak conditions, pressure drops uniformly along the pipeline. When a leak occurs, more liquid or gas flows through the pipeline before the leak than after it.

The pressure gradient along the pipeline therefore changes at the leak. The leak localisation can thus be identified at the point where the gradient changes.

Wave Propagation Method

![Wave Propagation Method diagram]

Figure 2-2: Wave Propagation Method

A sudden leak will cause a negative pressure wave in the pipeline, simply because gas or liquid is leaking out. This pressure wave will travel through the pipeline at the sound velocity of gas or liquid.

Depending on the localisation of the leak, the pressure wave will arrive at one end of the pipeline before it arrives at the other. The leak position can be calculated from the difference in the arrival times at the inlet and outlet.
Extended Wave Propagation Method

![Extended Wave Propagation Method](image)

Using the same physical principle as the wave propagation method, the extended method takes into account intermediate station measurements. Using the information from intermediate stations and E-RTTM’s knowledge about the velocity of sound profile in the pipeline, jitter error introduced by slow sensor scan rates can be eliminated.
3.1 General safety notes

**DANGER!**
This system operates on 230 VAC, 50/60 Hz. This current can cause serious injuries or death.

**WARNING!**
- None of the system components should be opened, unless by trained and certified electrical engineers.
- Damaged or interrupted electrical cables between the PC and the rest of the system, as well as terminated or damaged software, can lead to a failure in the leak detection system.
- The PCs must be properly grounded and cannot be used in an Ex area.

**INFORMATION!**
- Before shutting down (one of the) PCs all running software application should be closed in a normal way.
- The instructions mentioned in manuals from subsuppliers should be followed.
- Each operator must know the functionality of all functions that are accessible for this operator.
3.2 Start-up

The LDS software is automatically loaded after the monitoring station has been switched on. The software automatically starts to record measurement data and reaches its operational state shortly after start-up.

For the correct operation of the system, the following items should be considered:

- An uninterrupted power supply is required. Power supply variations can lead to re-starting of the computer and in the worst case cause the PC to crash.
- The data communication between monitoring station and the metering system must be running in order for the system to receive measurement data.

3.3 Layout of user interface

The main screen is the interface between the user and the leak detection system. The menu layout and the different windows are shown in the following drawing.

Figure 3-1: Layout of user interface

1. Status window
2. Operator window
3. Controls
3.3.1 Status window

The status window shows main information of each applicable system, which is available on each screen of the PipePatrol HMI. The functionality of each information is explained in the following part.

1. General error information from the operator station

The operator station is the PC where the actual HMI is running. The following information can be shown:
- Name of the user who is logged in
- Date and time of the operator station machine
- Error OPC Connection (red/flashing)

The connection to the OPC server of the leak detection software is lost.

2. Name of the leak detection system

The operator station HMI is designed to be able to monitor several running leak detection systems which are designated by a unique system name. A click on one of the systems, switches the operator screen to the leak information of the selected leak detection system.

3. Alarm information of the running leak detection

The system performs leak detection by using different modules. Each module provides alarm information by Signature-Test and Differential-Test. The usage of these modules depends on the actual running conditions of the pipeline.
- Shut-In: This module is performing an analysis of the pressure reading inside the closed pipe section. As long one of the readings is available it will perform leak detection for standstill conditions.
- E-RTTM: This module indicates the model based leak detection. It will be activated as long flow, pressure and temperature readings are available.
- Mass Balance: This module offers a statistical analysis of the inlet and outlet flow. As long both readings are available it will provide leak detection in pumping conditions.
- Following additional modules, following the same operating philosophy, may be available:
  - Virtual Flow
  - Substation Monitoring

The following information can be shown:
- Undefined (blue): LDS is not running; no leak information is available.
- Unknown (blue): LDS is starting-up; leak information will be available soon.
- No leak (green): The system is running; no leak is detected.
- Leak Alarm (red flushing): The system is up and running and a leak has been detected.
- Acknowledge alarm (blue): An alarm has been detected and confirmed by a logged operator.

4. States information of the running leak detection

The following state information are available:
- Main State: Indication of the main systems states.
- Pipeline State: Indication of the actual pipeline conditions.
- Watchdog: Indication of the actual status of the watchdog monitoring.
- Data State: Indication of the actual status of data gathering.
- Indication of the status of vapour monitoring along the line.

For detailed information refer to the following details.
Main State
A click on the "Main State" box of a system enables the change of the actual state.

The following information can be shown:
- **Undefined (blue)**: The system is not running; no system information is available.
- **Stopped (red)**: The system is stopped. The recording of data is still running.
- **Online-Mode (green)**: The system is running by using the current measured pipeline data.
- **Self Test-Mode (yellow)**: The system is running by using the recorded pipeline data.
- **Tuning-Mode (blue)**: Maintenance activities are carried out on the monitoring station. Therefore the leak detection is stopped at the moment.
- **Application alarm (red)**: An internal error of the leak detection software has been detected. System stopped working. A logged operator has to reset the alarm and to restart the system. If the failure occurs several times please contact our support.
- **Error (red)**: The application is not running correctly.

Pipeline State
The following information can be shown:
- **Undefined (blue)**: The system is not running; no information is available.
- **Unknown (blue)**: The system is filling up the internal FIFOs. There is not enough information available to estimate the pipeline conditions (possible after a restart of the system). The information will be available soon.
- **Shut-In (blue)**: The pipeline is running in shut-in conditions. Valves at the inlet and at the outlet are closed.
- **Multi Shut-in (blue)**: All valves are closed.
- **Partial Shut-in (blue)**: At least one section is closed.
- **Blocked Line (blue)**: Minimum one valve is closed, either at the inlet or at the outlet.
- **Standstill (blue)**: No flow conditions along the line. The flow readings are below a predefined value. Valves at the inlet and at the outlet are opened.
- **Start-Up (blue)**: The pipeline start-up with pumping operations. The flow readings are above a predefined value.
- **Shutdown (blue)**: The pumping operations stopped.
- **Nominal unknown (blue)**: The pipeline is running in pumping conditions at nominal flow level. The system is filling the internal FIFOs. There is not enough information available to estimate further exact pipeline conditions (possible after a restart of the system). Further pipeline information about pipeline conditions will be available soon.
- **Nominal high transient (blue)**: The pipeline is running in pumping conditions at nominal flow level. High transient conditions detected by high variation of flow readings.

