Manual **EN**

GUTERMANN

ZONESCAN NET – Version 1.9

Table of Contents

1 Indications for Use

It is essential to read the operating instructions carefully and completely before using the first time the equipment and software. They contain important information on safety, installation and use. Keep these instructions in a safe place.

1.1 Symbols

	**Warning of dangerous situations that can cause injury and damage to the devices.**
	**Warning** **The ZONESCAN Correlating Radio Noise Data Logger contains a very powerful magnet. The operation of cardiac pacemakers and implanted defibrillators can be influenced. People with cardiac pacemakers and implanted defibrillators are not permitted anywhere near this product.**
	**Important notes and tips. Follow these guidelines.**
	**Never put in your household waste bin.**

1.2 Safety

The operating and maintenance personnel must read carefully the instructions before operating. Knowing all the information contained therein - in particular the warning and safety instructions - is needed to safely operate the equipment. To protect yourself and others against possible dangers. Ignoring the warning, safety and operating instructions can result to a considerable shortening of the useful life of equipment. Do not make any intervention, changes and alterations to our products. Never open the device, otherwise any warranty and conformity expires. For questions concerning replacing the

battery, please contact your Gutermann distributor. If you use the software and associated mobile equipment, pay the necessary attention particularly in traffic.

1.3 Warning

The ZONESCAN Correlating Radio Noise Data Logger contains a very powerful magnet. The operation of cardiac pacemakers and implanted defibrillators can be influenced. People with cardiac pacemakers and implanted defibrillators are not permitted anywhere near this product.

1.4 Intended Use

ZONESCAN products, hardware, software and accessories, are exclusively intended for industrial use and exclusively intended for leak detection on water pipes of the public water supply. In particular, these products are not intended for the use of waste water and gas lines. Gutermann Technology GmbH is not liable for any damages caused by misuse, improper operation, and as a result of non-compliance with safety instructions and warnings.

2 Introduction

Gutermann Technology has developed the ZONESCAN NET System for professional leak detection in public drinking water pipelines. This unmanned, acoustic leak monitoring system with noise level and correlation measurements ensures that leak detection specialists are deployed only at the actual leak locations.

2.1 Main Features

Continuous leak monitoring of the entire water network

Distributed over the entire water network, ZONESCAN Loggers continuously monitor and analyze the noise characteristics and can thereby detect the presence and location of leaks.

Extensive leak database allows for a permanent reduction in water loss

Each data Logger stores the leak analysis results, including the detailed noise level distributions which are transferred to the ZONESCAN NET via the Repeater and Alpha array. This measurement data is automatically stored in the powerful ZONESCAN NET database. This is used to produce detailed logs for the maintenance personnel and, ultimately, a systematic analysis of historical data for optimizing future water network planning.

Integration of GPS in the ZONESCAN NET System

The ZONESCAN Net System offers the possibility to integrate GPS for automatically importing noise level and correlation data.

2.2 System Overview

The ZONESCAN Correlating Radio Noise Data Loggers are mounted directly in the water network to record and to save the existing noise level and the ambient temperature. The statistical analysis of the stored values indicates whether or not a leak is present. A number of strategically mounted ZONESCAN Correlating Radio Noise Data Loggers allow all segments with water losses to be identified.

The data measured by the logger is collected by the repeaters, which are mounted above ground. The repeaters then transmit the data via radio signal to the alphas. The collected data is then transmitted by means of GPRS (General Packet Radio Service) via the alpha to your ZONESCAN NET Program for further processing.

The software automatically evaluates the collected data daily. The more exact the pipe data entered by the user, the better the results. The results calculated in ZONESCAN NET are numerically and graphically presented in the form of histograms and frequency distributions, interpretation of the statistical evaluation facilitating the identification of the leak locations. A numerical leak indicator simplifies the interpretation of the statistical evaluation.

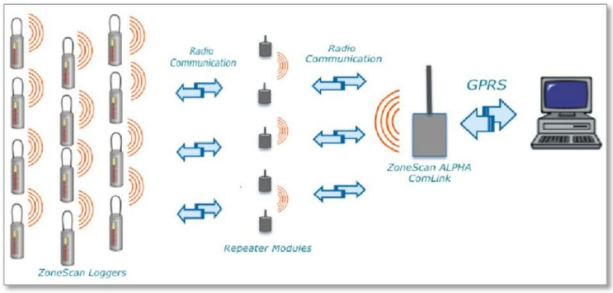


Figure 1: Functionality of logger, repeater and alpha

Interactive communication between ZONESCAN NET and the leak detector

While conventional radio loggers are equipped with a simple radio transmitter, the ZONESCAN Correlating Radio Noise Data Loggers feature a transceiver (combined transmitter and receiver). This allows for interactive communication between the sensor located in the chamber and the leak detector. In addition to correlation and remote listening, programming of the ZONESCAN Correlating Radio Noise Data Loggers is also performed via radio signal directly from the vehicle (i.e., without physical contact with the logger). Thus, the factory settings can be easily adapted at any time by you to meet your specific measurement needs.

3 Leak Detection View

3.1 Leak Detection Map

3.1.1 Structure of the Screen

Note! If the alpha fails, no data can be collected by the repeater and the logger and transmitted

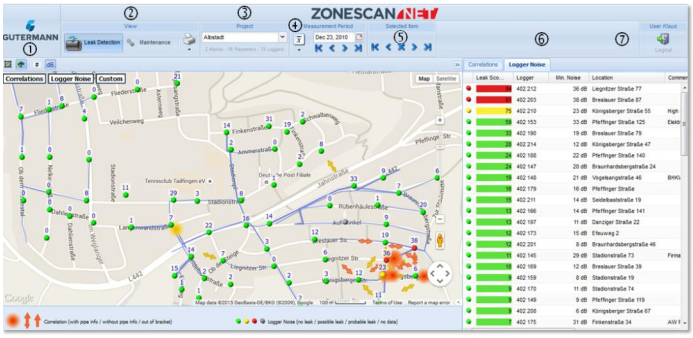


Figure 2: Structure of the screen with numbers ① to ⑦ for explanation

① Map Area
The Map Area contains a map by *Google Maps* with the area of the selected project. Use the buttons located above the map to execute various functions which vary depending on ② "View" - Leak Detection or Maintenance. For an explanation of the individual functions, hold the cursor over the button.

The buttons in the upper part of the map can be used to display and hide individual elements of the map. Depending on ② "View" - Leak Detection or Maintenance - the correlations, leak values and custom or alpha, repeater, logger and custom fields are displayed. Changes made here affect the view in ⑥ "List Area". By default, a legend is displayed in the lower part of the map.

② View
In View, you can switch between Leak Detection, Maintenance and Administration. Use the printer drop-down menu to print the screen, the map, correlated leaks or the leak values.

③ Project
In the Project menu bar, the user can select the desired project via the drop-down menu. **④ Measurement Period**

The measurement period can be changed in the drop-down menu. Select from 5 days, 30 days or an entire month. The current setting is displayed at the right.

⑤ **Selected Item**
Use the blue arrow buttons to change between the individual values in the list area. The current selection is displayed in the upper area.

⑥ **List Area**
In List area, the user finds all data relevant for the evaluation.

⑦ **Logout Button**
The user logs out with the logout button.

3.1.2 Google Maps Area

The *Google Maps* Area has the regular *Google Maps* features such as changing the map view to satellite and terrain (beneath the Map field)

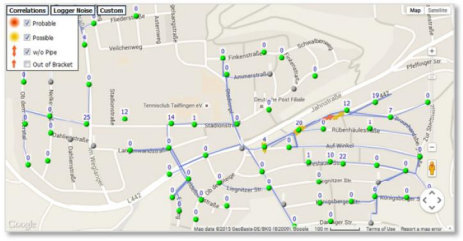


Figure 3: Google Maps Display

Figure 4: Google Satellite Display

~~Figure 5: Google Terrain Display~~

Kommentar [A1]: Das gibt es nicht mehr?

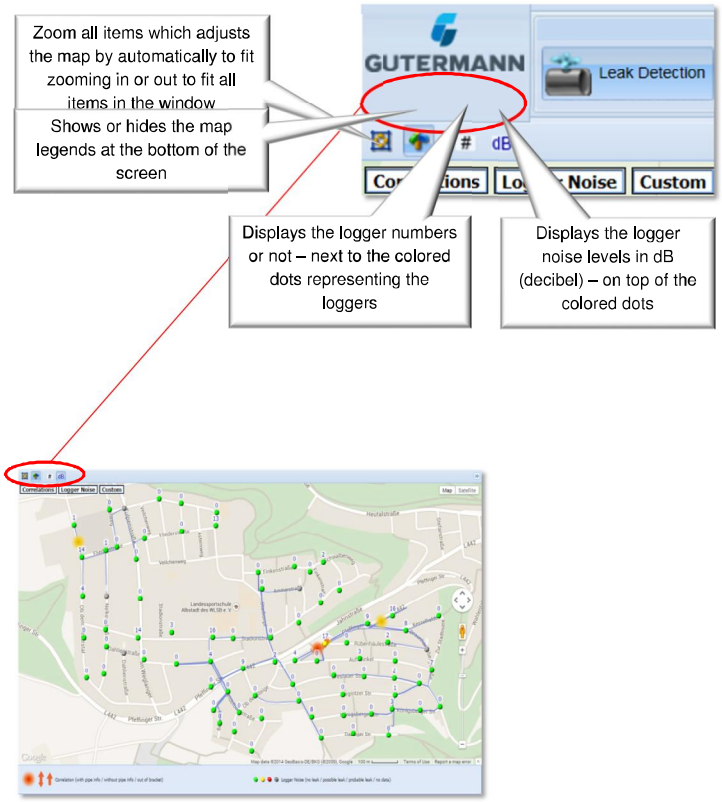


Figure 5: In the top left corner all four symbols are explained in speech bubbles

Figure 6: Zoom In/Out

The *Google Maps* Zoom Slider allows one to zoom in or out

Google Street View

This powerful function that *Google Maps* have introduced allows the user to view and walk through the photographed 3D streets. If there is an orange *Pegman* present above the zoom bar then *Google Street View* is available.

Follow the link for further detail about using *Google Street View:*
https://support.google.com/maps/?hl=en#topic=3092425

Figure 7: Google Street View

This is location dependent as not all countries, cities or towns have street view available.

