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Remote monitoring and control systems of cathodic protection - operation experience of SPP – distribúcia, a.s.

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Abstract:

SPP – distribúcia, as a leader gas distribution company in Slovakia operates approximately 32. 500 km of natural gas pipelines with different operation pressure levels. Almost 60% of operated pipeline network is made of steel pipes which implicates the use of cathodic protection (CP) system as a corrosion prevention measure.

Cathodic protection of steel pipeline network is provided by approx. 570 CP stations. Company also operates 165 drainage stations to decrease harmful influence of DC stray currents.

The reasons, why in 2005 company had decided to start introducing telemetry units for monitoring operation of cathodic protection, concept of CP monitoring system, benefits of its operation and current ratio of monitored CP equipment is described in following paper.

Résumé:

SPP – distribúcia, en tant que première compagnie de distribution de gaz en Slovaquie, exploite environ 32 500 km de canalisation de gaz naturel à différents niveaux de pression d'exploitation. Le réseau de canalisations exploité est constitué à près de 60 % de tuyaux en acier impliquant le recours à des systèmes de protection cathodique (PC) comme mesure préventive contre la corrosion.
La protection cathodique du maillage de canalisations en acier est assurée par environ 570 postes de protection cathodique. La compagnie opère également 165 postes de drainage pour réduire l'influence néfaste des courants continus vagabonds.
Les raisons qui ont mené en 2005 la compagnie à décider de commencer à introduire des unités de télémétrie pour surveiller le fonctionnement des protections cathodiques, le concept de système de surveillance des protections cathodiques, les avantages de son fonctionnement et le rapport de courant de l'équipement de protection cathodique surveillé sont décrits dans l'article suivant.

1. Characteristic of a pipeline network

Company distribution network is operated with gas pressure from low (5 kPa) up to high (6,3 MPa). Such pipeline grid comprises long solo lines in open country but distribution network in urban areas with all its complexity, as well. Seventy seven percent of country households have access for using gas, which is the second largest share in Europe, after Nederland.

Key high pressure network had been gradually developed since the end of sixties and was designed and built without electric separation by mean of section isolating joints, i.e. pipelines of different age but the same pressure level are mostly electrically interconnected into the common system. Distribution pipelines in urban areas are electrically separated from high pressure system at the point of gas pressure regulator station.

Part of the system, that is not inconsiderable, is influenced by DC stray currents (DC railways and trams). Despite the presence of high AC voltage power lines (22 kV – 440 kV) and AC railways (25 kV, 50Hz), AC corrosion is still not the crucial problem.

2. The reasons for implementing remote monitoring system

Before remote monitoring of cathodic protection was implemented, company had applied the standard control and maintenance recommendations according to frequencies given by EN 12 954; 2001; [1] – see table 1:

Table 1 - Maintenance before CP monitoring

	Frequency of	
	periodical checks	maintenance
CP station	every 3 month	once a year
Electric drainage	every month	once a year
Galvanic anodes	once a year	once a year
Selected test point	once a year	when necessary
Every test point	every 3 years	

At the times internal organisational structure was regionally orientated (13 local maintenance centres) with locally delegated competencies. Routine control and maintenance of CP equipment was provided by traditional, long term skilled and trained personnel. On the other hand, there was no central control system that was able to monitor performance of CP system, e.g. in case of CP station, cut-off its operation could took at least three months. In areas with significant DC stray current areas it might formed a potentially corrosion risky conditions. In 2003, company had operated 475 cathodic protection stations and 163 drainage stations.

Since the 2005, effort to create more flexible and efficient company brought the wave of organisational changes into traditional structure. During the period gradual changes came into the effect, such as:

- decreasing a total number of local maintenance centres and rearrangement of internal boundaries among them;

- spread of job competencies of CP personnel – responsibility not only for CP;
- and more frequent fluctuation of former CP personnel.

Besides above described reasons, there was additional demand why to start with monitoring of CP equipment. In 2006 company had approved a huge development program that estimated to install new CP systems on approximately 3 000 kilometres of distribution pipelines in urban areas [2]. Since 2008, when still on-going program has started, number of CP stations has increased up to 570.

Based on the arguments and expectations of the new installations, philosophy of the monitoring of CP systems was considered and approved. The material has outlined the following goals to be achieved:

- to decrease uncontrolled cut–off CP operation. In case it happened, to shorten the reaction time for bringing equipment into its repeated operation;
- to increase an operational reliability of cathodic protection systems especially in DC stray current areas that affected reliability of pipeline;
- to have a tool by mean of that we could compensate the expected increase of maintenance capacity related to new CP installation.

