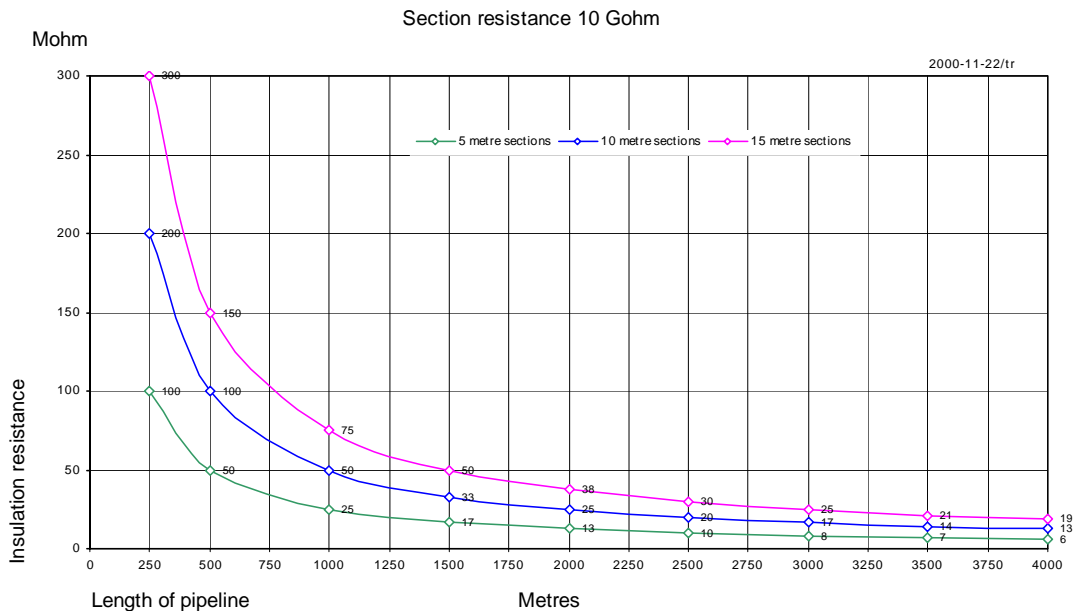


Section resistance

Theoretical insulation resistance for different lengths of pipelines



General information

An insulated pipeline is a large investment. A leakage in the pipeline or from ground water penetration in the insulation must be detected and located quickly and therefore requires a monitoring system. A monitoring system can consist of an uninsulated copper wire embedded in the insulation which is connected to an alarm unit.

Locating a fault takes place with the help of a measuring instrument (TDR) which transmits an electronic pulse through the system. The pulse is then reflected at the fault and returns to the measuring instrument. As the speed of the pulse is known the distance to the fault can then be calculated.

To ensure a precise location of a fault the embedded alarm wire should be positioned at a constant distance from the media pipe along the entire pipeline, and the moisture resistance in the insulation should be at a constant high level.

In "dry" insulation (with high resistance), fault location is made easier and detection of moisture in the insulation can take place earlier than in insulation which was damp from the beginning.

In order to show, in an easy way, the theoretical changes in the resistance of the insulation in extended lengths of pipeline we show a number of diagrams. We have chosen five diagrams showing section resistance at 10 Mohm, 1 Gohm, 10 Gohm and 100 Gohm. The measuring voltage is 1000 volts.

The measuring instrument for controlling the insulation resistance ought to be capable of measuring up to at least 10 Gohm.

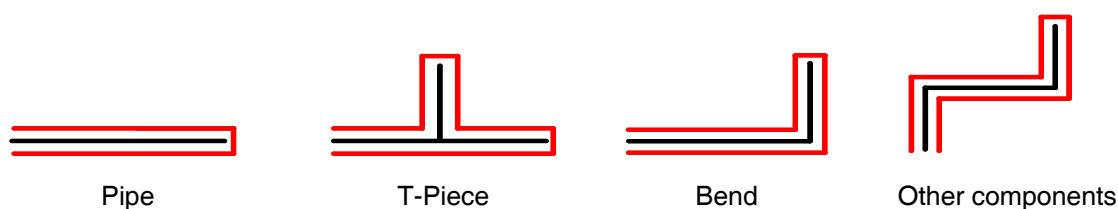
According to the technical recommendation, FVF D:207, of the Swedish District Heating Organisation regarding the connection of alarm wires in piping, the insulation resistance for each pipe and pipe section at 1000 volts measuring voltage should be greater or equal to 1 Gohm.

Basis for diagram curve construction

Each part of a curve construction is known as a section. A section can comprise a pipeline, T-joint, a bend, a valve housing, a reducer, a jointing sleeve, a measuring joint etc. Thus, a completed district heating pipeline consists of a large number of sections. Each of these sections show, when the pipeline is being constructed, a so-called section resistance. It is very important that each section shows the highest possible resistance value as all the section resistances will be parallel connected.

