



Electrical Troubleshooting of a Logstor Insulated Pipe Installation equipped with Tracer Wires

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Introduction

Løgstør Rør A/S, of Denmark, produce a series of insulated piping that is equipped with tracer wires in the insulating medium of the pipe. These tracer wires can be used to identify the following faults:

1. Leakage within the pipe
2. Rupture of the outer casing of the pipe, and/or
3. Actual breakage of the pipe.

The alarm sensor available from Logstor provides two fault indications:

- Open – break in wire
- Leakage – resistance between tracer wires and pipe is approximately 10k ohms or less.

Both of the fault indications normally require corrective action.

It is important that the initial installation be correctly documented in order that corrective action can be effectively taken as necessary. Failure to maintain accurate documentation can make a simple troubleshooting task into a significant challenge.

This document discusses the importance of correctly terminating the tracer wires and documenting the installation. This document also discusses troubleshooting the installation should a problem occur.

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Installation

The most important item about an installation is:

Connect your tracer wires correctly!

This cannot be over emphasized.

The second most important item about an installation is:

Verify your tracer wires!

The tracer wires in the pipes are colored tin and copper as an aid to installation.

Always connect copper-to-copper and tin-to-tin. See Figure 1, Logstor Insulated Pipe with Tracer Wires.



Figure 1 - Logstor Insulated Pipe with Tracer Wires

To install a Logstor system that is easy to maintain, the following should be observed:

1. Verify the tracer wires in each pipe, fitting, etc. before welding the sections. This can simply be done by joining the tracer wires at one end and using an ohmmeter to look for approximately zero ohms reading at the other end. When checking this, also verify that the tracer wire to pipe indicates open.
2. When connecting the tracer wires together, ***always connect tin-to-tin and copper-to-copper***. The crimps should be tested by lightly pulling on the two wires crimped together – they should not separate.
3. If you are connecting two pieces of pipe together, be sure that the “crack” in the insulating sleeve is 90 degrees from the tracer wires. If the crack and tracer wires line up, a potential short could occur should the tracer wire slip into the crack and touch the pipe.
4. Leave a little slack in the tracer wires at the junction points. This can help later should troubleshooting be required. This slack (pipe junction point) would be visible on some Time Domain Reflectometers.
5. Verify the continuity of the tracer wires as each section of pipe is added. This can simply be done by placing a jumper across the tracer wires of the first pipe and checking resistance between wires (close to zero ohms) and leakage to the pipe (open circuit).
6. If you “Tee” off the main pipe, be sure that your tracer wires are connected correctly. If in doubt, use an ohmmeter.

NOTE: In some installations, a very low voltage may occur in the piping and tracer wires. This will cause an anomaly with ohmmeter readings, in that the resistance will change if the test leads are reversed. So long as the continuity is there, there should be no problems.

A typical installation will use accessible junction boxes to allow access to the tracer wiring. An example would be an installation from a boiler room to Building “A” and Building “B”. Each building would have an accessible junction box where the tracer wires enter the building. See Figure 2, Logstor Junction Box. The wires have been removed for testing purposes.



Figure 2 Logstor Junction Box

Be sure to mark important information such as “from” and “to” on the junction box. This will aid in troubleshooting. You may even write on the inside of the cover in felt pen. Remember, a few extra moments now can save many hours later.

Obtain Time Domain Reflectometer (TDR) readings of each section between the junction boxes. An excellent product is the Bicotest TM-625 available from Eecol Electric Utility, Surrey, British Columbia, Canada. This unit will allow display of dual traces, long range readings, and saving/transferring of TDR data to the computer and printer.

In order to use the TDR accurately, you will have to calibrate it to a sample length of pipe. Simply acquire a TDR reading of a known length of tracer wire (tracer to pipe) and adjust the dielectric constant of the TDR, known as the Propagation Velocity Factor (PVF) until the TDR indicates the length of pipe under test. For the Logstar pipe under test in this document, the PVF was determined to be 0.825.

