

# OIL AND GAS CORROSION AND INTEGRITY MONITORING

## SentinelCorr™ Product Line

### Low Power Corrosion Sensors

Summary of SentinelCorr™ Product Line		
<b>SentinelCorr™ CR System</b>	The CR System is used to measure corrosion rate for both uniform and pitting corrosion and can measure temperature simultaneously	Corrosion Rates: 0.01-60 mm/yr Pressure: Up to 1,700 psi (11.7MPa) Temperature: Up to 350 °F (176 °C) Data: WiFi or USB Download Power: 3.6V Li Battery powered Battery Life: Up to 5 years Software: Desktop and Web-based
<b>SentinelCorr™ CRC System</b>	The CRC System is used to measure corrosion rate and other key parameters such as temperature, pH, and chloride concentration	Corrosion Rates: 0.01-60 mm/y Pressure: Up to 1,700 psi (11.7MPa) Temperature: Up to 350 °F (176 °C) pH Range: 3-10 Chloride Range: 0.001 – 1 M Data: WiFi or USB Download Power: 3.6V Li Battery powered Battery Life: Up to 5 years Software: Desktop and Web-based
<b>SentinelCorr™ ER System</b>	The ER System consists of single or multi-channel (up to 8) electrical resistance (ER) probes to measure corrosion rate and can measure temperature simultaneously; pH and chloride monitoring is also possible	Corrosion Rates: as low as 0.001 mm/y (depending on configuration) Pressure: Up to 1,700 psi (11.7MPa) Temperature: Up to 350 °F (176 °C) Data: WiFi or USB Download Power: 3.6V Li Battery powered Battery Life: Up to 5 years Software: Desktop and Web-based
<b>SentinelCorr™ ICE System</b>	The ICE System can be used to measure coating condition and environmental conductivity and corrosiveness; time of wetness, temperature and relative humidity can also be measured	Coatings: Measures Impedance Conductivity: Measures Impedance Wetness/Corrosiveness: Resistance Data: WiFi or USB Download Power: 3.6V Li Battery powered Battery Life: Up to 5 years Software: Desktop and Web-based
<b>SentinelCorr™ Custom</b>	We have the ability to create custom corrosion monitoring solutions to meet almost any needs. Please contact us to discuss how we can help. For example it is possible to combine the capabilities of the CRC and ER systems into a single solution or to add chemistry monitoring to the ICE system.	

### Software Options

<b>Desktop Software</b>	Any Windows or Mac PC can be used	Can support up to 30 sensors
<b>Enterprise Software</b>	Web server used for monitoring remotely	Supports Windows and Linux systems Supports up to 250 sensors
<b>Hosted Solution</b>	Use software in the Internet Cloud	Supports 1000 sensors

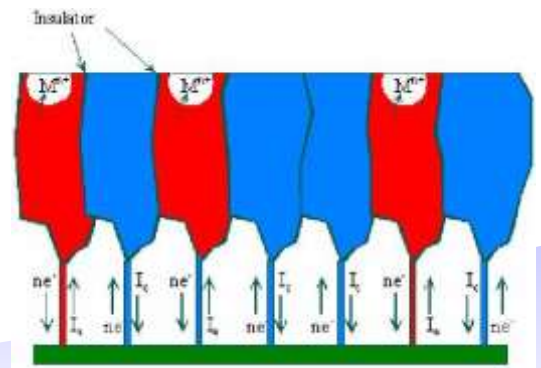
## SentinelCorr™ CR System



The SentinelCorr™ CR system is used to measure the rate of both general uniform corrosion and localized corrosion. The CR system is composed of a single data collection and transmitter unit along with a sensor probe that consists of either 8 or 16 elements to measure corrosion rate as well as an integrated temperature measurement capability. Probes are available in diameters from 1/2" to 1-1/4" (1.27 – 3.18 cm), lengths up to 24" (61 cm), and can be flush-mount or insertion type. The transmitter is powered using a replaceable 3.6V Li-ion battery. A plug-in power option is also available. All data collected by the CR system can be stored using on-board memory for eventual download using a micro-USB or WiFi. Using the WiFi solution, a dedicated network for the sensors can easily be set up (including the use of a cellular modem to ensure total isolation from existing company networks) or the transmitters can be programmed to send data using your existing network.

