CEOCOR - SECTOR A

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Paper A09 – Principles and results of a new measurement philosophy within GASUNIE

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Abstract

Gasunie, in The Netherlands, is a Company with about 12.000 km gas transportation pipelines. The pressure varies between 40 and 60 bar. The pipelines are protected against corrosion with coating and cathodic protection. As we comply with the CP-standards we have done for 30 years annually CP-measurements on the 22.000 test post. Because our measuring equipment, after 10 years of use, was no more supplied by the supplier, we had to look for a new measuring device. This was the moment to take a good look at our total CP-cost, the efficiency and quality of our measuring data.
The results of this study where that we designed a 4 channel measuring device (AC en DC) and that we designed a new approach how to handle the measuring data.
The following test case "Vollehove" will show what the results are.

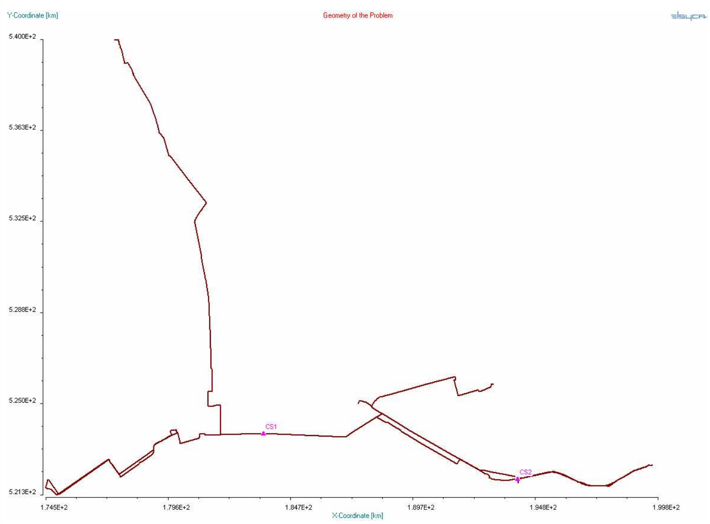
Historically , Gasunie has done annual measurements at the test posts. The measurements where performed according to a data-log principle. The logger measured DC-potentials every 5 min, 60 min or 24 hours. The logger collects the maximum and minimum values from the data and gives the % -values according to a few critical reference parameters (-850 mV and -550 mV). The measurements where done random. All data are dumped in a SAP system and compared with the set points; if set points are overcome, then the CP-technician has to look at the CP System and perform some investigations. The system has proven to work properly, but the state of the art and additional regulations and the requirements of the Asset Management asked for more control of the system. The last two years all the rectifiers and DC-drainages have been prepared with remote control. Having this it is acceptable to electrically section the pipe sections. In the past most of the Isolation Joints were electrically connected.

Test case from our new approach.

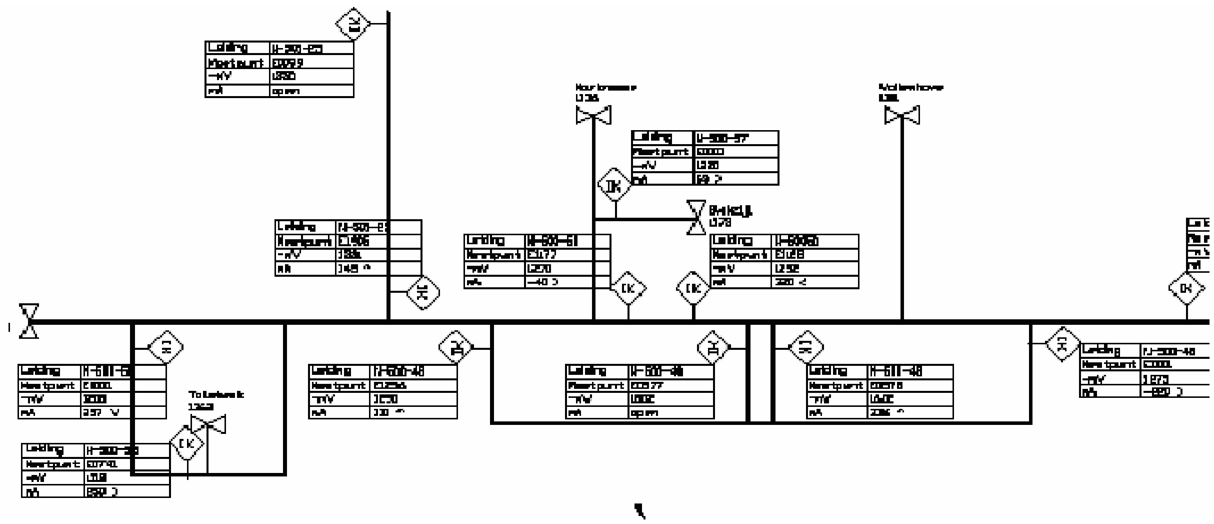
We will use the test result from the 40 bar (Region transportation pipeline) section Vollenhove, number T22601 in the region Oldenboorn. Before we started we made sure that the geographic information from the test post, pipelines, isolation joints, rectifier AC- and DC drains were up tot date in our drawings systems. With this information we made a detail design of the pipeline system. It is built up with two rectifiers and electrical isolated by isolation joint from other systems (section). We made the design using the simulation program CatPro (Designed by Elsyca, Belgium)