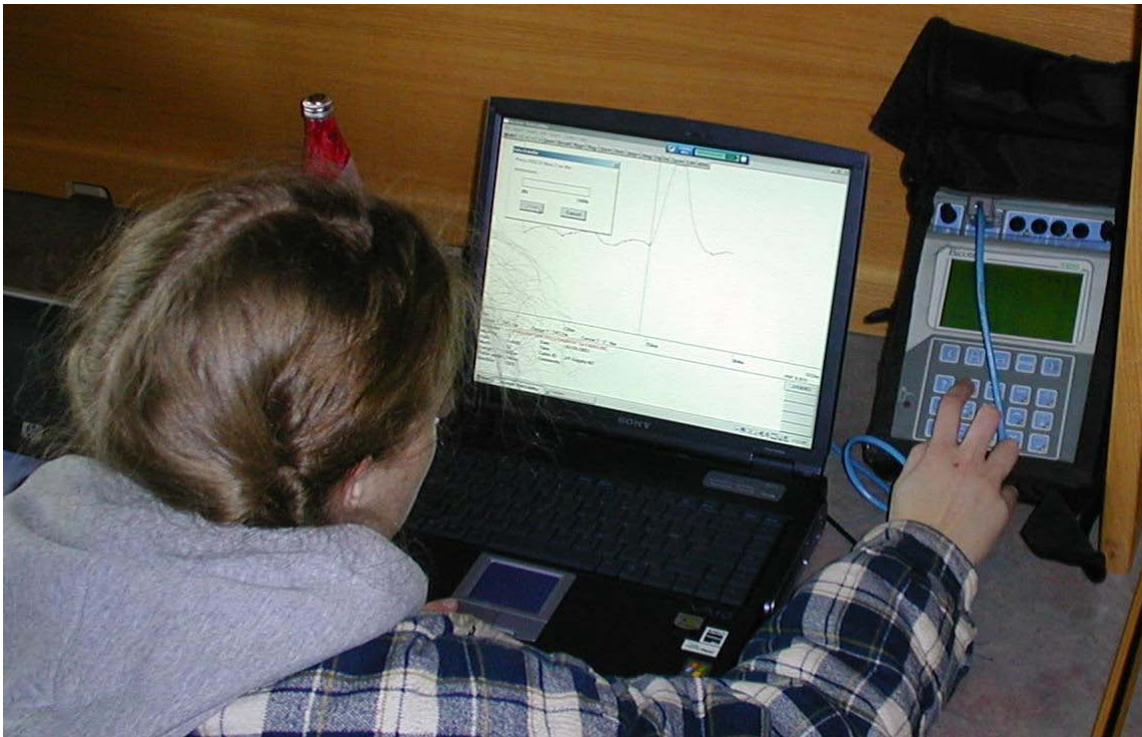


Figure 3 Technician Downloading TDR Data to Computer

Be sure to record a TDR reading for each tracer wire from each building. That is, test the tracer wire that goes from Buildings “A” to “C” from both ends. Be sure you save these readings. See Figure 3, Technician Downloading TDR data to Computer. If there is an anomaly, it should show up on the TDR readings. These readings will also assist later, should corrective maintenance be required.

Figure 4, Sample Test Waveform Using a Bicotest TM-625 shows a typical TDR waveform. The first positive pulse is the pulse sent from the TDR. Impedance variations are then shown on the graph, with a sharp rise being an “open circuit” and a sharp drop, a “closed circuit”. The cursor is placed at the beginning of the upward trace. Figure 4 shows and open circuit at 838.4 meters. The TDR may also, depending on sensitivity settings, show each junction in the pipe. Be sure to correct for the length of the TDR test leads. In our case, 2 meters would be subtracted leaving a total length of 836.4 meters.

