

WHITE PAPER / CATHODIC PROTECTION PERFORMANCE

TELLURIC CURRENTS — THE HIDDEN ENERGY SOURCE WITH POWERFUL EFFECTS ON CATHODIC PROTECTION SYSTEMS AND PROTECTED ASSETS

Telluric currents caused by ionospheric current variations can have considerable influence on corrosion in auroral zones but the phenomenon warrants serious consideration anywhere there are buried assets with CP. Geomagnetic interactions in telluric-affected areas create potential fluctuations of several volts.

Telluric activity induces time-varying electric currents that affect virtually every buried metallic pipeline on Earth to some degree. For many pipeline operators, these geomagnetically induced currents can cause fluctuations in pipe-to-soil measurements and create the appearance of non-compliance with required cathodic protection levels. In more serious situations, telluric currents can cause cathodically protected pipeline potential to become more electropositive than the required level of -850mV. This can result in a serious risk of corrosion if the pipe potential shift is sustained for an extended period and is regularly repeated.

Telluric currents occur naturally on Earth from dozens of sources and of varying intensities. But the strongest telluric currents are caused by the solar wind. The sun is continually releasing high energy particles that can disrupt the Earth's magnetic field and cause electric currents to be induced on to the planet's surface and into long conductors, such as pipelines.

The sun also influences convection in the ionosphere, which drives a dynamo effect and produces electrical currents that vary in intensity throughout the day and are induced into the Earth. In general, these electric fields follow a daily cycle; with greater intensity on the sunlit side of the Earth and tending to flow toward the direction of the sun.

RISKS OF TELLURIC ACTIVITY: ACCELERATED CORROSION AND CP NON-COMPLIANCE

The effects of telluric currents on pipelines and cathodic protection systems can be quite dramatic. One consequence is accelerated corrosion. For example, a study by W.H. Seager that examined an oil transmission pipeline located between 55 and 70 degrees N latitude concluded that, "telluric-related corrosion can override any standard corrosion prevention system and cause pipe perforation in unacceptably short periods of time." Seager estimated that based on the pattern of telluric activity on the pipeline, a 0.6 cm diameter coating flaw could lead to perforation in less than four years.

Another serious issue is the way that telluric currents affect the measurement of pipe-to-soil potentials along a pipeline. When a pipeline is experiencing telluric activity, pipe-to-soil potential measurements can vary significantly from regulatory requirements,

possibly leading to a non-compliance issue and the assumption that the CP system is not providing adequate protection.

One way for survey teams to handle this situation is to just wait for telluric activity to subside and then obtain more normal pipe-to-soil measurements. But this is an impractical solution since the teams may encounter numerous delays of unknown duration over the course of surveying the entire pipe length.

DATA LOGGERS ENABLE TELLURIC COMPENSATION

A better option is to compensate for telluric pipe-to-soil activity by obtaining a sufficiently large data set of measurements and average them over time. This approach enables survey teams to continue their work regardless of the strength of telluric currents while providing the data necessary to eliminate the telluric effect and generate an accurate pipe-to-soil potential under normal conditions.

A simple way to collect these measurements is to install stationary data loggers in test stations at both ends of the pipeline section that is to be surveyed. Field methodology developed by a major North American energy infrastructure company recommends that the data loggers are installed no more than 5 km (3 miles) apart. At minimum, stationary data loggers should run for at least one full day to collect sufficient data—through daytime and nighttime conditions—to establish a reasonably good baseline of telluric activity. Ideally, technicians should install stationary data loggers well in advance of the survey so that they can collect several days of data and improve the baseline measurements of telluric activity.



Pipeline technicians may also opt to install stationary data loggers to cover only the area that they are surveying during their workday. While this method does initially provide efficiencies in time and cost, it does not capture telluric activity overnight, which tends to be less intense. The baseline pipe-to-soil potential for telluric compensation is also less accurate when generated using only daytime data. As a result, CIS results may be inaccurate and field technicians may have to repeat surveys or implement mitigation strategies that could have possibly been avoided with better baseline data of time-varying telluric activity.

