# PHASE TO PHASE

**Safety, a very important factor**

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# 1          INTRODUCTION

This paper contains some additional remarks on the paper titled "Safety, a very important factor in Cost Optimal LV Distribution Network Design", which was presented at the 2001 CIRED in Amsterdam. The paper and the presentation are made by F. Provoost (NUON) and P.M. van Oirsouw (Phase to Phase).

In a Terra-Terra system the electrical installation is grounded at the client's location. In a Terra-Neutral system the electricity company provides the grounding as a service through the network together with the electric system. But in that case the electricity company is responsible for proper grounding. So, why are many distribution companies in The Netherlands changing their policy from a TT-grounded system to a TN-grounded distribution system?

The customers were used to ground the low-voltage terminals and their home electric systems at the metallic water system. But since the water companies are more and more using plastic instead of metal pipes nowadays, this grounding method is becoming obsolete. To apply grounding electrodes for each customer would be expensive or difficult in some cases. An alternative way would be to have the distribution company provide the grounding, but that also could be more costly, unless it would serve more purposes.

Good EMC in modern ITC equipment call for a TN method of grounding. Different providers have different grounding: e.q. through the water, electricity, telephone and TV-cable systems. These grounding systems meet in the equipment. Not all earthing terminals have the same potential, resulting in possible disturbances. For a proper electricity meter reading concept you will need a good earthing. Also for new secvices behind the meter a good earthing could be desirable. The TN system as a part of a total earthing concept should eliminate earthing conflicts in the future.

But implementing TN implies that calculations must be made in order to ensure safety at all times.
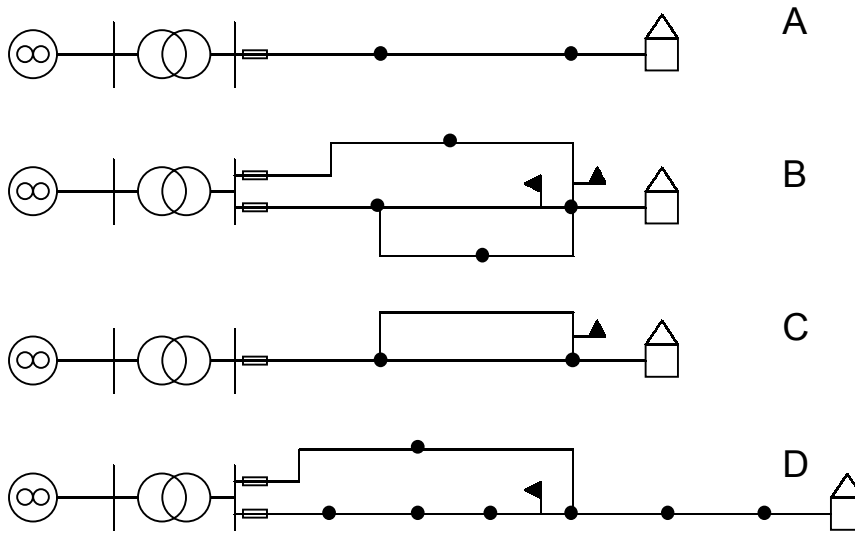
# 2          SAFETY: MODEL VERIFICATION

When it comes to human safety, a new network model and new cable data must definitely be validated for correctness. This is done by means of measurements in practice. The fault voltages and fault currents were measured by creating short circuits in existing low-voltage networks.

The short circuit tests must be in the field, since measurements on a cable on its spool are not usable. The cable's induction would cause very unlikely results.

