





US\$ 5/m in open right of way (again these are general price guidelines and can vary significantly).

When implementing a linear anode system, it is critical that a corrosion engineering firm with proven expertise is involved in the linear anode system design. The linear anode system design must take into proper consideration the critical issue of voltage drop and its affect on DC current attenuation. Excessive system voltage drops can have a significant impact on DC power distribution to the linear anode system. Rectifier location, header cable sizing and segment lengths must be co-ordinated with site power availability considerations. While rectifiers located no further than 1 - 2 km apart are ideal, practical considerations including availability of AC power, right of way issues and other factors can force this to be extended, further complicating the system design and affecting the installed cost.

While voltage drop considerations often drive the design, one of the benefits of a linear anode system is that the power consumption is relatively low. Ground bed resistance, as determined by Dwight's Equation, is significantly affected by anode length and this results in very low groundbed resistance values for linear anode systems relative to conventional ground beds. This makes the linear anode system much more suitable for low wattage power sources such as solar arrays and thermo-electric generators (TEGs) than conventional ground beds, whose wattage could be two or more times that of a linear anode system to achieve the same current discharge.

### Case study

For Energy Transfer's application, individual anode segments of approximately 150 m length were connected to a parallel header cable and zoned into approximately 600 m long operating circuits. The project included designing the power feeds, minimising DC current attenuation and finding AC power points for the rectifiers. Over the 5 km pipeline segment, AC power feeds were readily available at two locations. An additional rectifier location required a buried AC power feed of approximately 1 km in length to supply AC to a rectifier. The final system design utilised three rectifier locations roughly spaced evenly across the 5 km segment.

The project installation was closely managed by Energy Transfer's personnel. The anode was located in parallel to the pipeline approximately 3 m off the pipeline centreline and at a depth of approximately 1 m. The anode installation was completed in two

weeks, including three excavations of the pipe to connect system grounds and install test station leads. The project lost one day to weather, as the remnants of Hurricane Rita passed through the area providing some much needed rain and not so much needed excitement for the Houston based installation crew whose families evacuated Houston. The actual installation area was several hundreds of kilometers inland from the Gulf of Mexico.

### Conclusion

The system has been operating for almost two years and has been deemed a complete success. Indeed, the system is performing better than expected providing current attenuation beyond the length of the installation based on over the line indirect inspection testing. An ILI run is being scheduled to validate the over the line survey results and further installations are planned to address similar segments along the same pipeline and for other pipelines in the operator's systems. ●●●