The CR system functions by funneling the electrons passed between anodic and cathodic sites on the corroding surface discrete channels, where the current magnitude and direction (flowing to or away from that electrode) can be determined. This is achieved by breaking up a single surface into discrete pieces (wires). The pieces are then isolated from each other at the corrosion interface, but electrically connected through external measurement electronics away from the corroding face. This concept is shown schematically.

By measuring the flowing electrons, and knowing the electrode surface area, corrosion rate is calculated using Faraday's law. A single CR reading involves measuring each channel emanating from the electrodes. Therefore, for a 16-electrode CR system, a single reading consists of a group of 16 individual current



measurements. This helps make the CR quick to respond to changing conditions that result in changes in the corrosion rate.

## SentinelCorr™ CRC

The SentinelCorr™ CRC system combines the capabilities of the CR system with capabilities to measure pH, chloride, and temperature all in a single probe. Like the CR system, CRC can measure both general and localized corrosion. Measurement of pH and chloride is performed using solid state electrodes. By using solid state electrodes, there is no need for filling solutions or maintenance efforts making the probe simple to use and more robust. Probes are available in diameters from 1 to 1-1/4" (2.54 – 3.18 cm), lengths up to 24" (61 cm), and can be flush-mount or insertion type. Like the CR system, the CRC transmitter is powered using a replaceable 3.6V Li-ion battery. A plug-in power option is also available. All data collected can be stored using on-board memory for eventual download using a micro-USB or WiFi. Using the WiFi solution, a dedicated network for the sensors can easily be set up (including the use of a cellular modem to ensure total isolation from existing company networks) or the transmitters can be programmed to send data using your existing network.

## SentinelCorr™ ICE System

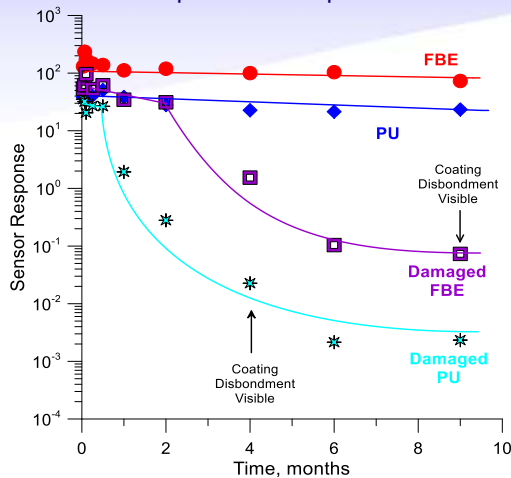


The SentinelCorr™ ICE system can be used to monitor the condition of epoxy coatings on rebar and painted steel structures, concrete conductivity, time of wetness, and corrosiveness. In addition, it is capable of monitoring the condition inside cable casings for water intrusion and corrosion. For coating condition monitoring, a 1.3V DC bias with a 180 mV peak to peak AC voltage superimposed is applied at a frequency of 1kHz. The resulting impedance provides an indication of coating condition and quality.

Both real and imaginary impedance are measured and recorded. When measurements are taken over a period of time, coating breakdown can be detected in areas where visual and other coating inspection methods are difficult or are impossible. This same impedance system can be used to monitor concrete conductivity.

Each SentinelCorr™ Coating Degradation Sensor (CDS) consists of two wires that are mounted from the back side into the probe (see photo) that acts as a witness or surveillance coupon. These two wires are electrically isolated from each other and from the probe. Prior to installation of the probe, the coating of interest is applied to the sensor head. A 1.3V DC bias with a 180 mV peak to peak AC voltage superimposed is applied at a frequency of 1kHz. The resulting impedance provides an indication of coating





condition and quality. Both real and imaginary impedance are measured and recorded. When measurements are taken over a period of time, coating breakdown can be detected before it is visible. Additional testing has shown that the detection of coating degradation quickly resulted in the onset of corrosion. Because early detection of coating degradation is possible, maintenance actions can be performed before significant coating damage and corrosion have occurred.