Watchdog
A click on the "Watchdog" box of one of the systems opens a dialogue windows which is showing all available counters, monitored by the HMI.

The following information can be shown:
- **OK**: The watchdog counter of the system is updated within the timeout range.
- **Alarm (red/flashing)**: The watchdog counter of the system is not updated and exceeds the timeout range. The system might be not working correctly.
Data State
The following information can be shown:

- **Undefined**: The system is not running; no information is available.
- **Unknown**: The system is filling the internal FIFOs. There is not enough information available to estimate the pipeline conditions (possible after a restart of the system). The information will be available soon.
- **OK (green)**: All measured data is available.
- **Warning (yellow)**: Minimum one measured data is not available. This measurement is not essential for the functionality of the LDS. The system is working by using fall back values.
- **Error (red)**: Minimum one measured data is not available. This measurement is essential for the functionality of the LDS. The system holds functionality until the necessary measurements are back online.

Vapour State
The following information can be shown:

- **Undefined**: The system is not running; no information is available.
- **No (green)**: The pressure along the line is above the predefined vapour pressure (product property).
- **Warning (yellow)**: The pressure along the line is reaching the area of predefined vapour pressure (product property).
- **Small (red)**: The pressure along the line is slightly below the predefined vapour pressure (product property). Small cavitation can be expected.
- **Large (red)**: The pressure along the line is below the predefined vapour pressure (product property). Large cavitation can be expected.
- **Error (red)**: There is not enough information available to estimate the vapour conditions (possible reason is no pressure readings are available).
3.3.2 Controls

The control buttons, at the bottom of the screen, enable to switch between different screens. The offered buttons and their functionality depend on the actual showed screen. The meaning of them will be explained in detail in the next chapters. The following buttons are available on each screen:

![Figure 3-2: Control buttons](image)

1. Button to switch to last showed screen
2. Events
3. Alarm History
4. Explanation

1. Last showed screen:
   Switch back to the last showed screen.
   (After a start-up of the HMI this button has no functionality)
2. Shows the event list (for details refer to Events on page 26).
3. Shows the alarm history (for details refer to Alarm history on page 29).
4. Shows the legend screen (for details refer to Explanation (Legend) on page 30).

3.3.3 Operator windows

The operator window is the essential part of the PipePatrol HMI. With this screen the operator can look on the details of each running leak detection system, monitor the behaviour and control the system. The actual showed information depends on the selected screen.

Description of the offered screen architecture of the HMI

Main Overview
- Leak Information
- Trends
- Pipeline Overview
- Trends
- Login/Logoff
- User Settings
- Exit
- Events
- Alarm History
- Explanation
3.3.4 Main Overview

An overview of the most important data for all pipelines is given in the “Main Overview”. This screen is also the start-up screen after a reboot of the station computer.

For each pipeline that is included in the leak detection system, the following information can be seen:

- Actual volume/mass flow at inlet and outlet
- Actual temperature and pressure at inlet and outlet
- Description of the product at inlet and outlet (multi-product applications only)
- Graphical tracking of batches in the pipeline (for fluids applications only)

Figure 3-3: Main Overview screen

**INFORMATION!**

With a click on one of the available pipelines, the HMI will switch to the particular “Pipeline Overview” screen (details on page 20).
The following controls, at the bottom of the screen, are available on this screen:

1. **Last showed screen**
   Switch back to the last showed screen.
   (After a start-up of the HMI this button has no functionality)

2. **Exit/Shutdown the Operator Station**
   Menu to stop the HMI and get back to Windows or to shut down the machine.

3. **Login/Logoff**
   At start-up, the system logs in automatically the visitor account. This account only allows to view the process data. To get unrestricted access the user has to log in as a specific user. To do this, click on the “Login/Logoff” button. This button is only available from the “Main Overview” screen.
   If the operator is already logged in, the first click logs the account off. A second click on the button opens a dialogue box with request of login data. With “OK” the system proves the input and grants access.
   The system is delivered with a list of predefined users. That allows the operator crew to log into the system immediately.
   
   **Note:** If the current operator doesn’t take any actions for more than 3 minutes, his account will be automatically locked.

4. **User Settings**
   Menu for administration of the HMI user accounts. The details are part of the functional design specifications (FDS).
3.3.5 Pipeline Overview

By selecting one of the pipelines showed on the "Main Overview", a detailed overview of this particular pipeline will be displayed. In this paragraph the pipeline details for pipeline 1 are described, details are however exactly similar for all pipelines.

The following data is shown:

- Actual volume/mass flow at inlet and outlet
- Actual pressure at inlet and outlet
- Actual product temperature at inlet and outlet
- Actual ground temperature at inlet and outlet (optional)
- Actual density at inlet and outlet (optional)
- Actual standardised flow at inlet and outlet (optional)
- Velocity of sound at inlet and outlet (optional)
- Actual measurement data of additional sensors (e.g. intermediate stations, optional)
- Actual state of measurement
  - (grey): unknown
  - (green): OK
  - (red): faulty
- Valves position at inlet and outlet (optional)
  - (grey): unknown
  - (black): closed
  - (yellow): open
  - (yellow/grey): moving
  - (red): faulty
Additional information

- Batch data at inlet and outlet (optional)

**INFORMATION!**
Trending: The screen will switch to trending view.

### 3.3.6 Trend

Trend means the presentation of measurement data in a curve. Using a trend enables to review the actual measurement data. Since all the measured data is stored on the hard disk, the trend also allows tracking back historical events.

![Figure 3-5: Example of a trend screen](image)

1. **Drop down for selection of the type of trend (overall, inlet or outlet)**
2. **Control boxes for viewing or changing settings**

**Selection of trends**

Use drop down menu and the check boxes from the title of the trend (1) to select which trend has to be displayed. It is possible either to take a look on the measurements from one station only (e.g. inlet, outlet or both (overall)) or to select or deselect one or more measurements (e.g. flow, pressure, temperature etc.).