ACCURATE SYNCHRONIZATION IS CRITICAL TO SUCCESS

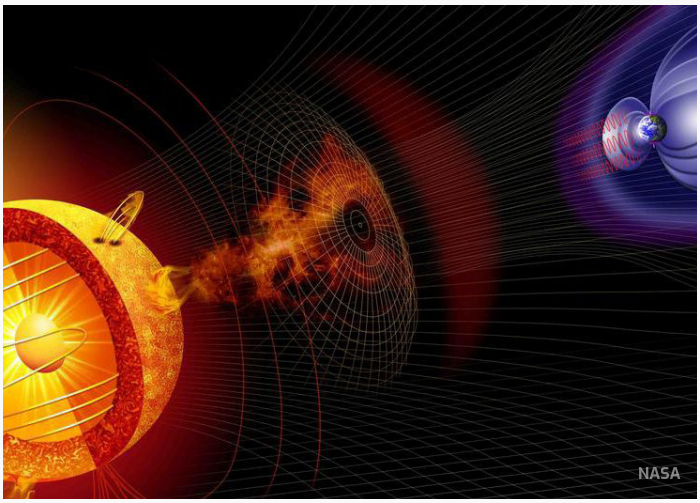
Data loggers equipped with an internal GPS receiver will provide an accurate time reference and site geo-location coordinates. Data loggers can also be time synchronized with a rectifier interrupter to collect “instant off” potential measurements for calculating telluric compensation. This robust, versatile device can be permanently installed in a rectifier and provides both remote monitoring of the CP system as well as GPS-synchronized interruption capabilities. Precise synchronization is one of the most important elements of this procedure since even slight misalignments can cause difficulties in applying the telluric compensation to the survey data.

As the survey team moves along the pipeline, the moving data logger should also be collecting synchronized data that are stamped with the time and location. This high level of synchronization will provide extremely accurate measurements relative to the interruption waveform.

Once the survey is completed, the measurements from the stationary data loggers are used to estimate the baseline potential; or the true pipe-to-soil potential, exclusive of telluric activity. Technicians can then match the simultaneous potentials measured at the stationary data loggers with the corresponding measurement from the moving data logger. If the telluric activity at the stationary data loggers exceeds a pre-determined threshold, then compensation of the CIS data should be applied.

NOT JUST A HIGH LATITUDE PROBLEM

Telluric currents are usually considered to be more problematic for pipelines located in northern latitudes, especially in areas such as the Canadian Shield where telluric currents can be amplified by large graphitic or iron ore formations. In these areas, it can be extremely difficult to interpret accurate CP readings without applying telluric compensation. But pipelines in lower latitudes can also experience telluric activity of sufficient intensity to impact survey measurements and cause accelerated corrosion.



Technicians in southern regions can sometimes attribute transient activity in CP measurements to changes in soil moisture rather than to telluric currents that vary over time. This misunderstanding can lead to two problems. First, survey data may not be accurate since the measurements can't be adjusted to account for time-varied telluric currents. The second potential problem is that technicians may alter the level of CP current based on incorrect survey data. If the current is too high, it can lead to damage of the pipe coating, leaving the pipe more vulnerable to corrosion and failure.

CONCLUSION

Telluric currents move continuously from the sunlit to the shadowed side of the Earth with many factors that influence their intensity, duration and predictability as well as the way that they affect CP measurements and pipelines. Regardless of the intensity of the telluric activity, pipeline operators can easily compensate for it with a large data set of time-synchronized pipe-to-soil measurements and ensure that survey data is accurate.

These data sets can also be extremely beneficial to technicians in developing mitigative strategies that work to maintain CP levels in the optimum range, avoid damage to pipeline coatings and prevent accelerated corrosion of pipelines.

The MOBILTEX reliable, easy-to-install **CorTalk uDL1** data loggers, and **CorTalk RMU1+INT1, CorTalk RDL1** and **CorTalk RMU3** Cathodic Protection remote monitors, combined with our powerful **CorView Cloud Platform** are effective solutions to collect GPS and time-synchronized data for telluric compensation of CIS data.

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