Figure 8: Google Street View Pegman (red circle)

- Hover the cursor over the orange *Pegman* and he will lean forward as shown above

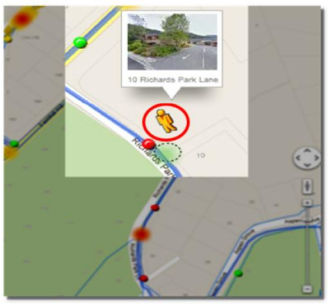


Figure 9: Google Street View moving the Pegman (red circle)

- Click and hold the cursor on the person then drag him to a chosen location on the street which will highlight blue to show which streets have the street view present. Simply release the mouse button to drop him on the street

Figure 10: Google Street View 1st person perspective

- The map changes to a photographic image of the street with the ZONESCAN Logger plotted in in place. The street names are marked and the white arrows are used to track forward or back through the street

Figure 11: Google Street View 1st person perspective – cont.

- The user is able to turn 360degrees on the spot by moving the cursor left or right until a rectangular white shadow appears, simply click the mouse to move in the chosen direction. The top left corner has the orientation wheel and zoom function bar similar to the normal *Google Maps*

Figure 12: Google Street View Guidance

Figure 13: Google Street View Correlation Point (red circle)

An orange fuzzy spot plotted on the road represents a correlated point for further investigation. This is a very powerful remote tool for the leakage technician to further investigate.

3.1.3 Correlations and Logger Layer

The user may choose their correlations and logger display preferences by ticking the relevant box within the drop-down menu as shown in the following screen shots:

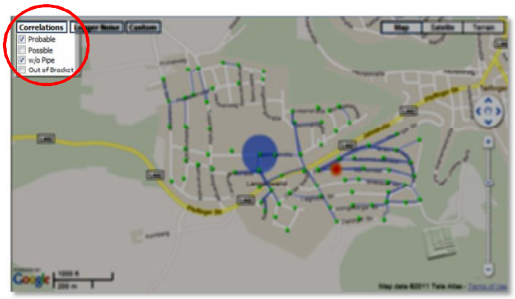


Figure 14: Correlation Drop-Down Menu

- In the window above the Probable, Possible, w/o Pipe and Out of Bracket correlations maybe ticked to show or unticked to hide the correlation icons

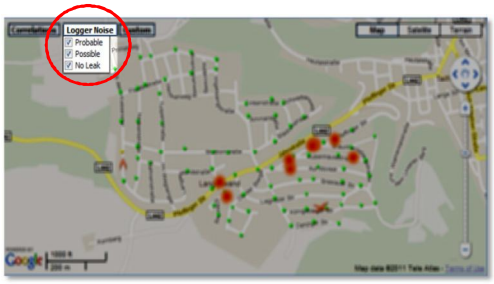


Figure 15: Logger Noise Drop-Down Menu

- Shows the Logger Noise options Probable, Possible and No Leak, tick to display all the Loggers on the map or untick to hide any of the options

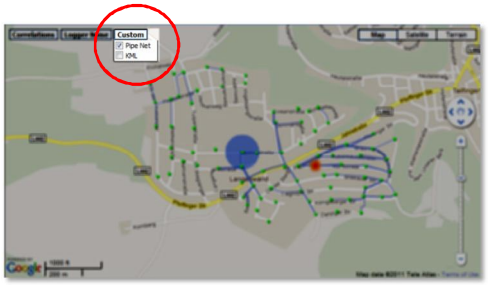


Figure 16: Logger Custom Drop-Down Menu

- Allows the user to select the pipe network created using the correlation wizard or KML (Keyhole Markup Language) layer provided by the water authority

3.2 Correlations Table

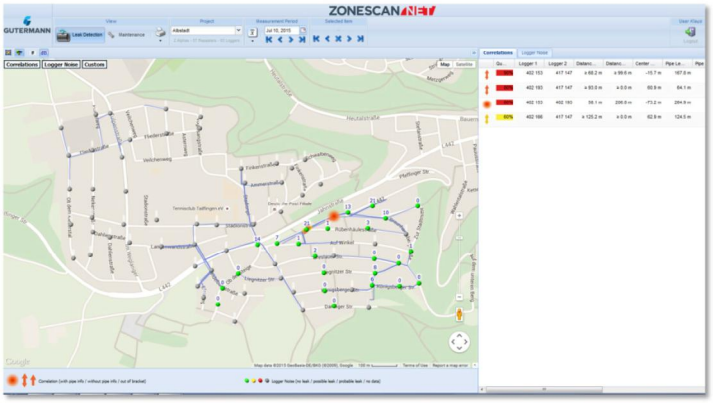


Figure 17: Correlated Leaks

- The sorting of the tables can be changed at any time. Click the small arrow in the title field of the value that you would like to change. In the selection box that opens, you can sort in either alphabetical or reverse alphabetical orderThe columns can also be displayed or hidden from the table. To do this, click the small arrow in the title field. In the selection menu that appears, move the cursor to the Columns item. In the list that is now displayed, you can set a check mark in the field that you would like to display or remove the check mark from a field that you would like to hideClick the Correlated Leaks table to display all values in the list area that you have displayed in the map

3.2.1 Table Fields

Figure 18: Correlation Table Fields

	A statement on the Quality of the correlation graph is made. The assessment ranges from 0 - 100%. The settings for the display of a possible or probable leak are made under Administration in Settings
Logger 1	Reference number of the first Logger that was correlated
Logger 2	Reference number of the second Logger that was correlated
Distance L1	Distance L1 specifies the distance between Logger 1 and the noise source. When the pipe material or a straight section of pipe is between L1 and L2 then a numerical value will be shown. If there is a bend in the pipe then a greater > sign will be given next to the value
Distance L2	Distance L2 specifies the distance between Logger 2 and the noise source. When the pipe material or a straight section of pipe is between L1 and L2 then a numerical value will be shown. If there is a bend in the pipe then a greater > sign will be given next to the value
Center Distance	If there is a correlation with no pipe data it's not possible to calculate the leak location especially without the pipe length. Using the sound velocity of the defined pipe material enables us to calculate the Distance of the leak from the middle of the pipe section between the 2 loggers. If there is a negative value (e.g. -67.4m) then the noise source is left of center in the direction of Logger 1. A positive value means the noise source is right of center and in the direction of logger 2

Pipe Length This is the total Pipe Length between Logger 1 and Logger 2

Pipe Setup Located in the Pipe Setup field are red, yellow or green indicators

Red indicators indicate that no pipe settings have been entered yet and the used data were taken over from the default values

Yellow images appear if manual settings were made and not all details are known (pipe length, diameter and material are known). With manual settings, the course of the pipe cannot be changed, unlike with the Pipe Wizard

Green indicators mean that all details are known for the settings and were taken over in full from the Pipe Wizard

To enter the pipe settings, use the mouse to click the small triangles, next to Comments, in the field that you would like to change. In the menu that appears, select "Manual Pipe Data Entry" if you would like to enter the data "manually" or "Start Pipe Wizard" if the data are to be determined automatically. To delete existing pipe data, select the "Delete Pipe Information" item

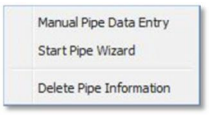


Figure 19: Entering pipe settings

3.2.2 Entering Pipe Data Manually

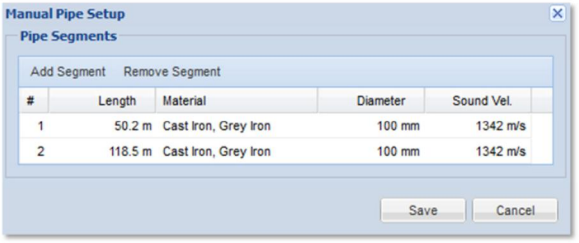


Figure 20: Entering pipe settings – cont.

- Click the "Add Segment" button to enter a new pipe segment. Then complete the "Length, Material and Diameter" fields. The sound velocity is automatically calculated from your values and entered in the respective field. If you have more exact information on the sound velocity in this pipe segment, you may enter it manually in this field
- To apply the settings, click the "Save" button
- An already stored entry can be removed by clicking "Remove Segment; confirm removal by clicking "Save"

3.2.3 Entering Pipe Data with the Pipe Wizard

With the Pipe Wizard, data for the pipe settings are determined automatically via the pipe network and entered.

- First, you are requested – if necessary – to move the Logger to the correct position. To do this, click the Logger that you would like to move and drag it to the desired position. Repeat the process with both Loggers until they are correctly positioned. Use "Undo" to undo your last change
- The Logger 1 and Logger 2 fields indicate the respective, current positions of the Loggers
- Once the Loggers are correctly positioned, click "Next"

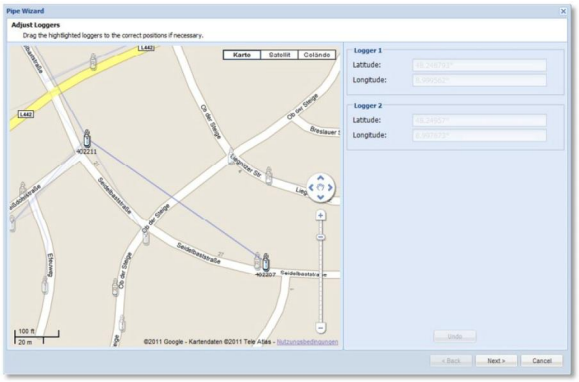


Figure 21: Adjusting loggers

- In the next step, you have the option of changing the course of the pipeline. To do this, click the small box in the middle of the pipe that you would like to move. With the mouse pressed down, drag the pipe to the desired position
- You can now repeat this with the individual segments until the pipeline is correctly positioned. Use "Undo" to undo your last change. Displayed in the Pipeline Properties box are the current number of segments and the current pipe length
- After adjusting the course of the pipeline, click "Next"

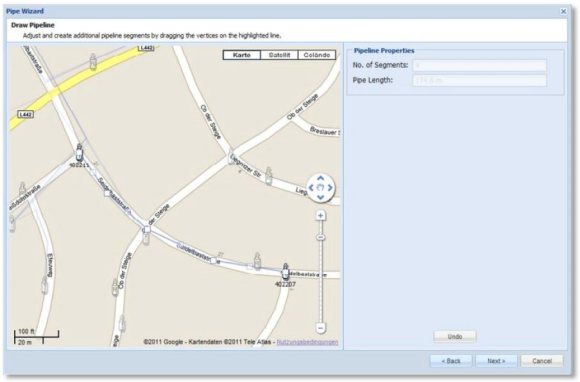


Figure 22: Adjusting the pipeline

- Next, you are prompted to edit the properties of the individual segments of the pipeline. Complete the "Length, Material and Diameter" fields