**Trend controls**

The control boxes (2) enable to change the settings of the trends and to scroll through the recorded data.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Help" /></td>
<td>Calls up the online help.</td>
</tr>
<tr>
<td><img src="image" alt="First data record" /></td>
<td>Course of a tag within the set time range is displayed. The display starts with the first archived value.</td>
</tr>
<tr>
<td><img src="image" alt="Previous data record" /></td>
<td>Course of a tag within the previous time range is displayed. The display starts with the currently set time interval.</td>
</tr>
<tr>
<td><img src="image" alt="Next data record" /></td>
<td>The course of a tag within the next time range is displayed. The display starts with the currently set time interval.</td>
</tr>
<tr>
<td><img src="image" alt="Last data record" /></td>
<td>The course of a tag within the set time range is displayed. The display ends with the last archived value.</td>
</tr>
<tr>
<td><img src="image" alt="Zoom area" /></td>
<td>Enlarge any area of the trend window.</td>
</tr>
<tr>
<td><img src="image" alt="Zoom +/-" /></td>
<td>Zoom the trend where the cursor mouse is pointing on.</td>
</tr>
<tr>
<td><img src="image" alt="Zoom time axis +/-" /></td>
<td>Zoom the time axis of the trend where the mouse cursor is pointing on.</td>
</tr>
<tr>
<td><img src="image" alt="Zoom value axis +/-" /></td>
<td>Zoom the value axis of the trend where the mouse cursor is pointing on.</td>
</tr>
<tr>
<td><img src="image" alt="Move trend range" /></td>
<td>Move the selected trend by using the mouse cursor.</td>
</tr>
<tr>
<td><img src="image" alt="Move axis range" /></td>
<td>Move the time or value axis of the selected trend by using the mouse cursor.</td>
</tr>
<tr>
<td><img src="image" alt="Original view" /></td>
<td>Return to the configured normal view from an enlarged trend display.</td>
</tr>
<tr>
<td><img src="image" alt="Select trends" /></td>
<td>Select or deselect several trends of the trending view. Minimum one trend has to be selected. With the buttons “Up” and “Down” it is possible to change the order of the displayed trends.</td>
</tr>
</tbody>
</table>
| ![Select time range](image) | Select a time range of the trending view. At minimum one trend has to be selected. **Settings:**  
- **Trends:** Select the trend, which time range has to be modified.  
- **Time range:** Several options are available to set the time range of the selected trend.  
  0 - Time range [set the start time and time range]  
  1 - Start and end time [set the start and end time]  
  2 - Number of measurement points [set the start and number of measurement points] |
<p>| <img src="image" alt="Previous trend" /> | The previous trend in the trend view will be marked as the active one. |</p>
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="symbol" alt="Next trend" /></td>
<td><strong>Next trend</strong>&lt;br&gt;The next trend in the trend view will be marked as the active one.</td>
</tr>
<tr>
<td><img src="symbol" alt="Start/Stop" /></td>
<td><strong>Start/Stop</strong>&lt;br&gt;Stops the updated display. The values are stored in a clipboard and re-entered after activating the button again.</td>
</tr>
<tr>
<td><img src="symbol" alt="Print" /></td>
<td><strong>Print</strong>&lt;br&gt;The current view will be printed out, if a printer is connected and configured.</td>
</tr>
</tbody>
</table>
| ![Export data](symbol) | **Export data**<br>Export the actual trend to a file.  
**Settings:**  
- **File name and directory:** Select the file name and the folder where the exported data has to be stored.  
- **Scope of data export:** Select between two options for data export.  
  0 - All (all data in the trending window will be exported)<br>  1 - Selection (only the selected view will be exported)<br>  - **Format:** Only “CSV” available as file extension. A click on the right box enables to set a delimiter symbol for the data export. |
| ![Ruler](symbol) | **Ruler**<br>Upright will be showed. |
| ![Define statistics area](symbol) | **Define statistics area**<br>This button is used to define the time range for calculating the statistics in the trend window. |
| ![Calculate Statistics](symbol) | **Calculate Statistics**<br>The button shows the statistical values in the statistics window. The displayed values refer to a selected trend with the configured calculation time range. The button is only functional if a statistics window is connected with the “OnlineTrendControl”. |
3.4 Detailed description of leak detection screens

3.4.1 Leak information

The "Leak Information" screen is showing in details the results which are generated by the leak detection system. In the standard configuration the information is divided into three parts: E-RTTM, Mass Balance (or Statistical Flow Balance) and Shut-In leak detection.

For each leak detection module the following information are available:

**Alarm State**

The following information can be shown:

- **Undefined (grey):** No information available (possible reason: the module is not running).
- **No leak (green):** Pipeline is running in leak free conditions.
- **Alarm (red):** Leak detected.
- **Alarm acknowledge (red):** A leak alarm has been acknowledge by the operator.
- **Alarm pressure Rising (red):** A positive pressure wave was detected (only for the Shut-In module)
- **Alarm pressure Drop (red):** A negative pressure wave was detected (only for the Shut-In module)

Figure 3-6: Example of leak detection screen

1. E-RTTM leak detection
2. Mass Balance leak detection
3. Shut-In leak detection
4. Button to switch to trend view of this module
Sensitivity
The actual sensitivity level of the module under current conditions. The Shut-In module is showing on the one hand the overall sensitivity of the module, on the other hand it shows the sensitivity of each monitored pressure transmitter (which can show different sensitivity states).

The following information can be shown:
- **Undefined**: The module is not running.
- **No Sensitivity**: No sensitivity available.
- **Lowest Sensitivity**
- **Low Sensitivity**
- **High Sensitivity**
- **Highest Sensitivity**: The module is offering the highest available sensitivity.
- **Mixed Sensitivity**: For the Shut-In module only. The sensitivities of the monitored pressure transmitters are showing different sensitivity states.

Running Leak Rate/Running Pressure Drop
For the Signature-Test and Differential-Test of the E-RTTM module, as well as for the Mass Balance module, it shows the average value of the estimated leak rate in volume or mass flow. For the Shut-In conditions it shows the average value of the estimated pressure drops.