Examples of four different sections.

The black line represents the pipeline and the red line the alarm wire.



With control of each section the alarm wire follows the pipeline as shown and the section resistance is measured between one of the alarm wires and the pipeline. In this way the section resistance covers the resistances on both sides of the piping. Measuring voltage 1000 volt.

The following formula is used for calculating the insulation resistance in the diagrams:

$$1 / R_T = 1 / R_1 + 1 / R_2 + 1 / R_3 + 1 / R_4 \dots\dots\dots\text{etc.}$$

Where R_T is the total resistance and $R_{1, 2, 3, 4}$ etc. are the section resistances.

When calculating R_T , it is presumed that the alternative R_1, R_2, R_3, R_4 etc have the same resistance values.

If any of the sections show a lower resistance value than the others, the total resistance of R_T will contain a lower value (theoretically a lower value than the lowest resistance).

Example

Length of pipeline: 2000 metres

Sections: Mainly 12 metre pipes. Use the blue curve with 10 metre sections.

Section resistance: 10 Gohm

Total insulation resistance according to the diagram on Page 1: 25 Mohm

If a section shows a lower value, e.g. 10 Mohm concerns the diagram for 10 Mohm. The total insulation resistance for the 2000 metre pipeline is, according to the diagram (Page 3) 25 kohm.

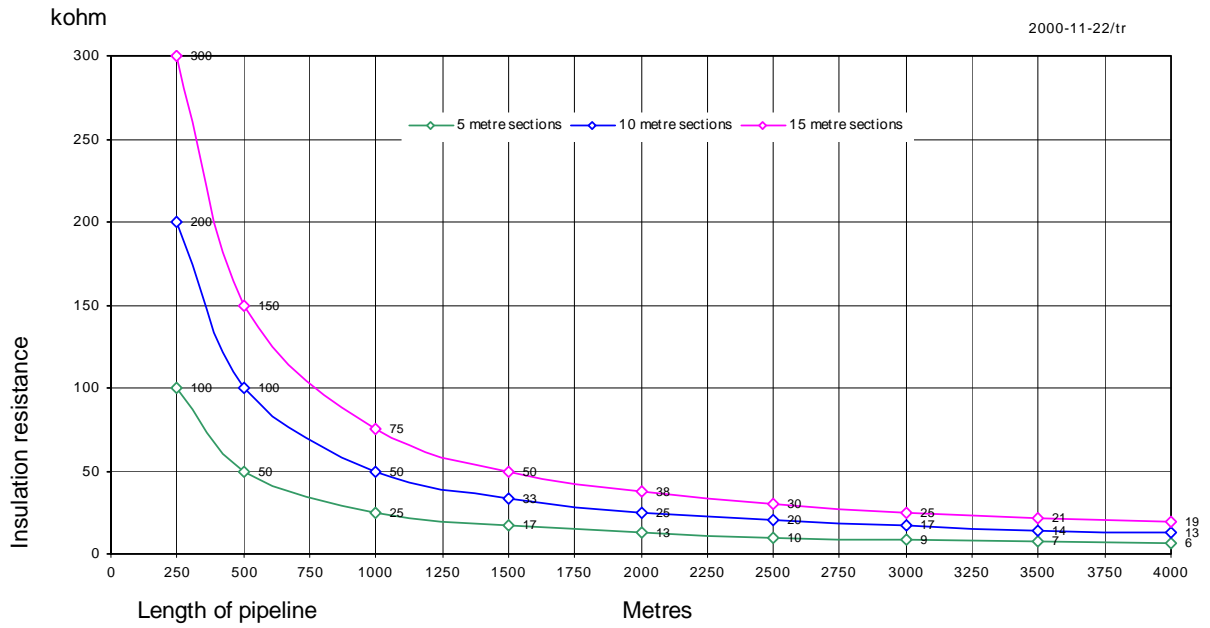
Conclusion

To achieve the highest possible total insulation resistance for the complete length of the pipeline, it is important that each small part of the length shows a high value. Thoroughly control each part of the pipeline and compare with the diagram in this document after each completed stage of the alarm connection. The reasons for any deviations in the insulation resistance from the values in the diagram should be investigated.