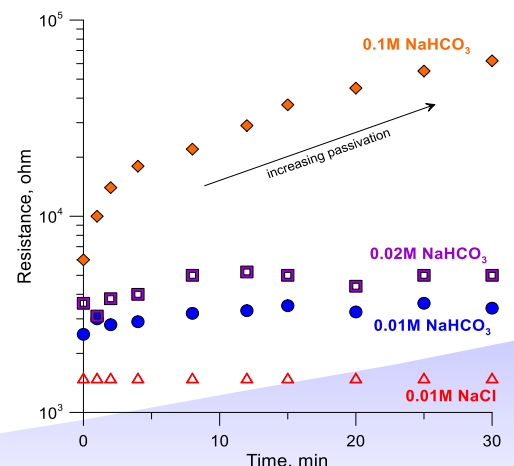
The SentinelCorr™ corrosivity sensor consists of a galvanic couple sensor using copper and steel. A 1.3V DC bias is applied for 10 seconds and then the resistance between the two metals is measured. The application of the short potential bias serves to drive the galvanic interaction between steel and copper enabling the distinguishing between environments of different aggressiveness. Shown below are data that demonstrate this. From the data shown, the probe resistance increased with time at higher bicarbonate concentrations illustrating that passivation of steel due to the formation of a carbonate film can be observed. In addition, it has been shown that the resistance measured can be directly correlated with corrosion rate in most instances.

The SentinelCorr™ time of wetness sensor (TOW) is constructed from an interdigitated set of copper elements. When it is dry, the resistance between the two sets of elements is infinite. When water contacts the sensor, the two elements are shorted through the solution and the resistance drops. The wetness sensor can provide some indication of corrosiveness since the resistance can change when the environment changes from water to other environments that contain salts, etc. However, this sensor is not as sensitive to environmental changes as the corrosiveness sensor.

The ICE transmitter is powered using a replaceable 3.6V Li-ion battery. A plug-in power option is also available. All data collected can be stored using on-board memory for eventual download using a micro-USB or WiFi. Using the WiFi solution, a dedicated network for the sensors can easily be set up (including the use of a cellular modem to ensure total isolation from existing company networks) or the transmitters can be programmed to send data using your existing network.

## SentinelCorr™ ER System

The SentinelCorr™ ER system is similar to other electrical resistance probe systems. However, we offer the added flexibility of having more than one sensing element (up to 8) on a probe and/or monitoring more than one probe (up to 8) simultaneously. This provides tremendous flexibility by being able to have different sized elements in use at the same time to provide a broader range of



corrosion rates that are possible as well as longer probe life. In addition, elements/probes using different materials can also be monitored together. When coupled with temperature and available chemistry monitoring features, a very powerful tool is at your disposal.

The ER transmitter is powered using a replaceable 3.6V Li-ion battery. A plug-in power option is also available. All data collected can be stored using on-board memory for eventual download using a micro-USB or WiFi. Using the WiFi solution, a dedicated network for the sensors can easily be set up (including the use of a cellular modem to ensure total isolation from existing company networks) or the transmitters can be programmed to send data using your existing network.

## **SentinelCorr™ Custom**

Because one-size does not always fit all situations, the need to have a customized corrosion monitoring solution can occur. We have the ability to create a customized solution using fully commercialized components and manufacturing processes. And we can do it cost-effectively. This is unmatched in the industry.

## **Software**

The data collected by the sensors can be viewed using either desktop or secure web-hosted solutions. The software allows for control and reprogramming of the sensors and data viewing in graphical or table format. In addition, data can be exported to MS Excel with the click of a button. The software can also be configured to send SMS or email messages when different events occur. Because our software uses MY SQL database, it is also possible to automatically send the data to your MY SQL compatible database system. This makes integration with your existing data management system easy and seamless.

## **Additional Information and Support**

In addition to corrosion sensors, other sensor solutions are also available. If you need additional information including product recommendations and price quotations, please contact [info@ArgusCorr.com](mailto:info@ArgusCorr.com) or go to our website at [www.ArgusCorr.com](http://www.ArgusCorr.com).