Note! If the data – Length, Material and Diameter – are contained in a displayed KML (Keyhole Markup Language) layer, it can be displayed in the map by clicking the corresponding pipeline. The values can be taken over 1:1 from the pop-up window that opens

- The Sound Velocity is automatically calculated from your values and entered in the respective field. If you have more exact information on the Sound Velocity in this pipe segment, you may enter it manually in this field
- After all fields are filled, click the "Finish" button to start the calculation. The calculated values are stored automatically

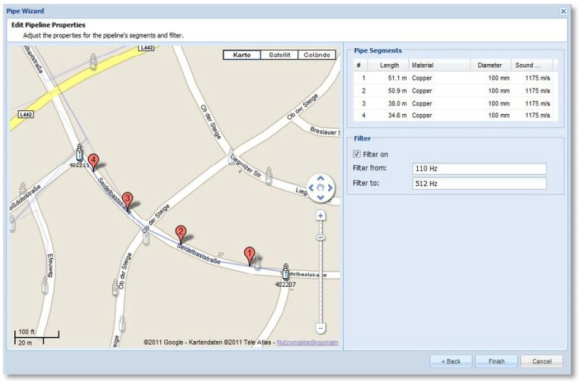


Figure 23: Adjusting the pipeline – Finish

Note! It is possible that the Pipe Wizard calculation cannot be performed immediately. It depends on the complexity of the recalculations and the workload of the server

3.2.4 Correlation Context Menu

- A context menu can be displayed for each individual, correlated leak. To do this, select the value in the table that you would like to visualize
- Right-click to open the context menu. Here, you can select the type of graph to be displayed. In addition, you can insert a comment
- The same menu can be opened by right-clicking a Correlation on the map

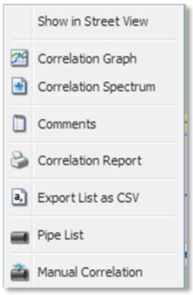


Figure 24: Context menu for correlations

Show in Street View The map will switch to *Google Street View* and automatically zoom in on the chosen correlated point. See previous section on *Google Street View*

Figure 25: Google Street View of correlated leaks

3.2.5 Correlation Graph

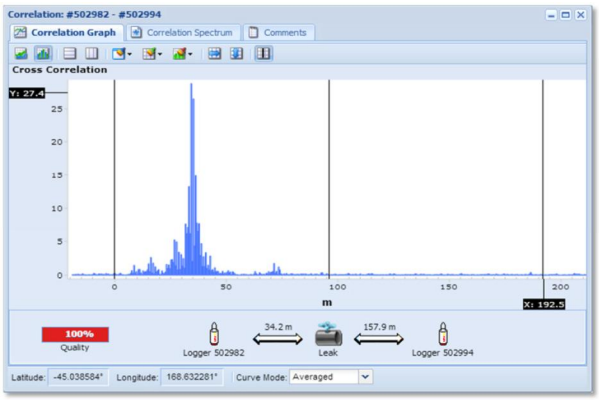


Figure 26: Correlation Graph

Correlation is a mathematical method for comparing two time synchronized signals with one another.

A leakage noise is simultaneously recorded by two sensors at different locations which are represented by the black lines at either side of the graph if the pipe data is known. The sound emitted by the leak spreads in the water pipe at a defined sound velocity. If the acoustic event were to be brief and occur only once, e.g., a blow with hammer, it would be simple to measure the arrival at both receivers. In this case, one would only need to compare the arrival times at the two receivers with one another. If these are the same, the sound has traveled the same distance to the receivers, i.e., the sound source lies in the middle of the pipe between the receivers.

If the arrival times are different, it is possible to calculate the distance to the two receivers from the measured time difference. The sound arrives at the closer sensor before the more distant sensor.

In the context of leakage noises, the goal of the correlation measurement is primarily to determine the propagation time difference of two signals.

Because the correlation curve also includes spectral information, it is often of interest to define the character of the leakage noise, particularly for distinguishing noises that are not related to the leak, provided this can be detected by means of a frequency analysis (e.g., electrical noise). The correlation curve can also be mathematically filtered for the purpose of

retroactively separating such interfering noise to better identify the correlation maximum caused by the leak.

3.2.6 Correlation Spectrum

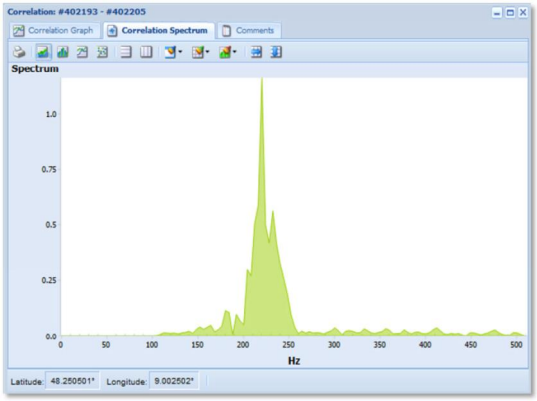


Figure 27 Correlation Spectrum

The correlation spectrum is a combination of the signal spectra of the two sensors, which is used for the correlation on the pipeline between the two sensors. In these common spectra, it may be possible to identify the influence of noises not related to the leak (e.g., electrical noise or pumps) on the correlation result (see also 3.2.4 Correlation Context Menu).

3.2.7 Correlation Report

Choose the required options by ticking the box opposite and then click open. A new window will open in the browser with the relevant maps and graphs associated with the chosen correlation.

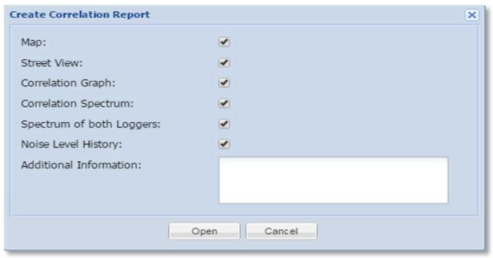


Figure 28: Correlation Report Options

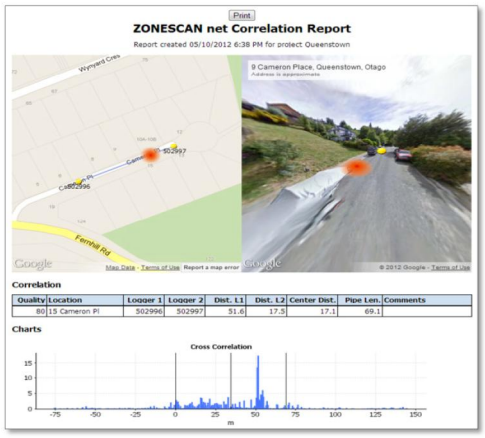


Figure 29: Correlation Report – Part 1

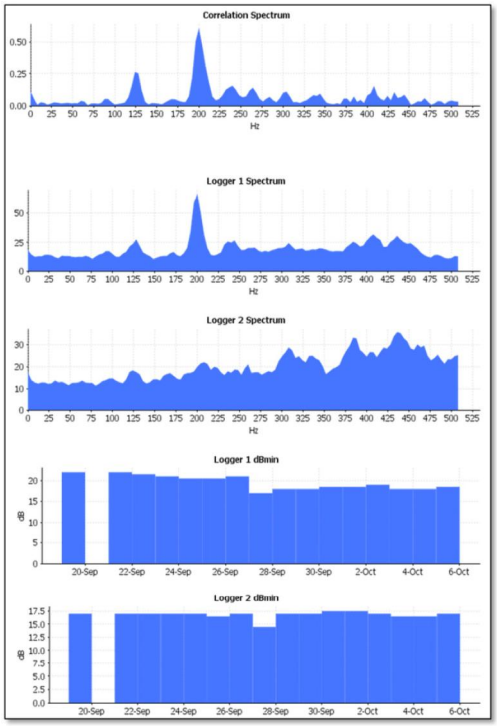
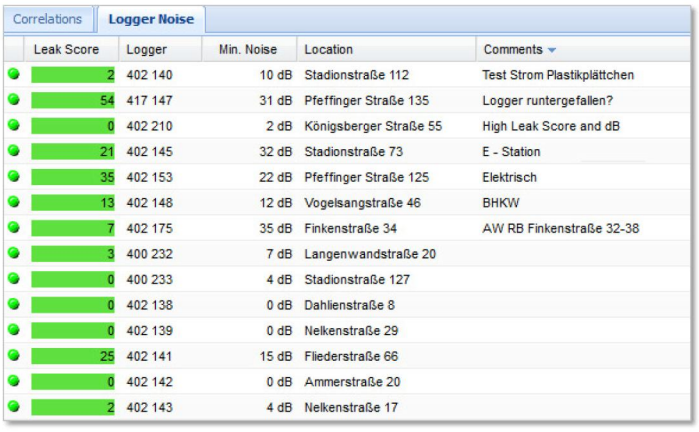


Figure 30: Correlation Report – Part 2

3.3 Logger Noise Table

Displayed in the Logger Noise Table are all values that are needed for an evaluation.



Correlations | **Logger Noise**

Leak Score	Logger	Min. Noise	Location	Comments
2	402 140	10 dB	Stadionstraße 112	Test Strom Plastikplättchen
54	417 147	31 dB	Pfeffinger Straße 135	Logger runtergefallen?
0	402 210	2 dB	Königsberger Straße 55	High Leak Score and dB
21	402 145	32 dB	Stadionstraße 73	E - Station
35	402 153	22 dB	Pfeffinger Straße 125	Elektrisch
13	402 148	12 dB	Vogelsangstraße 46	BHKW
7	402 175	35 dB	Finkenstraße 34	AW RB Finkenstraße 32-38
3	400 232	7 dB	Langenwandstraße 20	
0	400 233	4 dB	Stadionstraße 127	
0	402 138	0 dB	Dahlienstraße 8	
0	402 139	0 dB	Nelkenstraße 29	
25	402 141	15 dB	Fliederstraße 66	
0	402 142	0 dB	Ammerstraße 20	
2	402 143	4 dB	Nelkenstraße 17	

Figure 31: Logger Noise Table

3.3.1 Table Fields

Leak Score

The Leak Score is specified in a range from 0 to 100. The higher the number, the greater the probability that measurements will actually detect a leak.