Pos. and neg. Leak Threshold under current conditions
For the Signature-Test and Differential-Test of the E-RTTM module, as well as for the Mass Balance module, it shows the smallest detectable leak rate. For the Shut-In conditions it shows the smallest detectable pressure drop.

**INFORMATION!**
- In case of an alarm it shows the leak rate and leak location.
- The provided information of each module are also available as trending view by selecting the trend button \( \text{[4]} \) of each module.
3.4.2 Events

The "Events" screen shows all pending and historical events of the system (e.g. changes in states, etc.).

The following information will be shown:

- Number
- Date
- Time
- User name (name of the logged user)
- Message
- Pipeline (running LDS will change the states)
- State of the message (green: coming; red: going)

![Image of "Events" screen]

Figure 3-7: Example of "Events" screen

1. List of events
2. Control boxes to view and print events

**INFORMATION!**

Each event will be displayed in a separate line.

The following information will be shown:
**Event controls**
The control boxes, at the left side of the event view, offer the possibility to scroll through the recorded event data.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Help</strong> Calls up the online help.</td>
</tr>
<tr>
<td></td>
<td><strong>Configuration dialog</strong> Opens the configuration dialog, in which you can change the properties of the function.</td>
</tr>
<tr>
<td></td>
<td><strong>Message list</strong> Shows the actual event list.</td>
</tr>
<tr>
<td></td>
<td><strong>Short-term archive list</strong> Shows the messages stored in the short-term archive.</td>
</tr>
<tr>
<td></td>
<td><strong>Long-term archive list</strong> Shows the messages stored in the long-term archive.</td>
</tr>
<tr>
<td></td>
<td><strong>Print</strong> Current view will be printed, if a printer is connected and configured.</td>
</tr>
<tr>
<td></td>
<td><strong>Export data</strong> Dialogue box for export of the actual event to a file.</td>
</tr>
<tr>
<td></td>
<td><strong>Settings:</strong></td>
</tr>
<tr>
<td></td>
<td>• <strong>File name and directory:</strong> Select the file name and the folder where the exported data should be stored.</td>
</tr>
<tr>
<td></td>
<td>• <strong>Scope of data export:</strong> Selection between two options for data export.</td>
</tr>
<tr>
<td></td>
<td>0 - All (all data in the event list window will be exported)</td>
</tr>
<tr>
<td></td>
<td>1 - Selection (only the selected view will be exported)</td>
</tr>
<tr>
<td></td>
<td>• <strong>Format:</strong> Only &quot;CSV&quot; available as file extension. Clicking on the right box enables to set a delimiter symbol for the data export.</td>
</tr>
<tr>
<td></td>
<td><strong>Autoscroll</strong> If selected, the event list will automatically insert new events at the beginning of the list and will scroll down, so at any time the actual events are visible.</td>
</tr>
<tr>
<td></td>
<td><strong>First message</strong> List will be scrolled to the newest incoming message.</td>
</tr>
<tr>
<td></td>
<td><strong>Previous message</strong> Depending on the current selected message the previous message will be selected.</td>
</tr>
<tr>
<td></td>
<td><strong>Next message</strong> Depending on the current selected message the next message will be selected.</td>
</tr>
<tr>
<td></td>
<td><strong>Last message</strong> List will be scrolled to the latest upcoming message.</td>
</tr>
<tr>
<td></td>
<td><strong>First page</strong> List will be scrolled to the first page of the long-term archive. Only available if long-term archive is selected.</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| ![Previous page](https://www.krohne.com) | **Previous page**  
List will be scrolled to the previous page of the long-term archive. Only available if long-term archive is selected. |
| ![Next page](https://www.krohne.com) | **Next page**  
List will be scrolled to the next page of the long-term archive. Only available if long-term archive is selected. |
| ![Last page](https://www.krohne.com) | **Last page**  
List will be scrolled to the last page of the long-term archive. Only available if long-term archive is selected. |

The complete list of possible messages is available on page 38.
3.4.3 Alarm history

The "Alarm History" screen is showing all pending and historical alarms of the system (e.g. leak alarms, system alarms).

![Figure 3-8: Example of "Alarm History" screen](image)

1. List of alarms
2. Control boxes to view and print events of the alarm history list

INFORMATION!
Each message in the "Alarm History" will be displayed in a separate line.

The following information will be shown:

- Number
- Date
- Time
- User name (name of the logged user)
- Message
- Pipeline (running LDS which raised the alarm)
- State of the message (green: coming; red: going)

The controls of the alarm history are offering the same functionality as the ones on the events screen. For details refer to Events on page 26.

The complete list of possible messages can be found on page 41.
3.4.4 Explanation (Legend)

Figure 3-9: Example of “Legend” screen

1. Symbols of valves
2. Symbols of measuring points
3. Pointers of the leak positions
4. Data box
5. PLC

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Colour of filling/outline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>grey</td>
<td>Position unknown / undefined</td>
</tr>
<tr>
<td>1.2</td>
<td>black</td>
<td>Valve closed</td>
</tr>
<tr>
<td>1.3</td>
<td>white/orange</td>
<td>Valve moved</td>
</tr>
<tr>
<td>1.4</td>
<td>yellow</td>
<td>Valve opened</td>
</tr>
<tr>
<td>1.5</td>
<td>red</td>
<td>Valve error</td>
</tr>
<tr>
<td>2.1</td>
<td>black</td>
<td>Pressure sensor</td>
</tr>
<tr>
<td>2.2</td>
<td>black</td>
<td>Temperature sensor</td>
</tr>
<tr>
<td>2.3</td>
<td>black</td>
<td>Flow sensor</td>
</tr>
<tr>
<td>2.4</td>
<td>black</td>
<td>State of sensor: unknown / undefined</td>
</tr>
<tr>
<td>2.5</td>
<td>orange</td>
<td>State of sensor: initialisation</td>
</tr>
<tr>
<td>2.6</td>
<td>green</td>
<td>State of sensor: OK</td>
</tr>
<tr>
<td>2.7</td>
<td>red</td>
<td>State of sensor: error</td>
</tr>
</tbody>
</table>
3.5 Leak alarm handling

In this chapter it is described step by step how a leak alarm should be confirmed and how the LDS system can be reset.