Overview of the section

The red circle on the map from the Netherlands gives the location, the figure on the right shows the geometric layout as made in CatPro.



After making the geometric lay-out we also have to connect the pipeline according to the electrical scheme. This section has two rectifiers, the G-1011 and G-1055, that are connected to 8 transmission pipelines. Electrical the system ends at six places either by an isolation joint or by a client.

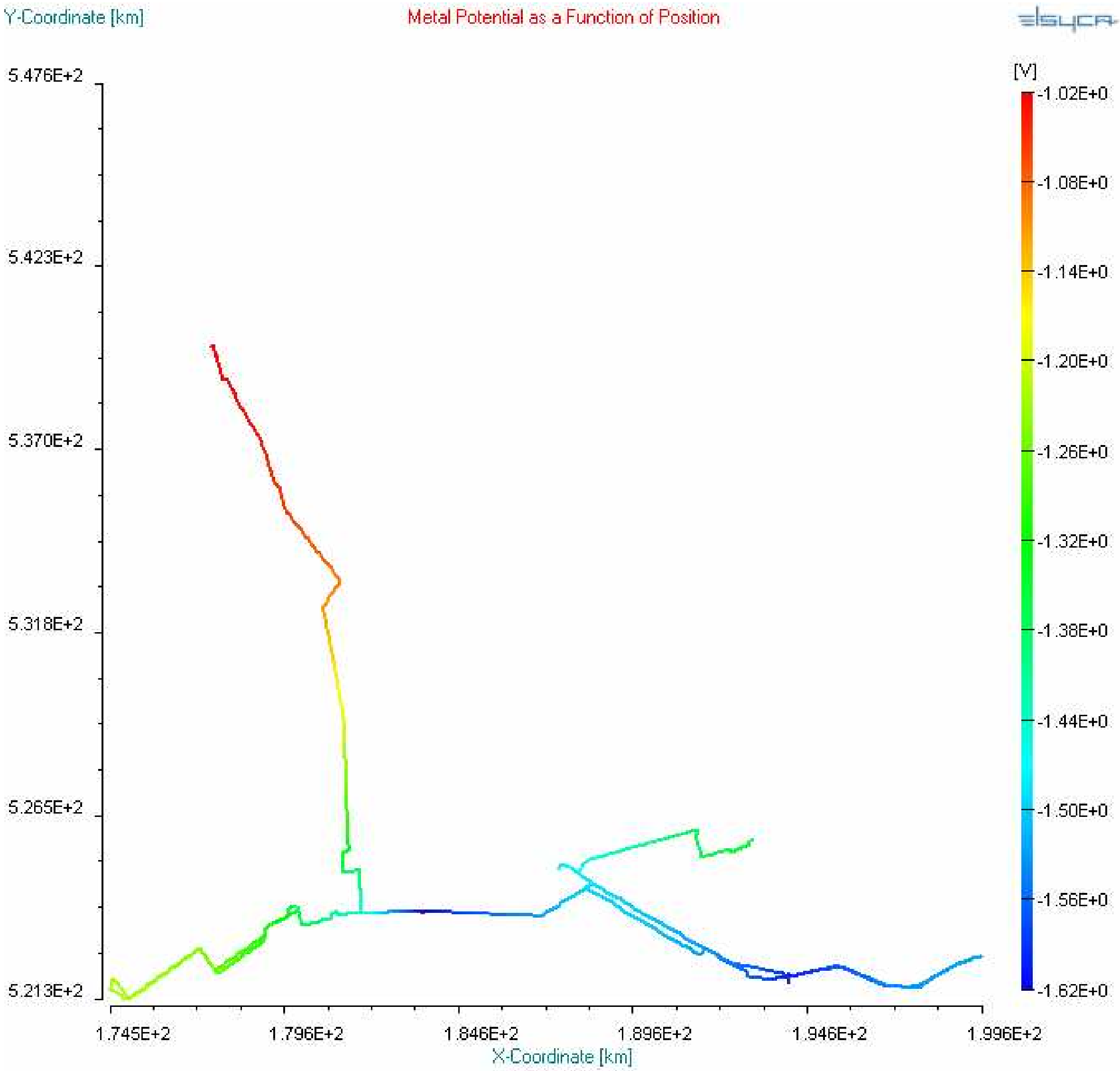


The section is built up with the following pipelines:

Pipeline + stationing	From	Till stationing	End
N-500-48-KR-001	0	N-500-48-KR-015	End
N-500-50-KR-009	E0572	N-500-50-KR-040	End
N-500-51-KR-001	0	N-500-51-KR-002	End
N-500-52-KR-001	0	N-500-52-KR-001	End
N-500-53-KR-001	0	N-500-53-KR-011	End
N-500-57-KR-001	0	N-500-57-KR-011	End
N-500-58-KR-001	0	N-500-58-KR-012	End
N-501-25-KR-001	E0099	N-501-25-KR-028	End

Detail design simulation of section Vollehove.

The results of the simulation we call the detail design. In this design we control the fact that if we would built the system like this, using the standard coating quality (conform to our standards) and setting the rectifier at a potential of -1600 [mV remote earth], the system works according the standards (Gasunie and European). We also call this the as built situation.
Our systems must have a pipe to soil potential between -1600 [mV] and -1200 [mV] to remote earth ($CuSO_4$) at all test posts.



In the figure you can see that only the pipeline to the north (N-501-25) doesn't conform to the criteria, all other pipelines should be properly cathodic protected. The N-501-25 is coated with asphalt bitumen and was built in 1972. According to the Gasunie Standards new bituminous coating has a design current requirement of 0.01 tot 0.1 [mA/m^2]. Degraded bitumen has a current requirement of 0.1 tot 0.5 [mA/m^2]. (PE/PP have a range between 0.001 tot 0.01 [mA/m^2] and degraded 0.01 tot 0.2 [mA/m^2]). The degraded design criterion is reached after 10 years.

For pipeline N-501-25 we have chosen the rate of 0.1 [mA/m^2]. With a potential shift of 500 [mV] it gives a Coating resistance of 5 [$k\Omega m^2$].(For PE/PP this will give a degraded coating resistance of 50 [$k\Omega m^2$].)

Results of Field measurements
In this case we only used the field measurements measured at the Isolating joints and rectifiers. In the future we want to use more measurement.