The goal of the noise measurement with Loggers is to obtain as reliable a statement as possible regarding the presence of a leak at a specific point of the monitored water network. For the greatest reliability with respect to the presence of even small leaks, all information that is indicative of a leak near a Logger should be included. Misinterpretations should be avoided in this process.

The measurement values obtained from the histogram (see 3.2.4 Correlation Context Menu) – particularly the lowest ascertained sound-level value dBmin – which are a strong general indicator of a leak, are included in the subsequent processing.

In addition to the described histogram evaluation, the Leak Score includes, above all, knowledge from the frequency response

	(spectrum). These values are used, in particular, for removing background noise. The frequency spectrum data enables the algorithm to differentiate between leak noise and mechanical noises. In addition, if there is a correlation at the same position near the logger for more than one day, this will also increase the leak score. The result is output as the Leak Score in a range from 0 to 100. The settings for the display of a possible or probable leak are made under Administration in Settings
Logger	Reference number of the displayed Logger
Location	The Location field is a text field in which the location of the Logger, e.g., the street and street number, can be entered
Min. Noise	The smallest dB value measured during the last measurement.
Comments	Comments is a text field with entries on, e.g., permanent noise sources

3.3.2 Logger Noise Context Menu

A context menu can be displayed for each Logger. To do this, select the Logger in the table that you would like to visualize. Right-click to open the context menu. Here, you can select the type of menu that is displayed. In addition, you can insert a comment. The same menu can be opened by right-clicking a Logger on the map.

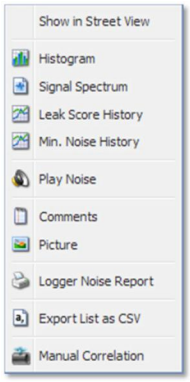


Figure 32: Graphical choices for leak score

Show in Street View The Map will switch to *Google Street View* and automatically zoom in on the chosen logger. See section 3.1.2 *Google Maps Area*

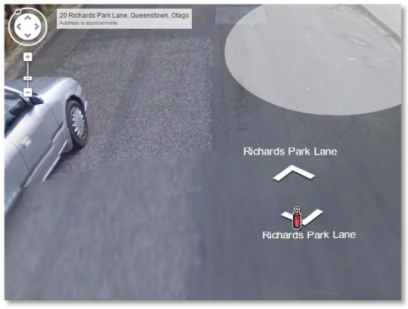


Figure 33: Google Street View shows chosen logger

Histogram The histogram is the graphical display of a noise distribution of the measured sound level

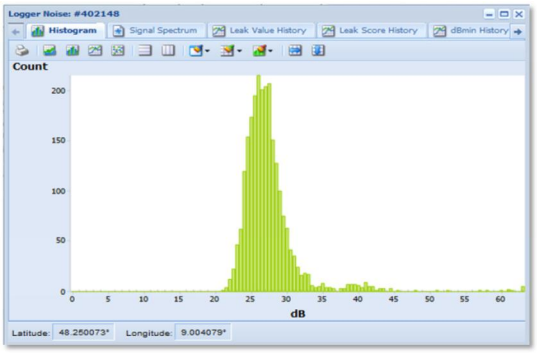


Figure 34: Logger Histogram

Histogram cont.

During noise monitoring, the noise level is repeatedly measured in intervals of a few seconds. During a one-hour measurement period (e.g., from 2 a.m. to 3 a.m.), several hundred individual measurement values are collected. The sound level is measured in dB. If, for example, the sound intensity of 15 dB is measured 120 times, this sound intensity has a frequency value of 120. Other sound intensity values are measured with a different frequency. If all of these frequencies are plotted as y values against a scale of the various dB sound intensities (x axis), one obtains the so-called histogram as a frequency distribution.

This histogram is a representation of the noise distribution in the measured period of time. The curve has a maximum, which represents the most frequently measured noise sound intensity.

For leakage noise monitoring, the quietest noise detected in the observed period is of particular interest. It is the smallest dB value for which a measurement value exists. Because a leakage noise is always present, one assumes that this value most likely characterizes the leakage noise, while higher dB sound intensity values arise from the addition of primarily random noise sources (e.g., vehicle traffic).

The so-determined smallest sound intensity value, found at the left edge of the histogram curve, is referred to as the dBmin value and plays a key role in the evaluation of the leakage noise

Signal spectrum

The signal spectrum can be used to make a statement about a possible leak.

Figure 36 shows a spectrum with electrical influence. If the curve has this appearance, one can assume that no leakage noise is present

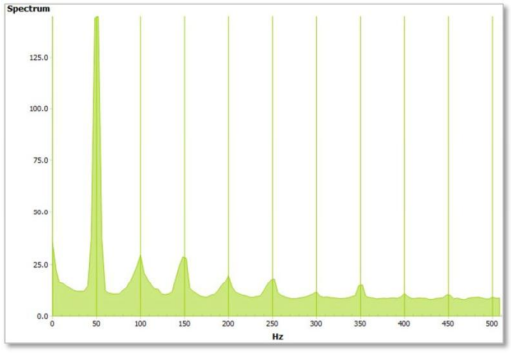


Figure 35: Spectrum with electrical influence

In figure 37, you see a typical spectrum of a leakage noise. It is clearly seen that the curve differs from that of a spectrum with electrical influence. If the graph has an appearance similar to that shown in figure 37, one can assume a leakage noise

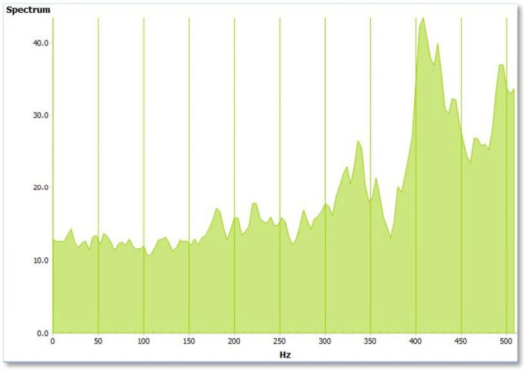


Figure 36: Spectrum with leakage noise

Leak Score History

The Leak Score History visualizes the historical values from the last 30 days, 3 months, 6 months, 12 months, 2 years or full history as long as the data is available for the time span. If the data available is less than a chosen period then the software will adjust the window to fit. On days with sound signal, the leak score is shown in blue, otherwise in green. In the example below, the leak score on days with sound signal is lower because the spectrum calculated from the sound signal is not typical of a leak.

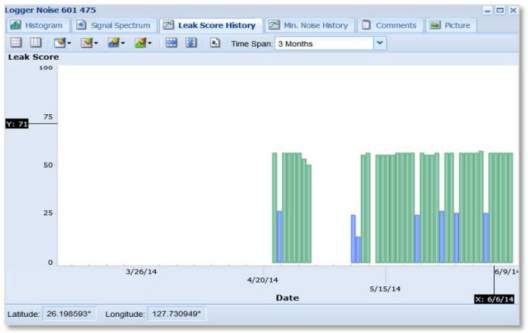


Figure 37: Logger Leak Score History

Min Noise History

The dBmin History visualizes the historical values from the last 30 days, 3 months, 6 months, 12 Months, 2 years or full history if data is available

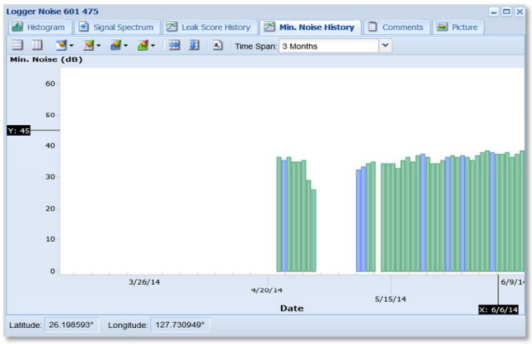


Figure 38: Logger dBmin History

Play Noise

The actual leak noise sample can be played through the PC speakers or headphones to help identify the type of sound recorded by the chosen logger. To help distinguish between background sound and leak sound compare a logger which has a leak score of 0 (zero) and then listen to a logger with a high leak score

- Depending on your browser, either click the Signal Spectrum and choose the Download Sound File or press the "Play" button.

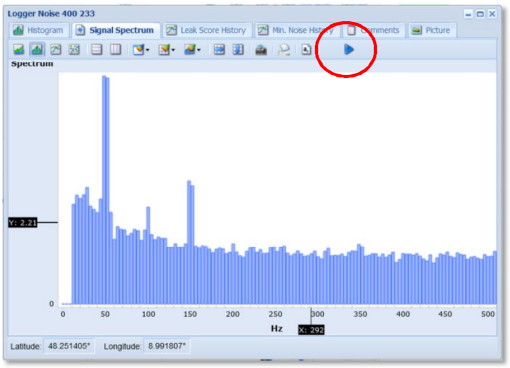


Figure 39: Download Sound File

Note! The sound files are only playable when the Measurement Period is in daily mode and not averaging mode

Comment

You can type any comment which will show in the comment line next to the logger. Make sure the Apply button is clicked to save the comment.

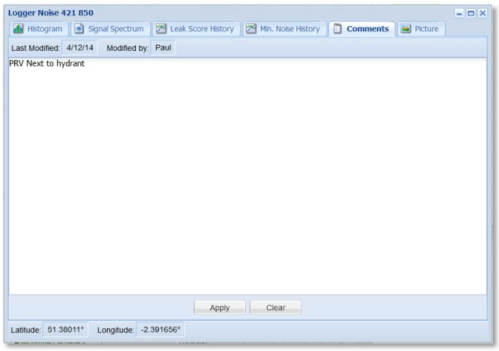


Figure 40: Comment Window

Picture

This opens up a picture of the installed logger onsite. For this facility to be fully operational a photo must be taken during the logger installation using the PDA (Personal Digital Assistant) and ZONESCAN Mobile installation tool.

Logger Noise Report

The Create a Logger Noise Report allows one to choose the options in the window below before creating a report.