**INFORMATION!**

This chapter only concerns the LDS. With regards to possible additional actions, the company policy should be followed.

In the standard configuration the system differs of four different kinds of leak alarms, which are coming from four different modules. Three alarms are possible during pumping conditions of the fluid, Signature-Alarm and Differential-Alarm and Mass Balance-alarm. During Shut-In operation these modules are disabled. In cases of leak during shut-in conditions, the Shut-In module will alarm if a leak is recognised.

The following example gives a detailed view on the alarm raises by the Signature-Test module of the E-RTTM leak detection.

In some cases during transient operation several modules, e.g. Signature-Test and Differential-Test, are able to raise an alarm. In this case all incoming alarms and leak information will be displayed. Additionally the alarm will be indicated by an acoustic signal of the Operator Station. The procedures and the order how to manage a leak alarm coming from another module are similar to the procedures described in the following. All screens and buttons described in this chapter are available in the same mode, see the special boxes for each module.

**INFORMATION!**

Each of the occurred alarms has to be acknowledged separately by the operator.
**Alarm handling procedure**

When a leak alarm occurs, this will be highlighted in both the “Status Window” and the “Operator Window” by means of red boxes (1).

If a leak alarm was raised, by any running LDS, the PipePatrol HMI returns automatically to the “Main Overview” screen.

**Step 1: Recognise leak and switch to “Leak Information” screen**

![Figure 3-10: Example of leak indication in “Main Window”](image)

1. Module which raise the alarm will be indicate in red (flashing)
2. Alarming system (affected pipeline) will be shown in red
3. Right click on the alarming system to switch to the “Leak Information” screen for details on the leak
Once the operator selects the alarming system the screen with additional information about the leak will be shown. In the red box details are given on the leak rate and the leak location.

**Step 2: Open leak detection details in “Pipeline Overview” screen**

1. Leak location is showed with an arrow (different colours dep. on the module) along the line
2. Numeric presentation of leak data for the alarming module is shown
3. Control to open the trending of the leak data of the alarming module
Clicking on the alarming box (①) of the module which raised the alarm, opens a dialogue box with the functionality to acknowledge the alarm (②) and to close afterwards the dialogue box.

Step 3: Acknowledge the alarm

Figure 3-12: Acknowledge the alarm

① Alarming box to open dialogue for acknowledgement
② Control to select “Alarm acknowledge”

**INFORMATION!**
After step 3 it is a good possibility to analyse the leak alarm using the trends and LDS data.
After the leak alarm has been acknowledged, the operator can either reset the classificatory only or reset the whole software and reinitialise the LDS.

**Reset the classificatory** means that the system is running in alarming state and therefore the modules which raised the alarm will not be able to recognise a new leak.

By executing an LDS reset, the system will start again to perform a leak detection. Indeed a reset of the LDS will take more time till the system is ready to detect leaks. This depends for example on the length of the pipeline, on the numbers of intermediate station along the pipeline, etc.

In these kind of applications it is more practicable if a leak occurs only to reset the classificator instead of restart the LDS. However, before doing so it must be sure that no leak is present in the line.

**INFORMATION!**

To reset any incoming alarm an operator has to be logged into the HMI with the authorisation of the operator group.

**Step 4: Reset the alarm**

![Figure 3-13: Reset the alarm](image)

1. Alarming box to open dialogue for alarm reset
2. Control to reset the classificator
3. Control to reset the complete leak detection system

**INFORMATION!**

After a reset of the system, the system will first go into a reinitialising phase. During this phase no leak information will be available. The time period of this phase is application dependant.
3.6 LDS system commands

3.6.1 Stop and start the LDS

It may be required from time to time to stop the LDS and then to put it back online again. This can be done from each screen by clicking on “Main State” in the “Status Window” of the selected system.

**Figure 3-14: LDS commands**

1. “Main State” box to control the system
2. Select “Stop” to stop the system and afterwards “close” the dialogue box

Only the currently possible commands will be enabled (i.e. if the system is online therefore only “Stop” is enabled).

- **Stop**
  Stops the LDS for the current pipeline.

- **Online**
  Starts the LDS for the current pipeline.

- **Reset SW-Alarm**
  Resets an application alarm that has been raised for a pipeline (for details refer to Application alarm on page 37).

**INFORMATION!**
Each of the displayed pipelines can be stopped separately.
3.6.2 Application alarm

**CAUTION!**
Weather this malfunction occurs, contact the manufacturer immediately to check-up the system!

In some cases it could happen that the current system conditions lead into a system failure. If this happens, the leak detection will stop and raise an application alarm shown in the “Main State” box of the "Status Window".

![Figure 3-15: Application alarm and reset of this alarm](image)

1. “Main State” box with the application alarm
2. Select "Reset SW-Alarm" to reset the system and afterwards "close" the dialogue box

After pressing the button [2], the system performs a restart and goes into the “Stop” mode. The operator has to set the system back online (for details refer to *Stop and start the LDS on page 36*).
3.7 Messages and error handling

In the next pages the alarm messages are rated by a priority. The following table gives you a description of the priority and the needed action to be taken after appearance of the message.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>fatal</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>2</td>
<td>serious</td>
<td>Proceed according to the written procedures of your company.</td>
</tr>
<tr>
<td>3</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>information only</td>
<td>-</td>
</tr>
</tbody>
</table>

