

# CLOCK SPRING®

## Application Note

### Cathodic Protection and Electrical Properties of Clock Spring®

While in service, the Clock Spring® composite sleeve will experience conditions much like an anti-corrosion coating. The composite will be exposed to a variety of conditions generated by the soil, cathodic protection system, and pipeline operation. The Gas Research Institute, GRI, undertook a broad research program to evaluate the engineering design, application procedures, and chemical and mechanical properties of the glass-fiber composite and adhesive system used in the Clock Spring® repair. Specifically, GRI report No. GRI-95/0072 “Engineering Properties of Clock Spring® for Repair of Defects in Transmission Pipelines,” addresses prolonged exposure to cathodic protection environments, the electrical resistivity and physical properties of the Clock Spring®, which could influence the potential for shielding.

This study used experiments to evaluate the propensity of Clock Spring® to shield cathodic-protection currents and the changes that occur in electrical resistivity and physical dimensions to the Clock Spring® materials when moisture is absorbed from ‘worse case’ simulated pipeline environments, such as, pH levels 3 to 13.5, fully saturated soil and temperature ranges up to 160° F. The following conclusions were drawn from this study:

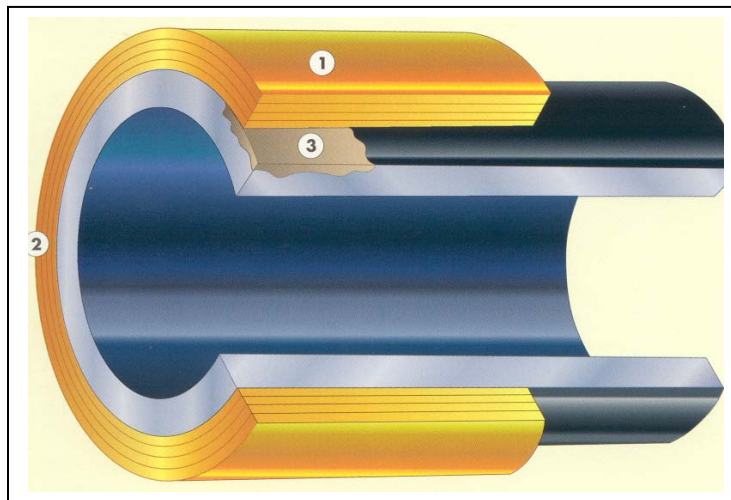
- Estimates of the electrical resistivity of the Clock Spring® composite sleeve and adhesive materials after 1, 10, 50 years of exposure to various aqueous environments indicated the resistivity will be in the range from  $10^9$  to  $10^{11}$  ohm-cm. The estimates are in the range of bitumen (coal tar), epoxy, polyurethane, and polyethylene pipeline coatings after exposure to actual field conditions from 3 to 20 years.
- Clock Spring composite can be expected to absorb some amount of moisture in wet environments. Reactions of the composite with that moisture would likely produce an internal environment that could conduct current. The amount of moisture absorbed ranged from 0.3 to 0.5 percent by weight at room temperature for the composite and 0.6 to 4.0 percent by weight for the adhesive. The low levels of moisture that can be absorbed, combined with the relatively large thickness (0.5 inch) of the Clock Spring® compared to other coating system, suggests that long-term integrity of the composite material is not likely to be a concern.

- Maintaining instant-off potentials close to  $-1000\text{mV}$  ( $\text{Cu}/\text{CuSO}_4$ ) may be more effective in reducing the likelihood of shielding. It should be possible to achieve the  $-850\text{mV}$  ( $\text{Cu}/\text{CuSO}_4$ ) polarized (instant-off) potential criterion or the  $100\text{ mV}$  polarization criterion for cathodic protection under the Clock Spring®. Also, the moisture absorbed by Clock Spring® can act as a barrier to oxygen transport to the steel surface. This will (1) reduce the current required to attain the  $-850\text{ mV}$  ( $\text{Cu}/\text{CuSO}_4$ ) potential and  $100\text{ mV}$  polarization criteria values, (2) reduce the corrosion rate of unprotected steel should a cell be present and the cathodic protection current be shielded, and (3) limit buildup of alkalinity from the cathodic protection reactions.