- Click Open and a separate window will open which then can be sent to print

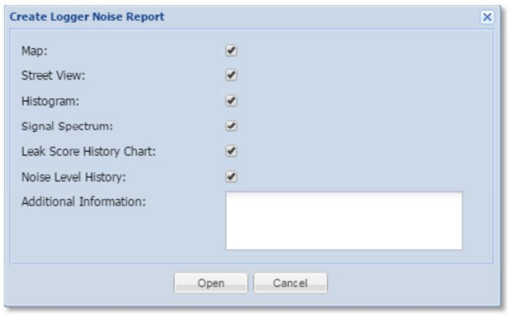


Figure 41: Create a Logger Noise Report

A separate window will open through the internet browser showing the included options chosen.

- Press the print button to send the report to a printer or PDF file

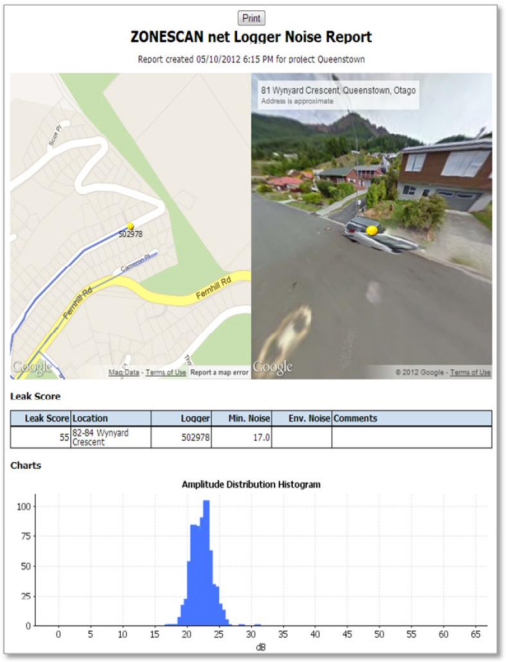


Figure 42: The Logger Noise Report

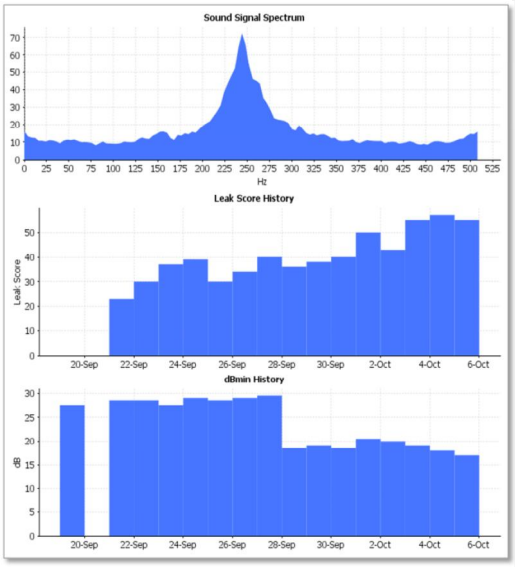


Figure 43: The Logger Noise Report – cont.

Export to CSV

The Export to CSV (Comma-separated values) will download the Loggers Leak Score into CSV file format and automatically open Excel with the data.

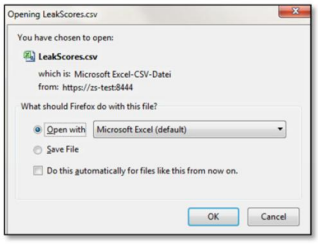


Figure 44: Create a Measurement Report

Manual Correlation

The Manual Correlation opens a separate window and allows the user to pick any two loggers in the project to correlate between.

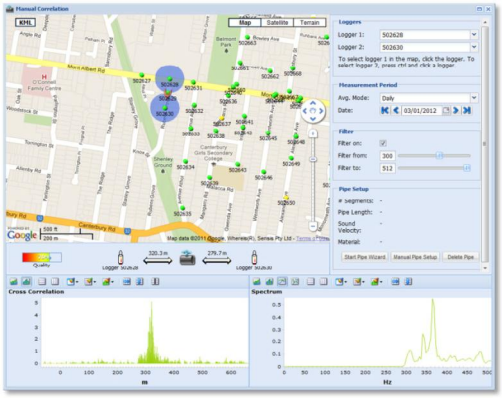


Figure 45: Manual Correlation Window

- Use the drop-down arrows in the Loggers' section to select your chosen Logger 1 and 2 or alternatively select logger 1 by clicking on the Map and Logger 2 by pressing CTRL and click on the Logger 2

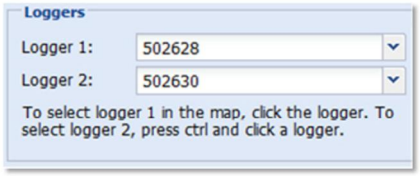


Figure 46: Selecting the Loggers

- Use the Measurement Period Average. Mode drop-down to select either daily, Last 5 days and last 30 days. Select the measurement date via the arrows or calendar

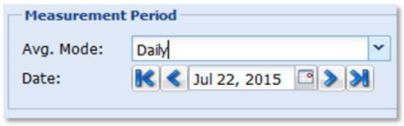


Figure 47: Selecting the Measurement Period

Note! Filters are a very important part of correlation, it's recommended that the Filter On is left ticked as it keeps the correlation clean and helps remove unwanted noise

- The Filter from: is the low filter cut off and Filter to: is the high filter cut off, click and hold either slider to increase or decrease the filter to improve the correlation quality and graph. Filter once the true pipe information has been entered as this gives a better result

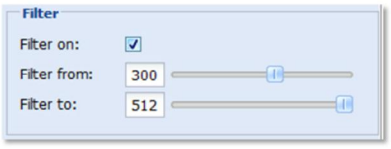


Figure 48: Selecting the Filter

Figure 51 is the section where the pipe data is entered for the correlation to give a true result. If no pipe data is entered then the correlation result will be displayed in survey mode; a distance over 600m.

- If the pipe data is known then select Manual Pipe Setup to enter the distance between the loggers, the pipe diameter and material type. If the distance between the correlated loggers is unknown then use Start Pipe Wizard to draw the pipe

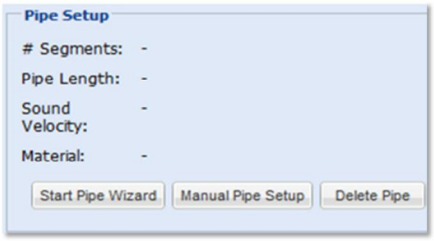


Figure 49: Entering Data Pipe

- In the Manual Pipe Setup window click Add Segment to enter the Length, Material and Diameter. When all segments are entered click Save

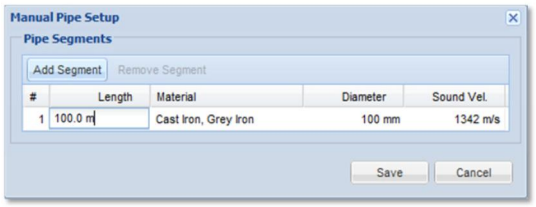


Figure 50: Manual Pipe Setup

- There is also a Pipe Wizard available, refer to 3.2.3 Entering Pipe Data with Pipe Wizard

Once the Pipe Setup and Filtering is complete the Manual Correlation Dashboard window will look similar to the screen below. In this example a 70% correlation was achieved and the leak position is depicted by an orange dot on the map and the diagram between the cross correlation graph and the map.

- Use the signal spectrum as a guide to position the filters, in the example below there is a concentration of sound between 300 and 400 Hz so this must be included

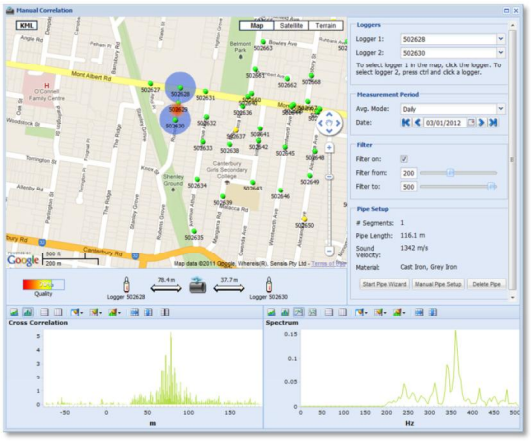


Figure 51: Manual Correlation Result

- If the Pipe information is incorrect then simply click the Delete Pipe and repeat the Manual Correlation steps

4 Print Menu

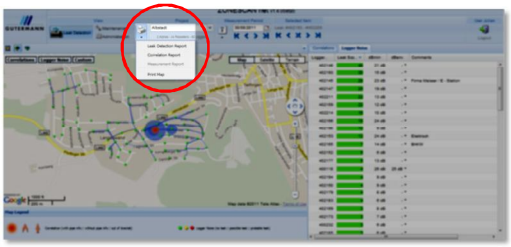


Figure 52: Print Menu

The print section has four options which include print Leak Detection Report, Correlation Report, Measurement Report and the Map.

The Leak Detection Report includes the Leak Scores, Correlations and Map for the chosen date. A window will appear which gives the user the option to remove correlations, Logger Noise or Map before printing.