Section	Leiding	MP	Zwart[-mV]	Traj-zijde	Rood (-mV)	Traj-zijde	I [mA]
I Vollenhove	N-500-48	E0577	1602		1602		Open
I Vollenhove	N-500-48	E0578	1602		1602		336
I Vollenhove	N-500-48	E1246	1290		1290		131
I Vollenhove	N-500-50	E0572	1044	Hoogeveen	1214	Vollenhove	Open
I Vollenhove	N-500-50	E1128	1292		1292		320
I Vollenhove	N-500-50	E1177	1270		1270		-40
I Vollenhove	N-500-57	E0001	1220		1220		63
I Vollenhove	N-500-58	E0001	1208		1208		257
I Vollenhove	N-500-58	E0741	1118		1118		250
I Vollenhove	N-501-25	E0099	980	Follega	1350	Vollenhove	Open
I Vollenhove	N-501-25	E1905	1331		1331		-145
I Vollenhove	N-500-48	E0001	1275		1275		-220

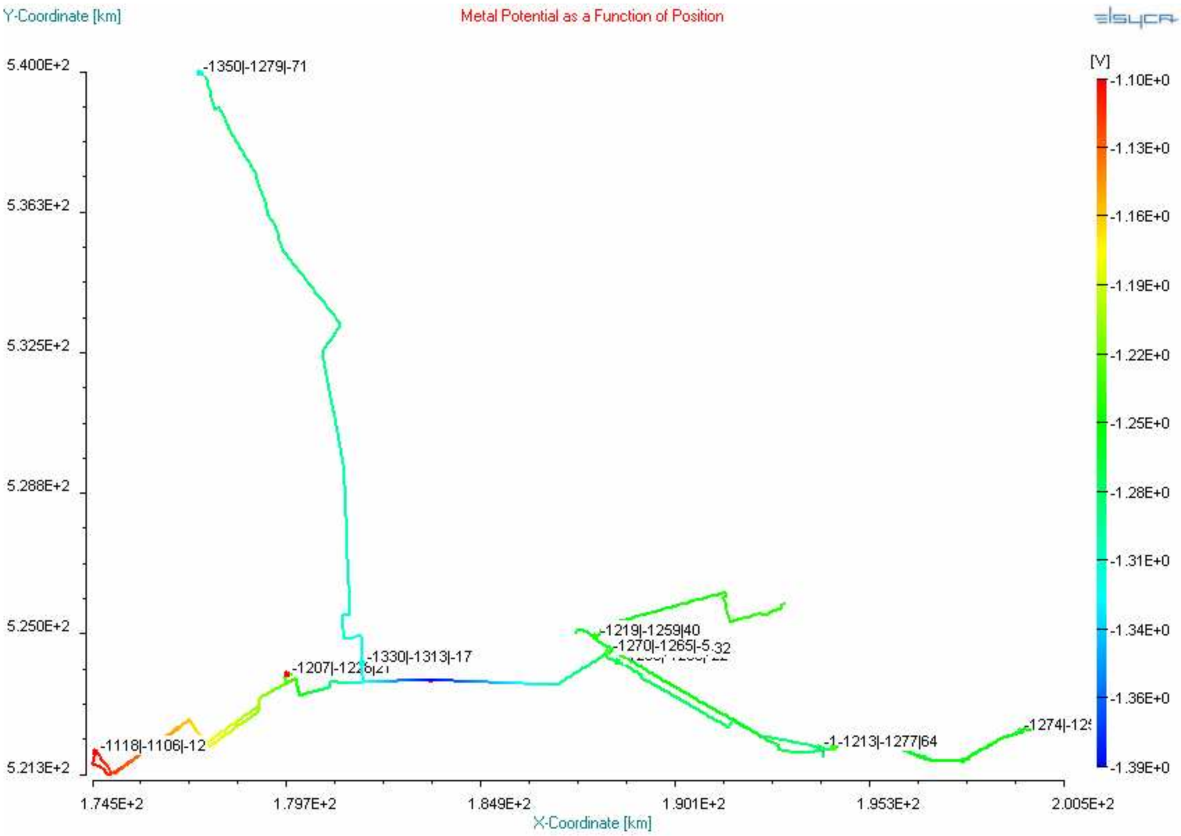
Analyse simulation and field measurements
In the CatPro model the field measurements were fitted. We adjusted the coating resistance to fit the field measurements. It is important to make sure that you keep on using realistic values. When changing the coating resistance doesn't fit and you get in to not realistic values you have to think about bigger fault like shorted casings, contact to foreign steel objects or defect isolation joints. The model makes it really easy to plug in "pseudo defect" with a adjustable current to fit the model.