As it was not possible to install the telemetry system at all existing CP equipment at once, following steps of gradual installation policy were adopted:

1. drainages systems for railways and CP stations on pipelines influenced by DC stray currents;
2. CP stations on distribution pipelines in order of priority according to level of their importance;
3. important interconnection points;
4. CP stations on the rest of company distribution network.

Of course, for every new CP equipment is requested, to be installed including telemetry system.

3. Examples of CP telemetry installation

SPP – distribúcia has applied the telemetry system on following cathodic protection equipment:

3.1. Electric polarised drainages

The drainage systems connected to DC railways were assumed as the most sensitive and most important CP equipment that is suffering the DC interference. Therefore they had been provided by telemetry unit in a first leg of their installation. In cases that drainage cabinet is not provided by AC power supply, remote terminal units (RTU) are battery operated.

In case of polarised drainage, telemetry unit allows to **monitor only** following information and data:

- pipe-to-rail voltage (± 250 V);

- drained current measured as a voltage drop (± 100 mV) across the shunt;
- on-potential E_{ON} of the pipeline measured by permanent CSE (± 25 V);
- voltage of drainage and RTU battery;
- drainage activity – derived statistical parameter;
- opening and closing the door of drainage cabinet.

Alarm management:

When unauthorised entrance is identified, AC power supply cuts-off or voltage of drainage battery drops bellow 20% of nominal capacity, spontaneous call and alarm message is activated.

Data processing:

In case of standard “monitoring mode” readings of monitored parameters (voltage, current, potential) are taken every second. From the data acquired during one hour, minimum, maximum and average value is calculated and stored in RTU memory. Once a day, RTU automatically transmits these hourly calculated values to upper SCADA system. In case of battery operated telemetry units due to limited capacity of the battery packs, more power saving mode of the data readings is applied.

“Measurement mode” is also available, when operator can choose the time of starting, ending and period of readings during measurement – see example in Figure1. The mode is used on-demand, e.g. when correct operation of the drainage is necessary to confirm.