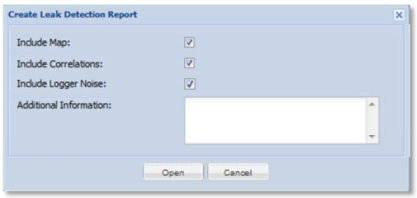
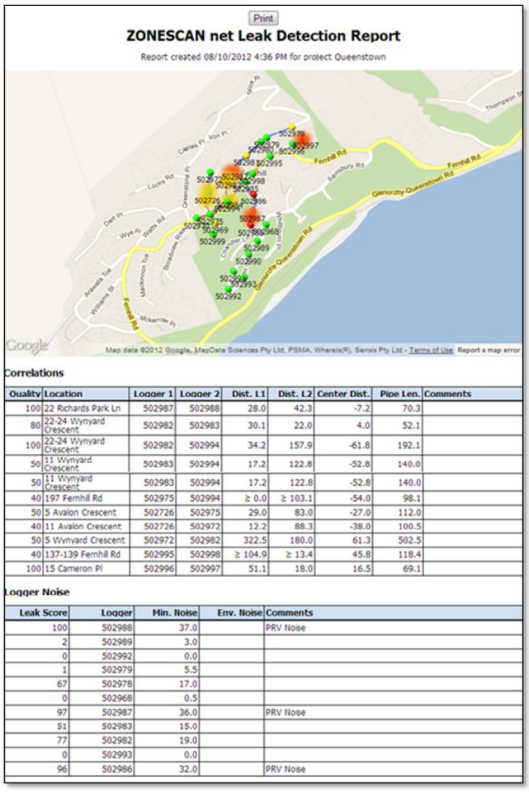


Figure 53: Print Report Window Options

- A new browser window opens with the report; use the print button on the browser



Print

ZONESCAN net Leak Detection Report

Report created 08/10/2012 4:36 PM for protect Queenstown

Correlations

Quality	Location	Logger 1	Logger 2	Dist. L1	Dist. L2	Center Dist.	Pipe Len.	Comments
100	22 Richards Park Ln	502987	502988	28.0	42.3	-7.2	70.3	
80	22-24 Wynyard Crescent	502982	502983	30.1	22.0	4.0	52.1	
100	22-24 Wynyard Crescent	502982	502994	34.2	157.9	-61.8	192.1	
50	11 Wynyard Crescent	502983	502994	17.2	122.8	-52.8	140.0	
50	11 Wynyard Crescent	502983	502994	17.2	122.8	-52.8	140.0	
40	197 Fernhill Rd	502975	502994	≥ 0.0	≥ 103.1	-54.0	98.1	
50	5 Avalon Crescent	502726	502975	29.0	83.0	-27.0	112.0	
40	11 Avalon Crescent	502726	502972	12.2	88.3	-38.0	100.5	
50	5 Wynyard Crescent	502972	502982	322.5	180.0	61.3	502.5	
40	137-139 Fernhill Rd	502995	502998	≥ 104.9	≥ 13.4	45.8	118.4	
100	15 Cameron Pl	502996	502997	51.1	18.0	16.5	69.1	

Logger Noise

Leak Score	Logger	Min. Noise	Env. Noise	Comments
100	502988	37.0		PRV Noise
2	502989	3.0		
0	502992	0.0		
1	502979	5.5		
67	502978	17.0		
0	502968	0.5		
97	502987	36.0		PRV Noise
51	502983	15.0		
77	502982	19.0		
0	502993	0.0		
96	502986	32.0		PRV Noise

Figure 54: Print Report Page

5 Maintenance View

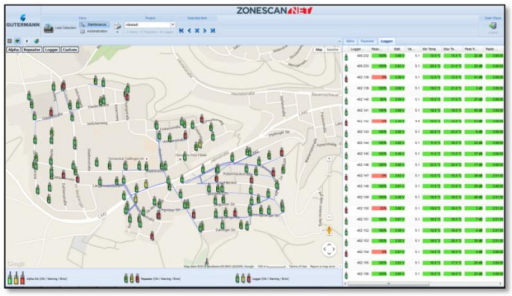


Figure 55: Maintenance View

Note! The following description assumes a fully activated map menu

5.1 Logger Table

In the Logger Table, all Loggers of the current project are displayed.

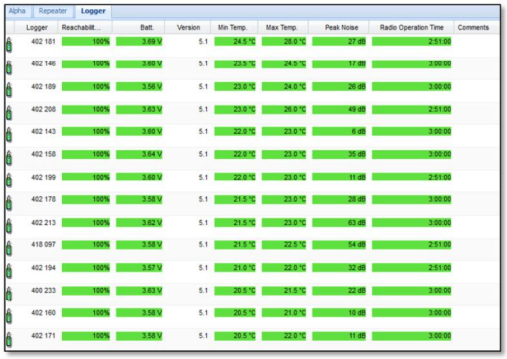


Figure 56: Logger Table

5.1.1 Table Fields

Logger	Reference number of the displayed Logger
Reachability	The fraction or percentage the loggers were reached in the last 5 days
Batt.	Current battery charge of the individual Loggers
Version	Version of the respective Logger
Min Temp.	The lowest temperature measured during the last measurement
Max Temp.	The highest temperature measured during the last measurement
Peak Noise	The largest dB value measured during the last measurement
Radio Operation	It's the time during which the logger can be reached for communication. Warning: 6 hours or longer radio operation times will reduce battery life
Comments	Comments is a text field with entries on, e.g. permanent noise sources

5.1.2 Context Menu

You can change the base settings of this table by right-clicking an entry in the table

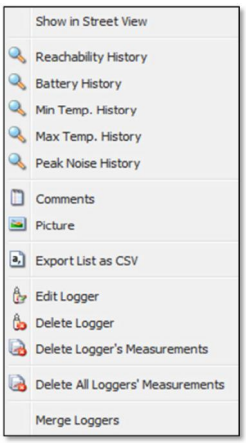


Figure 57: Logger Settings

Kommentar [A2]: Die gemeinsamen Elemente der 3 Tabellen sollten nur einmal erklärt werden.

Reachability History	To display the History of when the Logger had communication with the ZONESCAN NET
Min Temp History	To display the Minimum Temperature of the selected Logger, click the Min Temp item
Max Temp History	To display the Maximum Temperature of the selected Logger, click the Max Temp item
Battery History	To display the charge state of the selected Logger, click the Battery History item
Comments	To add a comment about a Logger, select the Comments item. Enter the desired comment in the text field that appears. Click Apply to save the entered comment. The text is displayed in the table in the Comments field
Picture	To view an available Picture of the selected Logger. The Picture should have been taken and uploaded by ZONESCAN Mobile during the installation process
Maintenance	To Print out a report for the selected Logger to include all the fields in the Table
Add Logger	Click Add Logger to add a not-yet existing Logger to the list. In the window that opens, enter the values for Logger No., Location, Latitude and Longitude. After entering all values, confirm your entries by clicking the Save button
Edit Logger	To make changes to the base settings of existing Loggers, select Edit Logger. Make the desired changes and then click Save
Delete Logger	Loggers listed in the table can be deleted with the Delete Logger item
Delete Logger's Measurements	To delete the measurement data of a Logger, click the Delete Logger's Measurements item
Delete Logger's Sound Signals	Click Delete Logger's Sound Signals to delete the recorded signals
Delete All Loggers	Use this item to delete all Loggers for the current project
Delete All Loggers' Measurements	The measurement data of all Loggers is deleted by clicking this item
Delete All Loggers' Sound Signals	Click this item to delete the sound signals of all Loggers

Furthermore you have the options with context menus to select the Alpha Link and the Last Reached

Alpha Link Indicates which Logger is connected

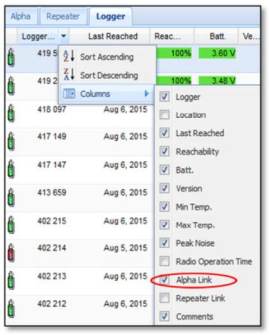


Figure 58: Alpha Link

Last Reached Shows the date when the Logger was contacted

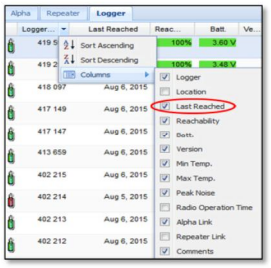


Figure 59: Logger Settings

5.2 Alpha Table

In the Alpha Table, all Alphas of the current project are displayed.

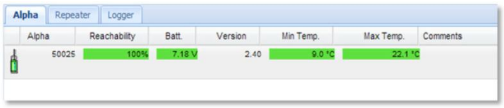


Figure 60: Alpha Table

5.2.1 Table Fields

Please refer to Tables and Settings of section Logger.

5.3 Repeater Table

In the Repeater Table, all Repeaters of the current project are displayed.

Figure 61: Repeater Table

5.3.1 Table Fields

Please refer to Tables and Settings of section Logger.

6 Administration View

Note! This section is only relevant for users with supervisor level

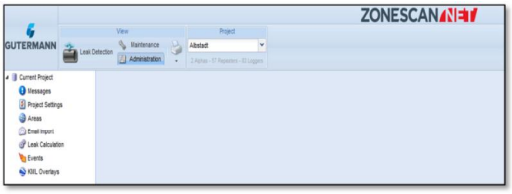


Figure 62: Administration

- To change the settings of an existing project, click Administration in the View area of the menu bar. In the Project area, select the project that is to be changed. In the navigation bar, then click the Current Project > Settings item
- To save your settings, click the Save button in the respective table

6.1 Current Project Settings

Note! The preset values are guide values and may vary

6.1.1 General Table

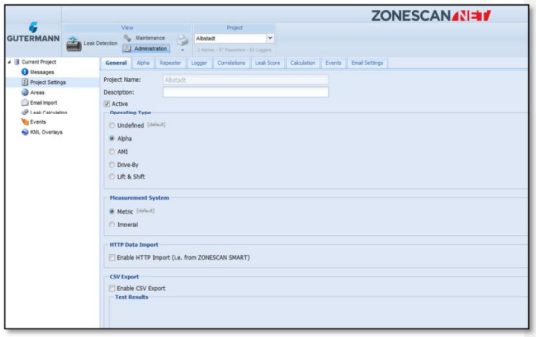


Figure 63: Settings > General

Project Name The name of the project is automatically taken over from the menu bar

Operating Type You can select the appropriate operating type according to operating mode. The Alpha item is preset. If you are working in a fixed network, click Fixed Network here. The data is then integrated in your network

6.1.2 Alpha Table

Figure 64: Settings > Alpha

Reachability Warning Limits	Warning when not reachable for: Define the number of days after which a warning is displayed if an Alpha was not reached. Preset: 2 days
	Problem when not reachable for: Define the number of days after which an error is displayed if an Alpha was not reached. Preset: 4 days
Battery Voltage Warning Limits	Warning when below: Enter the charge state of the batteries of the Alphas below which a warning is displayed. Preset: 6.00 V
	Problem when below: Enter the charge state of the batteries of the Alphas below which an error is displayed. Preset: 5.50 V
Temperature Warning Limits	Minimum temperature limit: Enter the lower temperature value below which a warning or an error is displayed. Preset: -30.0 °C
	Maximum temperature limit: Enter the upper temperature value above which a warning or an error is displayed. Preset: 70.0 °C
	Warning when temp. below minimum for: Enter the number of days after which a warning is displayed if the temperature measured at the Alpha remains below the limit value entered above. Preset: 2 days
	Problem when temp. below minimum for: Enter the number of days after which an error is displayed if the temperature measured at the Alpha remains below the limit value entered above. Preset: 4 days
	Warning when temp. above maximum for: Enter the number of days after which a warning is displayed if the temperature measured at the Alpha remains above the limit value entered above. Preset: 2 days