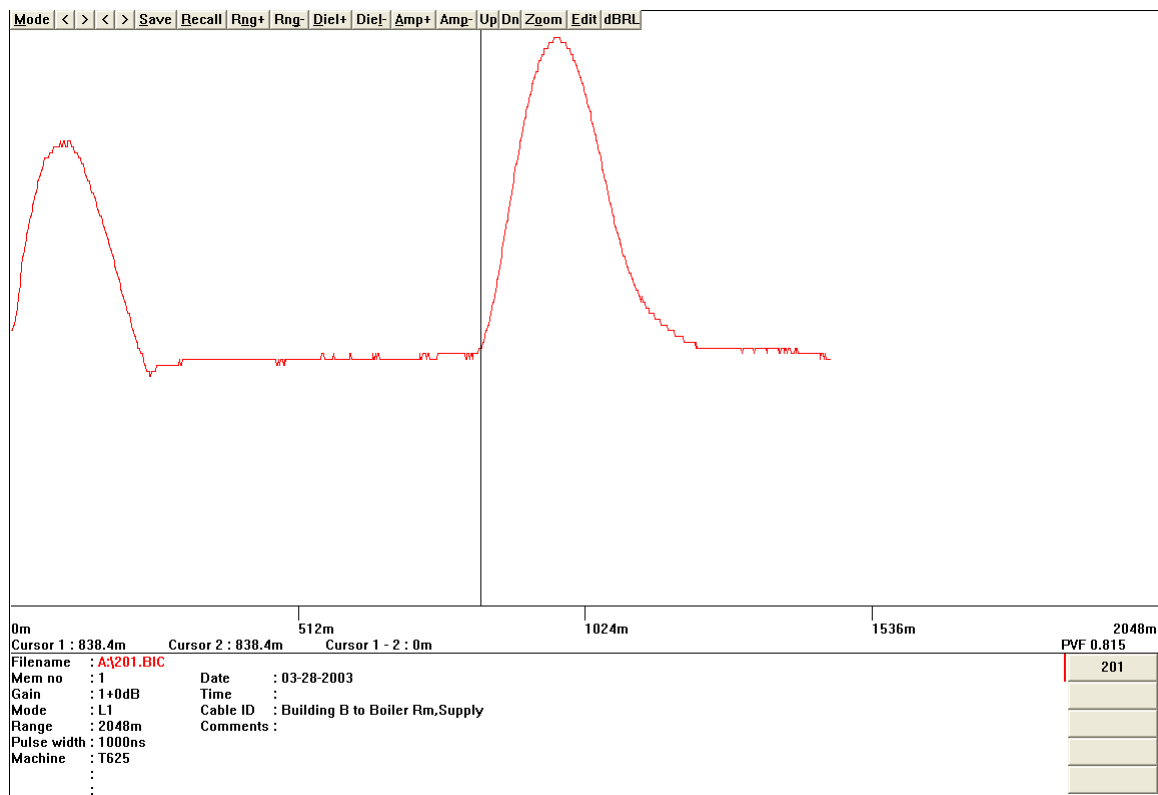


Figure 4 Sample Test Waveform Using Bicotest TM-625

This data obtained should then be inserted into a chart. An example, Figure 5 Test Data, follows.

BUILDING LENGTH	FILE	BUILDING LENGTH	FILE	DIFF		
A to J	244	107	J to A	244	101	0
A to F	144	108	F to A	145	105	-1
B to C	99	202	C to B	99	112	0
C to B	99	112	B to C	99	202	0
C to F	305	111	F to C	303	106	2

Figure 5 Test Data

In this example, the distance from each building is documented *EACH WAY*. For example, the TDR reading from “A” to “F” is 144 meters. The TDR reading from “F” to “A” is 145 meters, leaving a difference of 1 meter. This check provides an accuracy indication on the readings, and also identifies if wires have been crossed. If wires have been crossed when the pipe was assembled, readings of “DIFF”(difference) would normally be much higher. The “FILE” is the actual filename that the trace data is saved as.

If you are testing a heating system with Supply and Return pipes, the length of the Supply pipes and Return pipes from the same buildings would typically be similar.

Should you discover from TDR readings that wires have been crossed in the installation of the piping, the functionality of the leak detection system will still operate correctly. However, you must correctly document the path of the tracer wires, or else locating a problem will become a nightmare.

As an example, an installation Adtech Systems reviewed had three cross overs in the heating supply pipes. This installation was a remote boiler plant feeding seven buildings, with Supply and Return steam pipes. The planned installation had tracer wires running from Buildings "D" to "F" to "J". When the installation was reviewed, the actual tracer wires had been cross connected and instead were connected from Building "D" to "G" to "J". This was a simple error caused during installation. However, if corrective maintenance was done based on the perceived tracer path rather than the actual tracer path, pipes would be dug up in locations where no faults existed.

Cross over of tracer wires is not the end-of-the-world. The full functionality of the leak detection system can still be maintained, and the ability to locate a fault still exists, but only if the installation is accurately documented.

You are now in a position to document the installation. A sample chart, Figure 6 Link Data, follows.