In the Vollehoven section the next parameters were used to fit the model according to the field measurements;

Coating resistivity

Leiding	Coating [Ω.m2]
N500-50 – E0572->E1711	3850
N500-50 – E1711->E2410	5000
N500-50 – E2410->E2686	6250
N500-48	100000
N500-51	3800
N500-52	3850
N500-53	100000
N500-57	25000
N500-58	100000
N501-25	83333

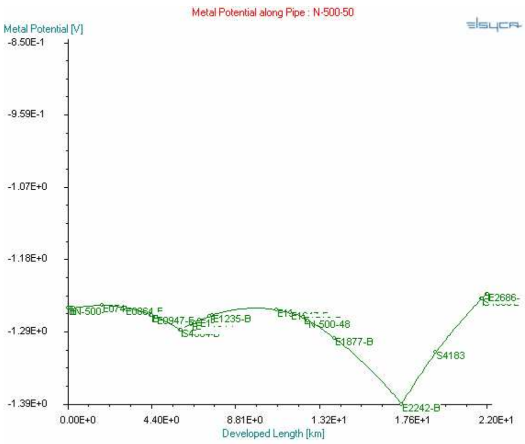
 # Rectifier output:
G1011: 2340 [*mA*]
G1055: 1380 [*mA*]
 # Shorted locations:
Shorted location Emmeloord: 400 [*mA*]
Shorted location Tollebeek: 400 [*mA*]

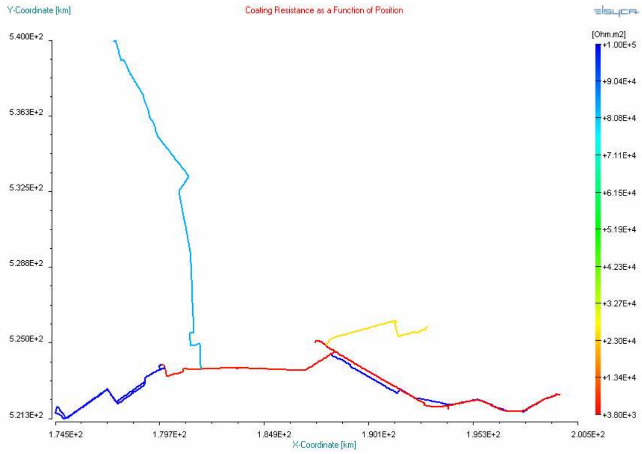


In this figure the result op the pipe to soil potentials is shown. Also we plot the calculated, measured values, and their delta's in mV. The figure shows in the lower left corner that the potentials exceed the -1200 mV. Tot realise this we had to fit two 400 [mA] defects, one at Emmeloord and one at Tollebeek.

All other sections of the section have good potentials even the section going up north!

Now we are able to do all kinds of analyse, for example in the next figures we look at the remote earth pipe to soil potentials (left) along the N-500-50 (the longest pipeline) and you can see the place where it passes a rectifier. It is also possible to show the coating insulation resistance (right) to spot bad pipelines.





Conclusion

According to the detail design the Vollehove section did not agree with the criteria. After tuning the model with the field measurements we found out that the coating conditions where better and that we have an area where we achieve a problem. Without the model the chance to find this area would be pretty hard because the potentials are not very bad.

We saw that the rectifiers where not adjusted to -1600 [mV] remote earth. In the model it is now very easy to change the rectifiers and find out how much current the rectifiers need and to see the new potentials. You don't have to go in the field to make testing measurements. Besides the practical approach saves a lot of time.

Result after adjusting the rectifiers.

Adjusting the rectifiers to -1600 [mV] you find out that the current will be approximately:

G1011: 2340 [*mA*]

G1055: 2500 [*mA*]

Because we simulated a "pseudo defect" (using an earthing with a defined resistance) it is also possible to find out how big the problem could be:

Shorted defect Emmeloord: 470 [*mA*]

Shorted defect Tollebeek: 470 [*mA*]

In this case the maximum potential would be approximately -1230 [mV] which means that we would never go looking for the fault. With the knowledge that we now have, we can zoom in on the area to do an investigation to find the problem.