Problem when temp. above maximum for: Enter the number of days after which an error is displayed if the temperature measured at the Alpha remains above the limit value entered above. Preset: 4 days

6.1.3 Repeater Table

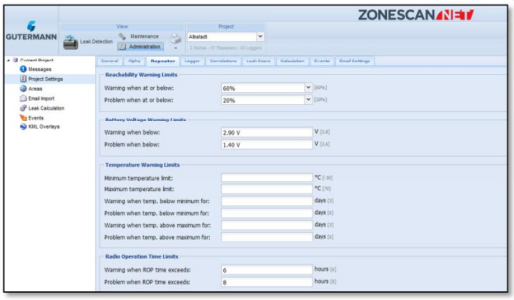


Figure 65: Settings > Repeater

Reachability Warning Limits

Warning when not reachable for: Define the number of days after which a warning is displayed if a Repeater was not reached. Preset: 3 days

Problem when not reachable for: Define the number of days after which an error is displayed if a Repeater was not reached. Preset: 6 days

Battery Voltage Warning Limits

Warning when below: Enter the charge state of the batteries of the Repeaters below which a warning is displayed. Preset: 2.80 V

Problem when below: Enter the charge state of the batteries of the Repeaters below which an error is displayed. Preset: 2.60 V

Temperature Warning Limits

Minimum temperature limit: Enter the lower temperature value below which a warning or an error is displayed. Preset: -30.0 °C

Maximum temperature limit: Enter the upper temperature value above which a warning or an error is displayed. Preset: 70.0 °C

Warning when temp. below minimum for: Enter the number of days after which a warning is displayed if the temperature measured at the Repeater remains below the limit value entered above. Preset: 3 days

Problem when temp. below minimum for: Enter the number of days after which an error is displayed if the temperature measured at

the Repeater remains below the limit value entered above. Preset: 6 days

Warning when temp. above maximum for: Enter the number of days after which a warning is displayed if the temperature measured at the Repeater remains above the limit value entered above. Preset: 3 days

Problem when temp. above maximum for: Enter the number of days after which an error is displayed if the temperature measured at the Repeater remains above the limit value entered above. Preset: 6 days

6.1.4 Logger Table

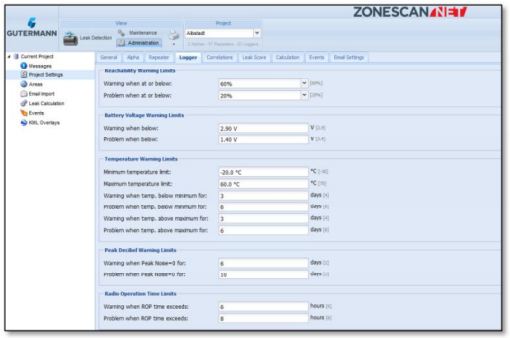


Figure 66: Settings > Logger

Leak Value Warning Limits	Possible leak: Enter the values based on experience for displaying a possible leak. Preset: 40
	Probable leak: Enter the values based on experience for displaying a probable leak. Preset: 70
Reachability Warning Limits	Warning when not reachable for: Define the number of days after which a warning is displayed if a Logger was not reached. Preset: 4 days
	Problem when not reachable for: Define the number of days after which an error is displayed if a Logger was not reached. Preset: 8 days
Battery Voltage Warning Limits	Warning when below: Enter the charge state of the batteries of the Loggers below which a warning is displayed. Preset: 2.90 V
	Problem when below: Enter the charge state of the batteries of the Loggers below which an error is displayed. Preset: 1.40 V

Temperature Warning Limits

Minimum temperature limit: Enter the lower temperature value below which a warning or an error is to be displayed. Preset - 30.0 °C

Maximum temperature limit: Enter the upper temperature value above which a warning or an error is to be displayed. Preset: 70.0 °C

Warning when temp. below minimum for: Enter the number of days after which a warning is displayed if the temperature measured at the Logger remains below the limit value entered above.
Preset: 4 days

Problem when temp. below minimum for: Enter the number of days after which an error is displayed if the temperature measured at the Logger remains below the limit value entered above. Preset: 8 days

Warning when temp. above maximum for: Enter the number of days after which a warning is displayed if the temperature measured at the Logger remains above the limit value entered above. Preset: 4 days

Problem when temp. above maximum for: Enter the number of days after which an error is displayed if the temperature measured at the Logger remains above the limit value entered above. Preset: 8 days

Peak Decibel Warning Limits

Warning when dBmax=0 for: Enter the number of days after which a warning is displayed if the highest dB value measured at the Logger is equal to 0. Preset: 1 day

Problem when dBmax=0 for: Enter the number of days after which an error is displayed if the highest dB value measured at the Logger is equal to 0. Preset: 2 days

6.1.5 Correlations Table

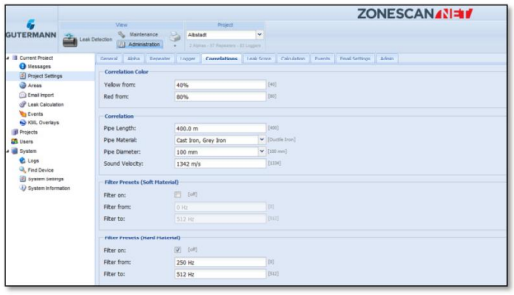


Figure 67: Settings > Correlations

Correlation Color

There are two levels of warning thresholds: yellow in the range of 40 - 79%, which indicates a possible, and red in the range of 80 - 100% indicates a probable leak. The green indicator (0 - 39%, everything is in order) is here not shown. The default values are 40% and 80%

Pipe Presets

Pipe Length: Enter the distance between two Loggers. Preset: 600m

Note! Incorrect evaluations will result if the entered length is shorter than the actual pipe length

Note! If not sure, enter a value that exceeds the actual distance between the Loggers. Example: actual pipe length: 255m, entered pipe length: 600m

Pipe - Material: Select the pipe material from the drop-down list. Preset: Ductile Iron

Pipe - Diameter: Select the pipe diameter from the drop-down list. Preset: 100mm

Sound Velocity: The sound velocity is dependent on the pipe material and is automatically set by the system upon selection of the pipe material. Preset: 1334 m/s

Filter Presets (Soft Material)

Filter on: Select the check box if your pipe is made of soft material (e.g., PVC, PE)

Filter from: Enter the lower Hz value above which filtering is to be performed. Preset: 0 Hz

Filter from: Enter the lower Hz value above which filtering is to be performed. Preset: 512 Hz

Filter Presets (Hard Material)

Filter on: Select the check box if your pipe is made of hard material

Filter from: Enter the lower Hz value above which filtering is to be performed. Preset: 120 Hz

Filter to: Enter the upper Hz value up to which filtering is to be performed. Preset: 512 Hz

6.1.6 Leak Score Table

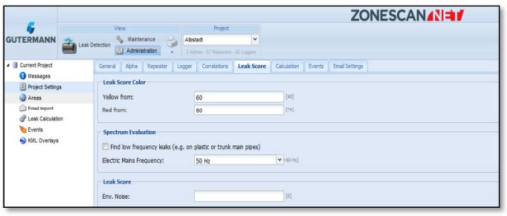


Figure 68: Settings > Leak Score

Env. Noise

In this field, the measurement sensitivity of the logger can be adjusted to the environmental sound intensity

6.1.7 Calculation Table

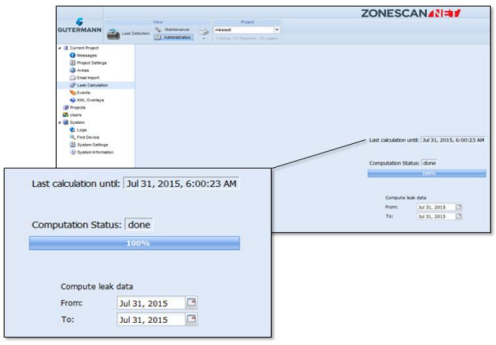


Figure 69: Settings > Calculation

Start Leak Calculation	Perform leak calculation manually
Interrupt Leak Calculation	Interrupt leak calculation
Delete Leak Scores	Delete all leak scores
Refresh Data	Check e-mail

6.1.8 Events Table

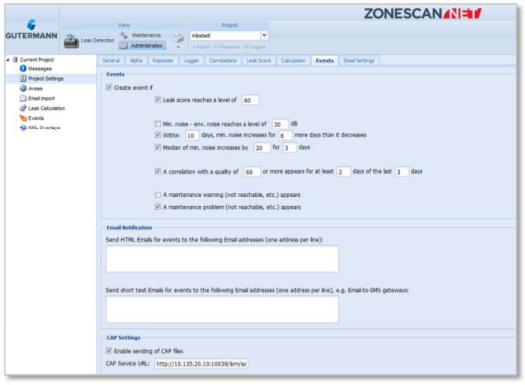


Figure 70: Settings > Events

One of the essential additions to version 1.5.0 is the Events Table where e-mail alarms can be set for the project. Within this table the project administrators can setup the e-mail alarm parameters including the e-mail addresses of the recipients. The settings are designed to alert on a genuine leak rather than a false positive.

6.1.9 E-mail Settings Table

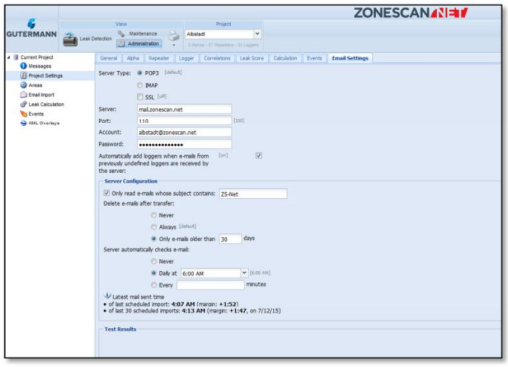


Figure 71: Settings > E-mail

Server Type: Click to define your server type. Select the SSL (Secure Sockets Layer) check box if necessary. Preset: POP3

Server: Enter your server's name. Example: pop.1and1.com

Port: Enter the port enabled for e-mail reception. Preset: Port 110

Account: Enter the e-mail account that receives the data for the project. Example: albstadt@zonescan.eu

Password: Enter the password for the e-mail account entered above

Check the "Automatically add Loggers when e-mails from previously undefined Loggers are received by the server" to avoid having to manually set up new Loggers
Preset: check box is selected

Server Configuration

"Only read e-mails whose subject contains:" Select the check box and enter ZS-Net in the text field

Delete e-mails after transfer: Select whether and when the transferred e-mails are deleted:

- Never
- Always

- Only e-mails older than N days
  Enter the number of days after which e-mails are deleted

Preset: Always

"Server automatically checks e-mail:" Select whether and when the server checks for new e-mail.