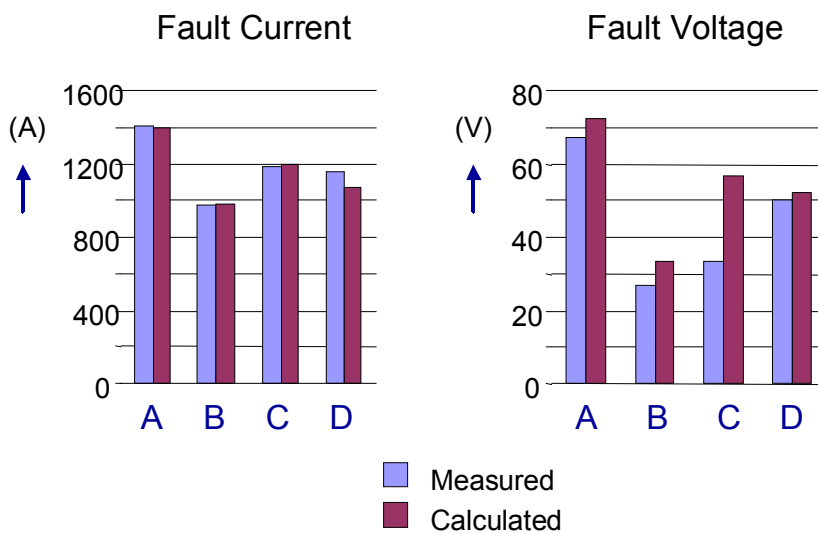The validation is demonstrated in four different networks:
–    one simple direction only
–    a radial system
–    a direction with a bypass at the end
–    a direction with a bypass at the begin

The available results of the field experiments show the differences in fault voltages compared with the values determined using Gaia. The results from Gaia were always on the safe side.

The first diagram below shows the measured (in blue) and the calculated (in red) fault currents. The differences are less than 10%.

The second diagram below shows the measured (in blue) and the calculated (in red) fault voltages. The measured voltage is always lower than the calculated values thanks to the environmental induction effects. There are always other cables and metallic pipes in the ground, that have a positive effect on the ground induction and impedances. This may be the cause of the difference in the low measured voltage in network C.



Of course, the safety aspects itself can not be tested, but they are covered by the standard IEC 479-1.

3          **GAIA IN PRACTICE**

The Gaia method started as a pure grounding and safety calculation program. But it soon developed to an integral tool for cost optimal Low-Voltage distribution network design. In near future the Gaia method will evolve from a user tool to an asset tool, which will enable evaluation of future scenarios, where new distribution techniques and dispersed generation call for probabilistic methods. New techniques involve dispersed wind and solar power, combined with power electronics devices and dispersed battery storage. The Gaia method will grow with it.

Once you have a good computer program it also has to be used in your company. Gaia was developed in close co-operation with the Dutch utilities. But before the program was fully accepted and used in daily practice many things had to be solved.

Firstly the company constraints like preferred cable types, voltage and power quality constraints and future local power production requirements had to be translated into the program constraints. Also data of specific company equipment and old components had to be added to the electrical standard equipment database.
Secondly a good teaching and training of the potential users is necessary. Nuon for example has developed a special one day training programme.

This enabled the acceptance of the program so that the users saw the advantages of it compared with the formerly used programs and common rules of thumb. The users want the simplest program that gives maximum results. Thanks to close co-operation between the users and the developers these requirements became reality within short time. The demand for more simplicity lead to more integrated calculations. Furthermore there is a growing demand for wizards helping to minimise the graphical inputting effort.

Nuon uses Gaia for developing new networks. All new calculated networks are stored for future evaluations and recalculations. But not only new networks are calculated. A large part of the existing Nuon Low-Voltage networks are already modelled. With the help of Gaia these networks are evaluated whether they still fulfil the voltage requirements and what to do when they don´t. But Gaia is also a good tool to calculate the consequenses of network expansions, for example to serve new customers.

When you have a good discipline in storing the network files in the computer network, they are a base for a quality control system on network development.

4          **CONCLUSIONS**

Gaia is a good tool for daily development of new low voltage networks and for examining existing networks. Due to close co-operation between users and developers the program gets more and more accepted.

As the program gets accepted the users want more functionality of it. Because of the growing work load, there is a need for simplicity and everything must be calculated with as little user effort as possible. This together provides a continuing challenge for the programmers and developers.