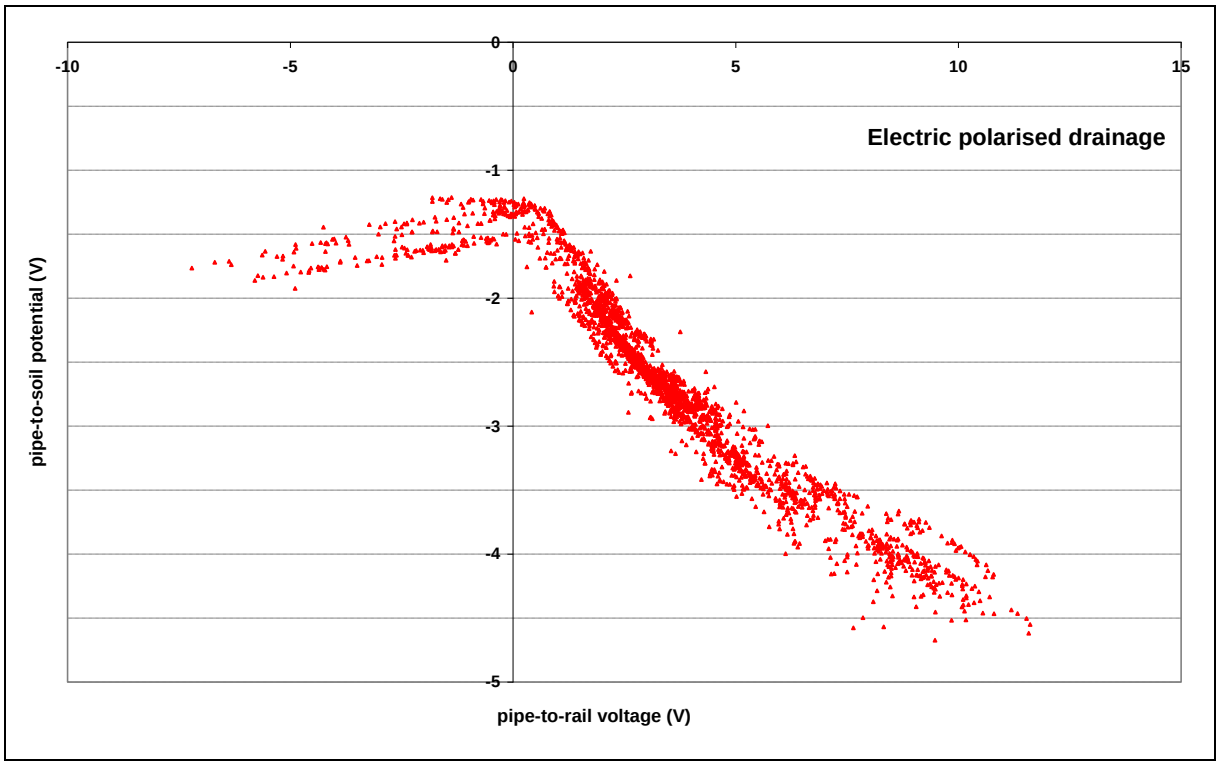

Figure 1 – Correlation between pipe-to-rail voltage vs. pipe-to-soil potential, measured via remote monitoring.

3.2. Cathodic protection stations

In case of CP stations, RTU provides **to monitor** following operation data:

- output DC voltage U_{OUT} of a rectifier (0 – 51 V);
- protective current I_P (0 – 40 A);
- on-potential E_{ON} of the pipeline measured by permanent CSE (± 5 V);
- indication of DC rectifier and GPS receiver failure;
- indication of surge protection unit failure;
- change of pre-set parameters of DC rectifier provided manually on-site;
- opening and closing the door of station cabinet.

In addition to drainage systems, telemetry unit in CP station allows **to remotely control** following parameters:

- switch on and off the CP rectifier as well as turn it into the synchronised switching mode. Off and on period can be chosen by operator. GPS synchronisation allows interrupting several CP rectifiers simultaneously.
- adjust on-potential or output voltage of CP rectifier according to demand of operator.

Alarm management:

Operation failure of DC rectifier or GPS receiver (e.g. lost of voltage in AC main, termination of communication between rectifier and RTU, number of GPS satellites…), unauthorised entrance into the station cabinet activated an alarm indication transmitted to centre control panel. Restart and return to pre-set operation parameters of DC rectifier and RTU after cut-off AC power supply, is fully automatic.

Data processing:

In case of monitored parameters (voltage, current, potential), system calculates average value of the readings taken from the period of every hour. These averages are transmitted once a day do SCADA network.

3.3. Important interconnections

As it was described, company is operating pipeline network of different pressure level. Therefore in some specified cases, the CP station that is installed at the pipeline system of higher pressure level can be used also to provide protective current for the local pipeline network with a lower operation pressure. These two pipeline systems are electrically interconnected, usually at the point of gas pressure regulator station. Typical example of such electrical bonds is shown at the Figure 2:

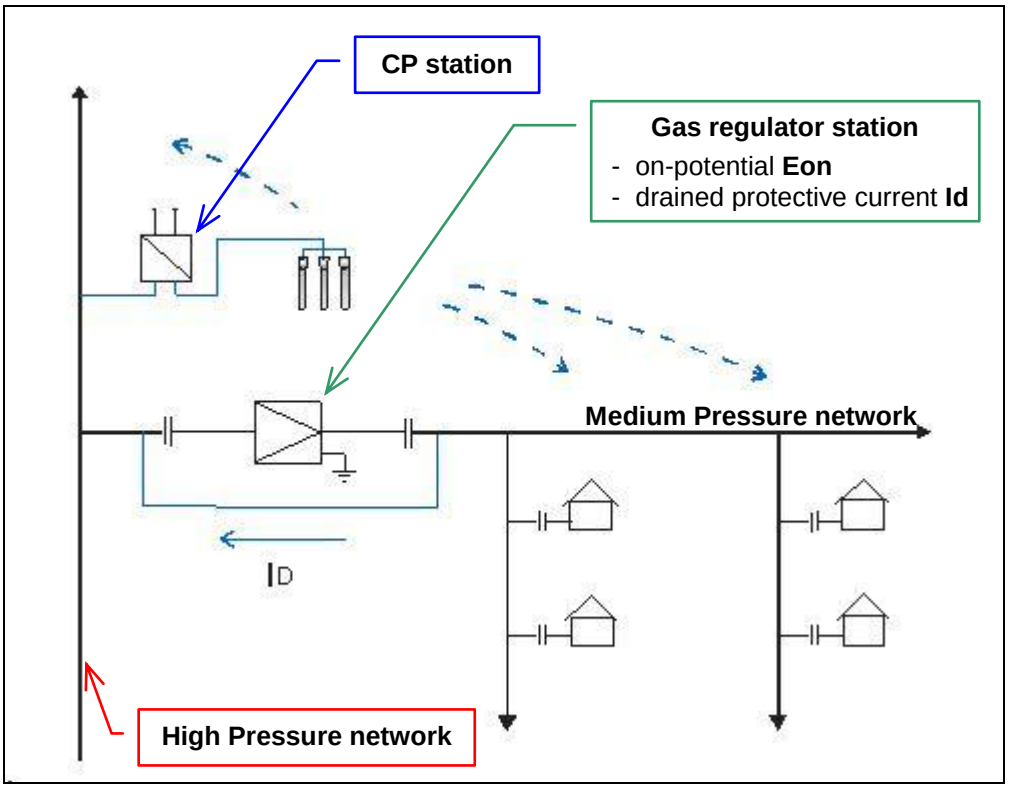

Figure 2 – Monitored interconnection point of two pipeline networks

Such interconnection points are able **to monitor only** CP parameters as follows:

- drained protective current I_P measured as a voltage drop (0 – 100 mV) across the shunt;
- on-potential E_{ON} (± 10 V) of the pipeline measured by permanent CSE at the point of interconnection – gas pressure regulator station;

Alarm management:

CP parameters do not trigger alarm. They are a part of operation data transmitted from gas pressure regulator station. When important parameters (e.g. input/output gas pressure, temperature, etc.) initiated spontaneous call, instant values of all monitored parameters, including CP ones, are transmitted to SCADA.

Data processing:

Due to variety of different RTU used on gas regulator stations, there are slight differences among the data acquisition system of CP parameter. In general, average values of monitored current and potential are available in SCADA.

4. System architecture

Former private company radio network was gradually replaced. Current remote control and monitoring system of CP equipment is based on GSM and GPRS technology. Received and transmitted data and commands through interface communicate to upper level - SCADA network. Data from all monitored CP equipment proceed to monitoring centre where they are checked, assessed and in

case of alarms or suspicious operation data, regional maintenance unit is contacted by operator.

Central operator is able to adjust operation parameters (CP stations only) or turn rectifiers into synchronised interruption mode. It is used in case of providing over-the-line measurements (e.g. coating fault survey, intensive measurement or measurement of CP effectiveness).

Up to now, company is operating telemetry units on following CP equipment:

- Electric drainages: total 165 / monitored 30 / percentage 18%;
- CP stations: total 570 / monitored 370 / percentage 65%;
- Interconnection points: total 245 / monitored 192 / percentage 65%.

The rest of drainages (still not monitored) are connected to urban traffic system (trams) and they are concentrated into 3 localities that are right at the site of maintenance centre.

Till 2013, it is expected to increase the coverage of CP stations by telemetry units up to approximately 80 %.

5. Conclusion

When summarising recent experiences from remote monitoring, it is necessary to mention following advantages, we have obtained:

- overview and better control about operation performance of particular monitored points. We get **prompt information**, when operation of monitored equipment falls down. That positively affected reliability of CP system and protected pipeline as well.
- control about failures that affected CP system as well as the time a quality of mitigation measures provided by local maintenance personnel;
- reduction of frequency for functional checks of monitored equipment;
- providing some controls, such as instant off-potential measurement is much more simplified for CP personnel, without needs of special and expensive synchronised units.

Along to above mentioned advantages that are related with application of CP monitoring there are secondary benefits, such as:

- replacement of obsolete CP rectifiers mainly produced in the 80-ies,
- increasing the grade of surge and overvoltage protection.

From the above description it can be stated, that monitoring system currently applied in SPP – distribúcia belongs to category “monitoring of functional failure”. If we want to continue and find higher utilization of the system, following steps should be prepared and realised:

– increase the coverage of monitored CP equipment;

– define CP critical and characteristic points on the network and install monitoring devices;
– increase a ratio of automatic assessment of the data provided by remote monitoring system in SCADA.

6. References

[1] STN EN 12 954 Cathodic protection of buried or immersed metallic structures – General principles and application for pipelines, 2001;

[2] Some aspects of ex-post cathodic protection application on pipelines after the years of their operation, Maros Melis, Miroslav Grosko, SPP – distribúcia, a.s., CEOCOR days Stary Smokovec 2008