- Never
- Daily at
  Select the desired time from the drop-down menu
- Every N minutes
  Enter the number of minutes after which the server checks for new e-mail.

Preset: Daily at 5:00 AM

Note! When entering the time, note that the calculation is useful only after e-mail has been checked. The time of the correlation calculation can be defined in the Server Configuration table

Test Results

If you test the e-mail settings with the Test e-mail settings button, the test results appear here

Use the Test e-mail settings button to test whether your settings are correct and e-mails can be received. The results of the test appear in the Test Results field

6.1.10 Administration Table

Figure 72: Settings > Administration

6.2 KML Overlays

The uploaded KML (Keyhole Markup Language) overlay files are displayed here in a list:

Figure 73: List of the KML files

Import	Click Import to upload the KML files stored on the PC
Delete	Click to delete a selected KML file from the list
Delete All	Delete all KML files in the list

6.3 Projects

All currently running projects are displayed in a list:

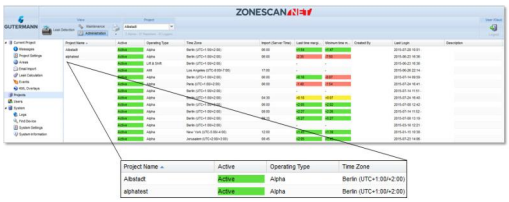


Figure 74: Project List

Add	Create a new project
Edit	Edit a project selected in the list
Delete	Delete a selected project from the list
Import Project	An existing project stored on the PC is imported
Merge Project	To merge two projects, you need an (exported) project file that is then imported into an already existing project. In the project list, select the project into which the file is to be imported. Then click Merge Project
Export Project	All projects are exported

Import Loggers	Selected Loggers are imported
Export Loggers	All Loggers contained in the project are exported

6.4 Users

All users and their assigned projects are displayed in this table:

Figure 75: Users

Add	Click Add to create a new user. In the window that opens, enter user name, password, user type as well as the first and last name. Click to assign the user individual projects. Once all data has been entered, click Save to activate the profile
Edit	Click the Edit button to edit an existing profile
Delete	Click Delete to remove an existing profile

6.5 System

The system category lists all information related to the ZONESCAN NET server. This category is only available for Administrators.

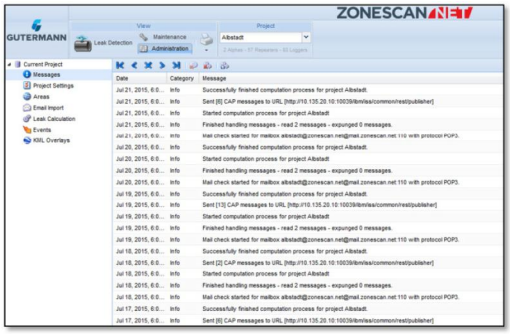


Figure 76: System Messages

6.5.1 Messages

There are two types of messages:

Info This is a simple status message about system activities and background processes

Warning Please contact support if a message is displayed with the warning status

7 Appendices

7.1 Correction explained in detail

Leakage noise is generally a wild mixture of tones, each of which can be associated with individual frequencies (tone pitches, oscillations). The distribution of this frequency content is referred to as a spectrum.

First, the time series signal is recorded. These time series values can undergo a mathematical transformation, Fourier analysis.

A particularly efficient computational technique of Fourier analysis is the FFT (Fast Fourier Transform). This is used to calculate the frequency content and, in particular, identify the presence of dominant individual frequencies. Using this information, it is possible, for example, to draw conclusions on disturbances (e.g., electrical machines).

Frequencies are specified in units of Hz (Hertz) as the number of oscillations per second. For leakage noises, one usually finds a uniform mixture of frequencies, primarily located in the range from 50 to 1000 Hz.

The knowledge of the spectrum, i.e., of the frequency response, is particularly helpful for the computational use of filters, by means of which one can separate the useful and the interfering portions of the noise measurement spectra.

Correlation is a mathematical method for comparing two time series signals with one another.

A leakage noise is simultaneously recorded by two sensors at different locations. The sound emitted by the leak spreads in the water pipe at a defined sound velocity. If the acoustic event were to be brief and occur only once, e.g., a blow with hammer, it would be simple to measure the arrival at both receivers. In this case, one would only need to compare the arrival times at the two receivers with one another. If these are the same, the sound has traveled the same distance to the receivers, i.e., the sound source lies in the middle of the pipe between the receivers.

If the arrival times are different, it is possible to calculate the distance to the two receivers from the measured time difference. The sound arrives at the closer sensor before the more distant sensor.

Leakage noise, however, is not a one-time acoustic event, but it is also not completely monotonous. Small, irregular changes in sound intensity and frequency occur. These changing signatures travel to the two receivers in the same way as a hammer blow and may arrive at the sensors at different times.

Because the identification and comparison of an individual signature is not as simple as in the case of a hammer blow, the two time series signals are first recorded for a period of time; the time series includes many individually measured signal values.

The two time series signals are mathematically compared with one another, i.e., correlated with one another. If the leakage sound arrived at the sensors simultaneously, the same signatures are compared and the signals are then similar and the correlation is high.

In general, however, the respective signatures arrive at the sensors at different times and simultaneously recorded signals do not correlate with one another. Because the signals were digitally recorded and stored, it is possible to retroactively shift the signals with respect to one another and re-correlate them with one another.

This is performed systematically. From the results, one obtains a correlation curve that includes the individual correlation values over the respective computationally performed time shift.

If, during this process, one reaches precisely the time shift that corresponds to the propagation time difference from the sound source to the two receivers, the signal signatures match and one obtains a correlation maximum at this point.

Because this is the comparison of two different signals, it is also called a cross correlation.

In the context of leakage noises, the goal of the correlation measurement is primarily to determine the propagation time difference of two signals.

Because the correlation curve also includes spectral information, it is often of interest to define the character of the leakage noise, particularly for distinguishing noises that are not related to the leak, provided this can be detected by means of a frequency analysis (e.g., electrical noise). The correlation curve can also be mathematically filtered for the purpose of retroactively separating such interfering noise to better identify the correlation maximum caused by the leak.

7.2 Center Correction explained in detail

With correlation we measure the time delay between the leak noise reaching both sensors:

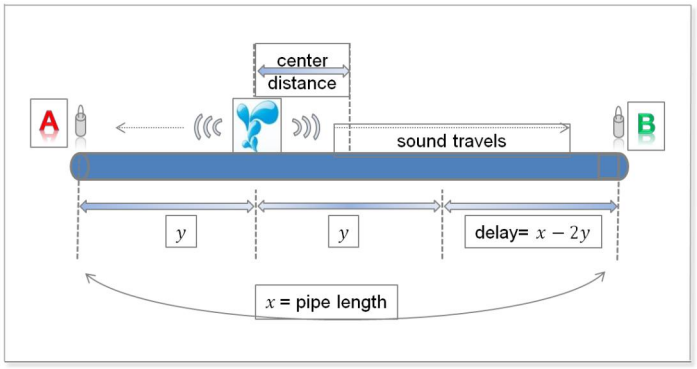


Figure 77: Center Correlation

From this we can calculate the leak distance from both sensors, but only if we know the pipe length between the sensors x. In practice, in ZONESCAN NET we often don't know the pipe length because it was not entered using the pipe wizard of manual pipe entry.

Even if we don't know the pipe length however, we can always calculate the offset of the leak from the center between the sensors using the default sound velocity. This is called center distance.

7.2.1 Example

The selected correlation between sensors 402179 and 402193 in project "Albstadt" below seems to be left of sensor 402193.

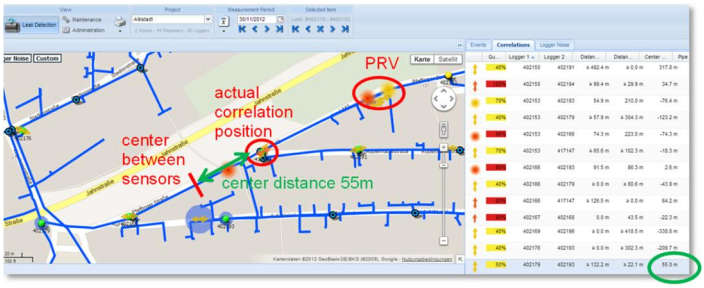


Figure 78: Center Correlation – cont.

As we can see from the KML (Keyhole Markup Language) overlay this is not possible because there is no direct pipe connection between the sensors. However, the center distance of 55m tells us that the noise source is 55m from the center between the sensors towards logger 402193 (if it was towards the first sensor, the center distance would be negative). From this we can see that the correlation position is the junction with the pipe coming from the PRV (Pressure Reduction Volve), which is also the cause for the correlation.

8 Hardware Description

8.1 Overview

As shown in Figure 1, the ZONESCAN system consists of the devices

- ZONESCAN 820 Radio Logger
  - Model 4-1-C1 (EU, internal antenna),
  - Model 4-2-C1 (EU, external antenna),
  - Model 5-1-C1 (North America, internal antenna)
  - Model 5-2-C1 (North America, external antenna)
- ZONESCAN 820 Radio Repeater
  - Model 4-1-C1 (EU)
  - Model 5-1-C1 (North America)
- ZONESCAN Alpha communication unit

8.2 Installation

The initial setup of the ZONESCAN system and/or specific training for the setup is provided by a qualified Gutermann representative.

8.3 Conformity

This device complies with part 15 of the FCC Rules and with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
(1) l'appareil ne doit pas produire de brouillage, et
(2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

9 Disposal

Never put electrical appliances, accumulators, and batteries in household waste bin. Always collected separately and perform an environmentally friendly recycling. When disposing of electrical appliances, accumulators, and batteries always comply with national and regional waste disposal regulations. If an orderly disposal of our products is not possible, send the unit to us. We dispose our products environmentally friendly. Address see imprint.

10 Imprint

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