SUPPLY			RETURN		
<i>BUILDING</i>	<i>DISTANCE</i>	<i>TOTALS</i>	<i>BUILDING</i>	<i>DISTANCE</i>	<i>TOTALS</i>
Boiler to D	660	660	Boiler to D	660	660
D to G	346	1006	D to J	394	1054
G to J	148	1154	J to G	151	1205
J to A	244	1398	G to A	206	1411
A to F	144	1542	A to F	147	1558
F to C	303	1845	F to C	305	1863
C to B	99	1944	C to B	100	1963
B to Boiler	838	2782	B to Boiler	844	2807

Figure 6 Link Data

From this chart, you will notice that the path between the Supply and the Return tracer wires is different in several areas. This does not affect troubleshooting, as the installation is now correctly documented.

Troubleshooting an Installation

Lets look at a case where the fault indicator equipment shows an open in the Supply line. You have approximately three kilometers of pipe where that open could exist.

Your first step from the Boiler Room would be to connect the Bicotest TDR on the supply leg to Building “D” against pipe ground and take a reading. Next, connect the TDR against the supply leg to Building “B” against ground and take a reading. Your initial readings could typically be 1845 meters and 937 meters. Both readings add up to the total length of 2782 meters, so probably only one fault exists.

If the Link Chart is reviewed, you will notice that 1845 meters occurs at Building “C”. A review of the junction box at Building “C” indicated a bad connection. Simply correct the bad connection and the system is restored.

If the Supply TDR reading shows 1200 meters to the open on the Building “D” leg and 1582 meters to the open on the Building “B” leg, the fault would be between Buildings “J” and “A”. While this reading will provide a good location to the fault at 46 meters from Building “J”, you may wish to TDR the actual “J” to “A” link before digging.

You can detect leakage within a pipe by looking for an anomaly in the reflected TDR waveform. A leak is a low resistance and would normally show as a spike on the TDR at the fault location.

If you retain the original TDR printouts, you will be able to compare future readings against the original baseline to verify changes in the piping.

In order to accurately locate the place to dig, items such as TDR lead length, the lead length of wires from junction box to heating pipe, and the depth of burial must be taken into account. You must also know the actual path the pipe takes.

A recommended tool for tracing the pipe path is the Radiodetection Model PXL2-4M Receiver with a RD433HCT-x2 five watt transmitter. This equipment is available from Eecol Electric Utility, Surrey, British Columbia, Canada. Figure 7 Tracing a Pipe, shows this equipment in use.

This equipment has the ability to trace for both peak and null signal strength readings, and it can also indicate the depth to the pipe. Remember, underground congestion can lead to unusual readings. When the tracer was used in a typical installation, the peak and null readings were typically one foot apart. This usually does not matter when you dig to locate the fault. Always check your readings against common sense; remember that you are visualizing the unknown and something else could be present underground that you are not aware of.

Remember to mark the location of the pipe on the ground. This way, you can measure along the pipe path to the exact location of the fault.

Another useful feature of this equipment is the ability to locate marker balls. Should a need exist to identify an area, a marker ball can be left underground at the exact location. The PXL2-4M can precisely locate these marker balls.



Figure 7 - Tracing a Pipe

Should your problem be a break in a tracer wire and you have now exposed the pipe at the approximate location of the break, a simple communications tracer (Progressive Electronics, etc.) can be used. Simply connect the tracer to one free end of the tracer wire at a building and follow the signal along the pipe until it disappears. Where the signal disappears would typically be where a break in the wire has occurred. This save unnecessarily removing too much insulation.

Remember, the nature of the splice places the tracer wires closer to the surface at the splice location than along the rest of the pipe. This will result in a stronger signal at the splice and a weaker one along the pipe.

Problems with tracer wires are easy to find, but only if your installation documentation is accurate. Be sure that you have a clear understanding of the test equipment used, and how they work. If in doubt, contact someone that can do the testing and locating for you.

It is a good idea to label the fault sensor equipment with the location of the baseline documentation, and the person and/or company that supports fault locating.

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This document is not intended to provide a complete detailed description of troubleshooting procedures, but to highlight some methods that have been used. Knowledge of the equipment used, and basic electrical and electronic understanding is necessary to find a fault.

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