3.7.1 List of event messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Priority</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leak Alarm State: No Alarm</td>
<td>4</td>
<td>The LDS judges this line to be leak free. No one of the alarming module recognised a leak.</td>
</tr>
<tr>
<td>Leak Alarm State: Alarm</td>
<td>2</td>
<td>For this pipeline a leak has been detected. One of the alarming module recognised a leak. The operator is asked to confirm the leak.</td>
</tr>
<tr>
<td>Leak Alarm State: Alarm Acknowledge</td>
<td>3</td>
<td>An alarm has been confirmed by the operator.</td>
</tr>
<tr>
<td>E-RTTM Signature-Test: No Leak</td>
<td>4</td>
<td>The LDS judges this line to be leak free. No dynamic leak signature recognised.</td>
</tr>
<tr>
<td>E-RTTM Signature-Test: Alarm</td>
<td>2</td>
<td>For this pipeline a leak has been detected. A dynamic leak signature during pumping conditions has been recognised. The operator is asked to confirm the leak.</td>
</tr>
<tr>
<td>E-RTTM Signature-Test: Alarm Acknowledge</td>
<td>3</td>
<td>An alarm has been confirmed by the operator.</td>
</tr>
<tr>
<td>Shut-In: No Leak</td>
<td>4</td>
<td>The LDS judges this line to be leak free.</td>
</tr>
<tr>
<td>Shut-In: Alarm</td>
<td>2</td>
<td>For this pipeline a leak has been detected. A dynamic leak signature during Shut-In conditions has been recognised. The operator is asked to confirm the leak.</td>
</tr>
<tr>
<td>Shut-In: Alarm Acknowledge</td>
<td>3</td>
<td>An alarm has been confirmed by the operator.</td>
</tr>
<tr>
<td>E-RTTM Differential-Test: No Leak</td>
<td>4</td>
<td>The LDS judges this line to be leak free. No slow leak signature recognised.</td>
</tr>
<tr>
<td>E-RTTM Differential-Test: Alarm</td>
<td>2</td>
<td>For this pipeline a leak has been detected. A slow leak signature during pumping conditions has been recognised. The operator is asked to confirm the leak.</td>
</tr>
<tr>
<td>E-RTTM Differential-Test: Alarm Acknowledge</td>
<td>3</td>
<td>An alarm has been confirmed by the operator.</td>
</tr>
<tr>
<td>Mass Balance: No Leak</td>
<td>4</td>
<td>The LDS judges this line to be leak free. No statistic leak signature recognised.</td>
</tr>
<tr>
<td>Mass Balance: Alarm</td>
<td>2</td>
<td>For this pipeline a leak has been detected. The operator is asked to confirm the leak. A statistic leak signature during pumping conditions has been recognised.</td>
</tr>
<tr>
<td>Mass Balance: Alarm Acknowledge</td>
<td>3</td>
<td>An alarm has been confirmed by the operator.</td>
</tr>
<tr>
<td>E-RTTM Signature-Test: Alarm Acknowledge (User)</td>
<td>3</td>
<td>An alarm has been confirmed by the operator logged on the operator station.</td>
</tr>
<tr>
<td>E-RTTM Signature-Test: Reset Classifier (User)</td>
<td>3</td>
<td>A reset of the classificator has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>Message</td>
<td>Priority</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>E-RTTM Signature-Test: Reset Leak Detection [User]</td>
<td>3</td>
<td>A reset of the leak detection has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>E-RTTM Differential-Test: Alarm Acknowledge [User]</td>
<td>3</td>
<td>An alarm has been confirmed by the operator logged on the operator station.</td>
</tr>
<tr>
<td>E-RTTM Differential-Test: Reset Classifier [User]</td>
<td>3</td>
<td>A reset of the classifier has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>E-RTTM Differential-Test: Reset Leak Detection [User]</td>
<td>3</td>
<td>A reset of the leak detection has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>Mass Balance: Alarm Acknowledge [User]</td>
<td>3</td>
<td>An alarm has been confirmed by the operator logged on the operator station.</td>
</tr>
<tr>
<td>Mass Balance: Reset Classifier [User]</td>
<td>3</td>
<td>A reset of the classifier has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>Mass Balance: Reset Leak Detection [User]</td>
<td>3</td>
<td>A reset of the leak detection has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>Shut-In: Alarm Acknowledge [User]</td>
<td>3</td>
<td>An alarm has been confirmed by the operator logged on the operator station.</td>
</tr>
<tr>
<td>Shut-In: Reset Classifier [User]</td>
<td>3</td>
<td>A reset of the classifier has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>Shut-In: Reset Leak Detection [User]</td>
<td>3</td>
<td>A reset of the leak detection has been executed by the operator on the operator station.</td>
</tr>
<tr>
<td>Leak Detection E-RTTM: Initialising</td>
<td>4</td>
<td>The module for model based LD in pumping conditions is starting up and will be online soon.</td>
</tr>
<tr>
<td>Leak Detection E-RTTM: Standby</td>
<td>4</td>
<td>The module for model based LD in pumping conditions is initialising the pipeline conditions, after initialisation the module will start-up.</td>
</tr>
<tr>
<td>Leak Detection E-RTTM: Running</td>
<td>4</td>
<td>The module for model based LD in pumping conditions is running.</td>
</tr>
<tr>
<td>Leak Detection E-RTTM: Error</td>
<td>1</td>
<td>A serious error occurred automatically (e.g. instrument outtake).</td>
</tr>
<tr>
<td>Leak Detection Shut-In: Initialising</td>
<td>4</td>
<td>The module for leak detection in shut-in conditions is starting up and will be online soon.</td>
</tr>
<tr>
<td>Leak Detection Shut-In: Standby</td>
<td>4</td>
<td>The module for leak detection in shut-in conditions is initialising the pipeline conditions, after initialisation the module will start up.</td>
</tr>
<tr>
<td>Leak Detection Shut-In: Running</td>
<td>4</td>
<td>The module for leak detection in shut-in conditions is running.</td>
</tr>
<tr>
<td>Leak Detection Shut-In: Error</td>
<td>1</td>
<td>A serious error occurred automatically (e.g. instrument outtake).</td>
</tr>
<tr>
<td>Leak Detection Mass Balance: Initialising</td>
<td>4</td>
<td>The statistical leak detection module is starting up and will be online soon.</td>
</tr>
<tr>
<td>Leak Detection Mass Balance: Standby</td>
<td>4</td>
<td>The statistical leak detection module initialising the pipeline conditions, after initialisation the module will start-up.</td>
</tr>
<tr>
<td>Leak Detection Mass Balance: Running</td>
<td>4</td>
<td>The statistical leak detection module is running to detect leaks during standstill conditions.</td>