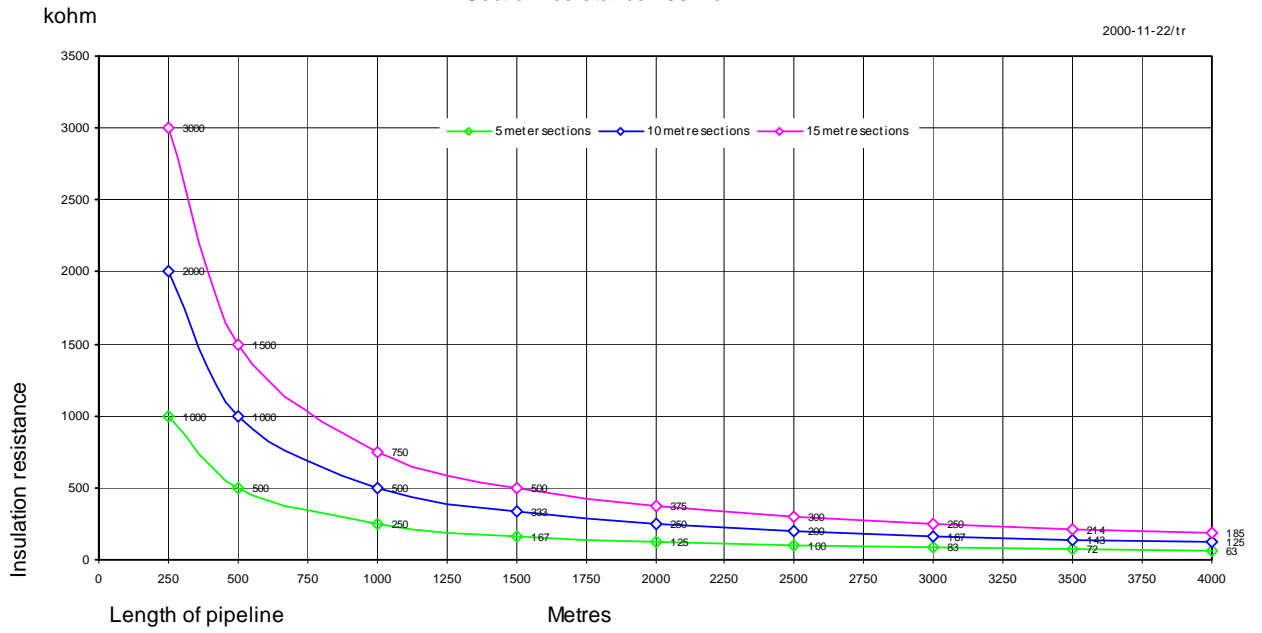
This document is also available on www.wideco.se



Section resistance 10 Mohm

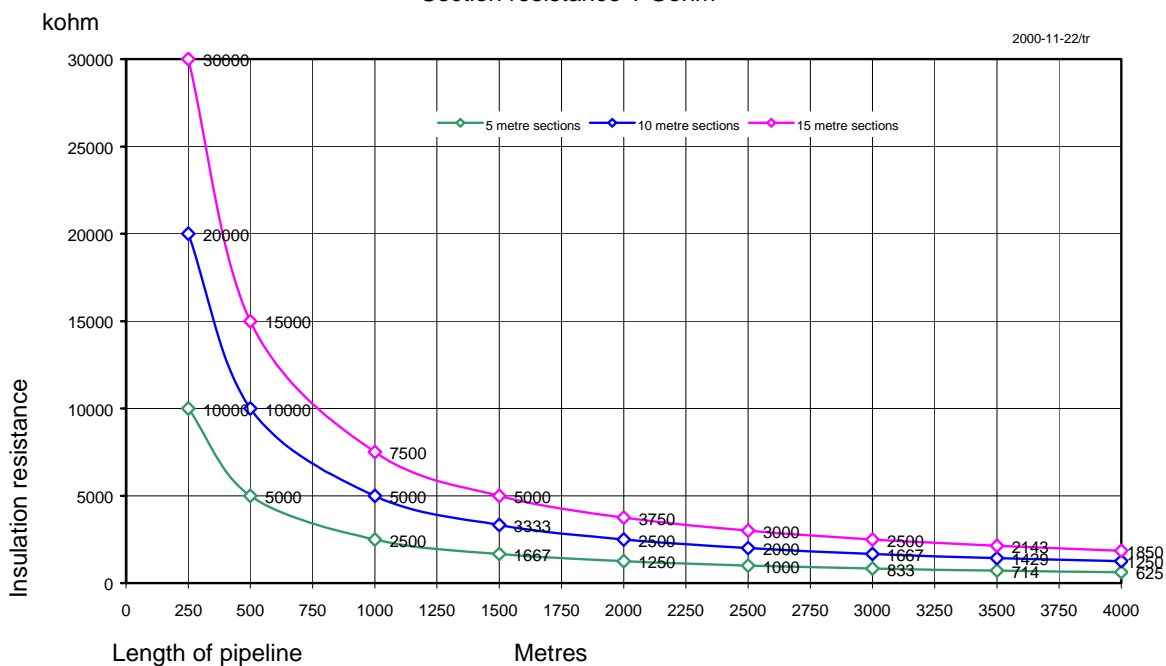


Section resistance 100 Mohm





Section resistance 1 Gohm



Section resistance 100 Gohm