<b>Resistivity of Pipeline Coatings and Clock Spring® Composite</b>			
<b>Coating</b>	<b>Thickness (Inches)</b>	<b>Age (Years)</b>	<b>Resistivity (Ohm-cm)</b>
<b>Field</b>			
Coal tar	0.1	> 43	$8 - 60 \times 10^5$
Cold applied coal tar	0.1	35-43	$6 - 12 \times 10^6$
Bitumen + jute	0.15	28-35	$4 - 15 \times 10^6$
Bitumen + felt	0.15	18-28	$1 - 4 \times 10^7$
Bitumen + felt	0.15	10-18	$4 - 8 \times 10^7$
Bitumen + glass fiber	0.15	5-10	$4 - 15 \times 10^7$
Bitumen + glass fiber	0.28	0-5	$9 - 14 \times 10^7$
Bitumen	0.39	20	$3 \times 10^9$
High pressure polyethylene	0.08	3	$2 \times 10^{10}$
High pressure polyethylene	0.08	8	$3 \times 10^{10}$
PE tape + reinforcement	0.03	5	$3 \times 10^9$
PE heat shrink sleeve	0.12	10	$3 \times 10^{11}$
Epoxy tar fiberglass reinforced	0.08	20	$1.5 \times 10^{11}$
Urethane tar	0.1	10	$4 \times 10^{13}$
<b>Laboratory</b>			
Bitumen + glass fiber	0.016	New	$>2.5 \times 10^{13}$
Bitumen + glass fiber	0.016	15	$2.5 \times 10^{10}$
High pressure polyethylene	0.08	New	$>5 \times 10^{13}$
High pressure polyethylene	0.08	9	$>5 \times 10^{13}$
PVC tape	0.012	0.5	$1 \times 10^{14}$
11 polyamide	0.012	0.5	$1 \times 10^9$
Epoxy resin	0.008	1	$4 \times 10^6$
FBE (206N)	0.026	2	$>10^8$
E-glass polyester (this study)	0.5	1	$2 \times 10^{11}$
E-glass polyester (this study)	0.5	50	$3 \times 10^{11}$
E-glass vinyl ester (this study)	0.5	1	$5 \times 10^{11}$
E-glass vinyl ester (this study)	0.5	50	$1 \times 10^{10}$

<b>Clock Spring's Predicted Average Electrical Resistivity at Year 50 In Various Environments (Ohm-cm)</b>					
<b>pH level</b>	<b>Temperature (F)</b>				
	<b>74</b>	<b>100</b>	<b>120</b>	<b>140</b>	<b>160</b>
3	$4.05 \times 10^9$	$6.93 \times 10^8$	$2.18 \times 10^8$	$2.73 \times 10^9$	$5.31 \times 10^8$
6	$2.28 \times 10^9$	$1.05 \times 10^{10}$	$2.55 \times 10^8$	$3.70 \times 10^8$	$5.71 \times 10^8$
8	$7.22 \times 10^{10}$	$3.37 \times 10^9$	$4.95 \times 10^8$	$3.52 \times 10^7$	$8.01 \times 10^8$
10	$7.84 \times 10^8$	-	-	$2.99 \times 10^8$	-
12	$1.03 \times 10^{12}$	-	-	$5.19 \times 10^{11}$	-
13.5	$1.13 \times 10^{12}$	-	-	$4.85 \times 10^6$	-

"Experiments on full-scale Clock Spring®-wrapped pipes in soil boxes in the laboratory suggest that shielding of cathodic protection currents is not likely." GRI 95/0072, "Engineering Properties of Clock Spring® For Repair of Defects in Transmission Pipelines".



**Simply the smartest pipeline repair decision you can make!**

**Clock Spring Company L.P. • 14107 Interdrive West • Houston, Texas, 77032**  
**Telephone 281.590.8491 • 800.471.0060 • Fax 281.590.9528**  
**Clock Spring • 4A The Causeway, Godmanchester, Huntingdon, Cambs, PE29 2HA, England**  
**Telephone 011 44 1480 414 703 • Fax 011 44 1480 414 705**  
[www.clockspring.com](http://www.clockspring.com)