</tr>
<tr>
<td>Leak Detection Mass Balance: Error</td>
<td>1</td>
<td>A serious error occurred automatically (e.g. instrument outtake).</td>
</tr>
<tr>
<td>Data Processing: Best Condition</td>
<td>4</td>
<td>All field signals are available.</td>
</tr>
<tr>
<td>Data Processing: Warning</td>
<td>3</td>
<td>One or more signals are not available. The LDS is still running and performing leak detection.</td>
</tr>
<tr>
<td>Data Processing: Error</td>
<td>1</td>
<td>One or more signals are not available. The LDS is on pending till the necessary measurements are back online.</td>
</tr>
<tr>
<td>Message</td>
<td>Priority</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Leak Detection System: Stop</td>
<td>4</td>
<td>The system has stopped and the following functions are no longer supported:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leak Detection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Batch tracking (optional)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pipeline conditions are recognised</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Data logging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Nominal value calculation</td>
</tr>
<tr>
<td>Leak Detection System: Online-Mode</td>
<td>4</td>
<td>The system is running and the following functions are supported:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leak Detection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Batch tracking (optional)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pipeline conditions are recognised</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Data logging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Nominal value calculation</td>
</tr>
<tr>
<td>Leak Detection System: Self Test-Mode</td>
<td>4</td>
<td>The LDS system is being tested using historical data. Leak detection is not active.</td>
</tr>
<tr>
<td>Leak Detection System: Tuning-Mode</td>
<td>4</td>
<td>Maintenance activities are carried out on the monitoring station. Leak detection is not active.</td>
</tr>
<tr>
<td>Leak Detection System: Error</td>
<td>1</td>
<td>The application is not running correctly.</td>
</tr>
<tr>
<td>Stop Command Leak Detection System</td>
<td>3</td>
<td>A stop command has been received. The system is going to shut down.</td>
</tr>
<tr>
<td>Online Command Leak Detection System</td>
<td>3</td>
<td>An online command has been received. The system is starting up.</td>
</tr>
<tr>
<td>Offline Command Leak Detection System</td>
<td>3</td>
<td>An offline command has been received. The system is going to “Self-Test” mode.</td>
</tr>
<tr>
<td>Reset Command Leak Detection System</td>
<td>3</td>
<td>A reset has been executed. The system will be restarting.</td>
</tr>
<tr>
<td>Leak Detection System: Application Alarm</td>
<td>1</td>
<td>An internal error of the leak detection software has been detected. System will go in “Stop” mode and can be reset by the user. Please contact our support.</td>
</tr>
<tr>
<td>Flow-Tracker: Unknown</td>
<td>4</td>
<td>The system is starting-up, the classification of the flow is not available.</td>
</tr>
<tr>
<td>Flow-Tracker: Standstill Safe</td>
<td>4</td>
<td>The stand still model is running to detect leaks in a closed pipeline.</td>
</tr>
<tr>
<td>Flow-Tracker: Standstill</td>
<td>4</td>
<td>The pipeline has been shut down but is still not closed.</td>
</tr>
<tr>
<td>Flow-Tracker: Starting up</td>
<td>4</td>
<td>The pumps are starting up.</td>
</tr>
<tr>
<td>Flow-Tracker: Shutdown</td>
<td>4</td>
<td>The pumps are shutting down.</td>
</tr>
<tr>
<td>Flow-Tracker: Nominal Unknown</td>
<td>4</td>
<td>The pipeline is operating in unknown conditions.</td>
</tr>
<tr>
<td>Flow-Tracker: Nominal High / Low Transient</td>
<td>4</td>
<td>The pipeline is operating in transient pumping conditions.</td>
</tr>
<tr>
<td>Flow-Tracker: Nominal Steady</td>
<td>4</td>
<td>The pipeline is operating in stationary pumping conditions.</td>
</tr>
<tr>
<td>Pressure-Tracker: Unknown</td>
<td>4</td>
<td>The system is starting-up, the classification of the pressure is not available.</td>
</tr>
<tr>
<td>Pressure-Tracker: Steady</td>
<td>4</td>
<td>The pipeline is operating in stationary pumping or standstill conditions.</td>
</tr>
<tr>
<td>Pressure-Tracker: Low / High Transient</td>
<td>4</td>
<td>The pipeline is operating in transient pumping or standstill conditions.</td>
</tr>
<tr>
<td>no connect to LDS-MS</td>
<td>1</td>
<td>The communication between the operator [OS] and monitoring station [MS] is connected [e.g. the network connection is lost or the MS is down].</td>
</tr>
</tbody>
</table>
### 3.7.2 List of alarm messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Priority</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>State E-RTTM Signature-Test: Alarm</td>
<td>2</td>
<td>The E-RTTM module Signature-Test detects a leak.</td>
</tr>
<tr>
<td>State E-RTTM Differential-Test: Alarm</td>
<td>2</td>
<td>The E-RTTM module Differential-Test detects a leak.</td>
</tr>
<tr>
<td>State Shut-In Signature-Test: Alarm</td>
<td>2</td>
<td>The Shut-In module Signature-Test detects a leak.</td>
</tr>
<tr>
<td>Shut-In Inlet: Alarm Pressure Rising</td>
<td>2</td>
<td>The Shut-In module Signature-Test detects a leak and indicates that the inlet transmitter shows a positive pressure wave.</td>
</tr>
<tr>
<td>Shut-In Inlet: Alarm Pressure Drop</td>
<td>2</td>
<td>The Shut-In module Signature-Test detects a leak and indicates that the inlet transmitter shows a negative pressure wave.</td>
</tr>
<tr>
<td>Shut-In Outlet: Alarm Pressure Rising</td>
<td>2</td>
<td>The Shut-In module Signature-Test detects a leak and indicates that the outlet transmitter shows a positive pressure wave.</td>
</tr>
<tr>
<td>Shut-In Outlet: Alarm Pressure Drop</td>
<td>2</td>
<td>The Shut-In module Signature-Test detects a leak and indicates that the outlet transmitter shows a negative pressure wave.</td>
</tr>
<tr>
<td>Leak Detection System: Application Alarm</td>
<td>2</td>
<td>The system stopped working due to an internal error.</td>
</tr>
<tr>
<td>Alarm LDS-Watchdog</td>
<td>2</td>
<td>A failure of the leak detection system. The Leak Detection software is not working correctly.</td>
</tr>
</tbody>
</table>
3.7.3 Troubleshooting

For troubleshooting it is necessary that the maintenance crew has a profound knowledge of the leak detection system.

Possible errors can be divided in internal and external. Internal errors are declared as occurring in the leak detection software program, e.g. an incorrect parameter setting. External errors are failures outside the LDS operator or monitoring station, e.g. a failure in the data communication system.

### Internal error

<table>
<thead>
<tr>
<th>Error</th>
<th>Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The status window of the OS indicates a system error</td>
<td>Wrong parameter setting</td>
<td>Correct parameter.</td>
</tr>
<tr>
<td>The status window of the OS indicates a system error</td>
<td>Internal error</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>No reaction when PC is switched on</td>
<td>No power available</td>
<td>Check electrical connection.</td>
</tr>
<tr>
<td>No reaction when PC is switched on</td>
<td>Power supply failure</td>
<td>Check the power supply of each LDS station.</td>
</tr>
<tr>
<td>No reaction when PC is switched on</td>
<td>Other reason</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>The PC does not boot</td>
<td>Disk or CD in drive</td>
<td>Take out disk and press any key.</td>
</tr>
<tr>
<td>The PC does not boot</td>
<td>Other reason</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>PC starts-up, software loads but LDS is not operational</td>
<td>Error in software/hardware or outside the PipePatrol software.</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>PC does not boot and internal speaker gives signal</td>
<td>Component in PC broken</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>The data states on the user HMI reports periodically data errors</td>
<td>Runtime problems caused by the installed operating system</td>
<td>Restart the monitoring station. If the system is reporting the error again contact the manufacturer.</td>
</tr>
<tr>
<td>The “Status Window” of the user HMI indicates ERROR OPC-Connection</td>
<td>Connection to the LDS OPC-Server fails</td>
<td>Restart the monitoring station. If the system is reporting the error again contact the manufacturer.</td>
</tr>
</tbody>
</table>

### External error

<table>
<thead>
<tr>
<th>Error</th>
<th>Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The “Status Window” of the OS indicates that the LDS is not working or “Data State” indicates data error/warning while the pipeline is in normal use</td>
<td>A measurement sensor is broken</td>
<td>Check status of datacom</td>
</tr>
<tr>
<td>The “Status Window” of the OS indicates that the LDS is not working or “Data State” indicates data error/warning while the pipeline is in normal use</td>
<td>Data communication is lost</td>
<td></td>
</tr>
<tr>
<td>The “Status Window” of the OS indicates that the LDS is not working or “Data State” indicates data error/warning while the pipeline is in normal use</td>
<td>Some transmitted signals are out of the predefined range</td>
<td></td>
</tr>
<tr>
<td>The “Status Window” of the OS indicates that the LDS is not working or “Data State” indicates data error/warning while the pipeline is in normal use</td>
<td>No signal received from valve position change</td>
<td></td>
</tr>
<tr>
<td>The “Status Window” of the OS indicates that the LDS is not working or “Data State” indicates data error/warning while the pipeline is in normal use</td>
<td>No signal received from batch change</td>
<td></td>
</tr>
</tbody>
</table>
3.8 Expert functions on Operator Station

3.8.1 User settings

Clicking on the button "User Settings" in the "Main Overview" screen of the PipePatrol HMI, opens the "User Administration".

In "User Administration" the following settings are available:

- add new users and user group
- change the user permission
- change the access protection
- block specific functions
- automatically log of a user after a certain period

3.8.2 Default passwords

Operating system
The following password allows you to login to both machines: Operator Station and Monitoring Station

<table>
<thead>
<tr>
<th>Name</th>
<th>Password</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrator</td>
<td>Administrator</td>
<td>Administrator</td>
</tr>
</tbody>
</table>

HMI
The system is delivered with a list of predefined users. That allows the operator crew to login into the system.

<table>
<thead>
<tr>
<th>Name</th>
<th>Password</th>
<th>Group</th>
<th>Permissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrator</td>
<td>Administrator</td>
<td>Administrator</td>
<td>All</td>
</tr>
<tr>
<td>Visitor</td>
<td>Visitor</td>
<td>User</td>
<td>Change screens</td>
</tr>
<tr>
<td>Merchandiser</td>
<td>Merchandiser</td>
<td>Merchandiser</td>
<td>Auto logged after reboot</td>
</tr>
<tr>
<td>Operator</td>
<td>Operator</td>
<td>Operator</td>
<td>Change screens</td>
</tr>
<tr>
<td>Engineer</td>
<td>Engineer</td>
<td>Engineer</td>
<td>Change screens</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alarm handling (acknowledge)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alarm handling (acknowledge and restart)</td>
</tr>
</tbody>
</table>

**INFORMATION!**
If the current operator doesn’t take any actions for more than 10 minutes, his account will be automatically locked.
4.1 Maintenance on the hardware

Frequently maintenance on the hardware will improve the lifetime and avoid downtime of the leak detection system. The following maintenance recommendations should be carried out on a regular basis.

Maintenance on the software is not required.

4.1.1 Filters

The components inside the computer machine are air cooled by a ventilator. Pending on the pollution of the environment the air filters need to be cleaned regularly. Refer to the manual of the PC supplier for further details.

4.1.2 Mechanical damages

Regularly check the cables and connectors for damages. In case of a damage replace immediately the components!

4.2 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, maintenance, technical support and training.

INFORMATION!
For more precise information, please contact your local sales office.
KROHNE product overview

- Electromagnetic flowmeters
- Variable area flowmeters
- Ultrasonic flowmeters
- Mass flowmeters
- Vortex flowmeters
- Flow controllers
- Level meters
- Temperature meters
- Pressure meters
- Analysis products
- Products and systems for the oil & gas industry
- Measuring systems for the marine industry

Head Office KROHNE Messtechnik GmbH
Ludwig-Krohne-Str. 5
47058 Duisburg (Germany)
Tel.:+49 (0)203 301 0
Fax:+49 (0)203 301 10389
info@krohne.de

The current list of all KROHNE contacts and addresses can be found at:
www.krohne.com