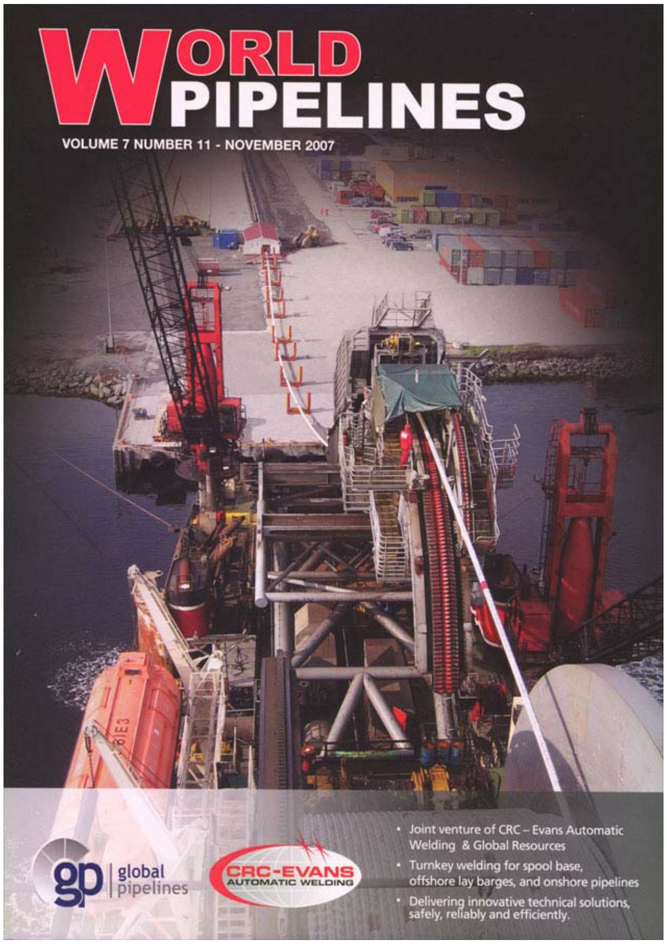


Combined CIPS and DCVG Survey For More Accurate ECDA Data

J. Peter Nicholson
Managing Director
Cathodic Technology Limited
Bolton Ontario Canada

Corrosion is a leading cause of pipeline failures; it is reported that nearly 30% of all pipeline failures in a 30 year period 1971 and 2001 in Europe where due to external corrosion of underground or underwater pipelines. Leaks due to corrosion of pipelines result in huge economic losses and damage to the environment and can result in loss of life.

With the publication of the NACE International Recommended Practice ***RP0502-2002 Standard Recommended Practice Pipeline External Corrosion Direct Assessment Methodology,*** pipeline operators are required to utilise a minimum of two indirect method tools to assess the effectives of the corrosion control method(s) on underground and underwater pipelines. The NACE International Standard Practice ***SP0207-2007 Standard Practice Performing Close-Interval Potential Surveys and DC Surface Potential Gradient Surveys on Buried or Submerged Metallic Pipelines,*** has now defined the methods for undertaking CIPS and DCVG surveys.

These standards require the pipeline operator to select indirect inspection tools based on their ability to detect corrosion activity and/or coating holidays reliably under the specific conditions to be encountered. The pipeline operator should select indirect inspection tools that are complementary. The operator should select the indirect inspection tools such that the strengths of one tool compensate for the limitations of another.

Undertaking a combined CIPS and DCVG survey satisfies the requirement for indirect inspection under RP0502-2002. The CIPS and DCVG surveys are complimentary and compensate for the weakness of each survey system, thus meeting the requirement of ECDA.

Pipeline operators that adopt these standards as there corrosion control procedures should see a significant reduction in external corrosion of pipelines and a consequential reduction in leaks.

Photograph 1 a CIPS Surveyor at Work

Close interval potential surveys (Photograph 1) indicate the level of cathodic protection on a pipeline but not necessarily coating holidays or defects on the pipeline. DCVG surveys, on the other hand, indicate coating holidays or defects but not the level of cathodic protection. By combining the two surveys, not only can the level of cathodic protection be determined but coating holidays and defects can be correlated with the CIPS data.

With improvements in electronics and integrated circuits, measurement equipment has become small and lighter with improved accuracy. Modern equipment such as the Cath-Tech™ Hexcorder™ Millennium can measure and record the rectifier ON and instant OFF potential every second as well as the voltage gradient value with the rectifier ON and OFF.

This survey data is stamped with the chainage (distance), GPS coordinates, date and time and even the elevation above sea level. The corrosion engineer now has a data file where the pipe-to-soil potentials and the direct current voltage gradients are correlated by distance and time, eliminating spatial errors and mismatch in data correlation.

Traditionally DCVG surveys have been undertaken utilizing an analogue DCVG instrument. The analogue DCVG instrument does not have data storage capability nor does it have the ability to stamp the measured voltage gradients with the location or GPS coordinates.

Photograph 2 Defect Stakeouts using Analogue DCVG Instrument

Because analogue DCVG instruments cannot measure or store chainage or GPS coordinates, coating defect locations must be staked (Photograph 2) and then the distance manually measured from a reference point. This contributes to errors and in time the loss of stakes indicating the defect location due to traffic or other factors.

When two half cells are placed on the ground some distance apart there is often a voltage difference between them due to soil chemistry and other factors. Analogue DCVG instruments are equipped with a compensation circuit to bias out the potential difference between the two half cells, such that only the voltage gradient due to current flow to a coating defect shows on the analogue meter. Since there can be a potential difference between the two half-cells, pulsed DC current is used to indicate current flow to a coating defect. This pulsed current is usually achieved by cyclically interrupting the rectifier(s) or by installing a temporary rectifier and ground bed and cyclically interrupting the DC current.

Photograph 3 DCVG Surveyor

The pulsed current causes the pointer on the meter to move rapidly and when operated correctly the movement of the pointer points in the direction of the coating defect. Since the voltage gradient around a defect dissipates quickly, small coating defects can be easily missed if the surveyor is not taking sufficient readings. The Cath-Tech™ Hexcorder™ Millennium (Photograph 3) utilizes a bar graph to represent the movement of a meter needle. The bar graph points in the direction of the coating defect just as an analogue meter movement does.
Digital equipment such as the Cath-Tech™ Hexcorder™ Millennium solves the problems associated with analogue DCVG instruments by recording the chainage and GPS coordinates of each reading location. Measuring and recording the pipe-to-soil potential with the rectifier on and off can accurately measure the level of cathodic protection on the pipeline at the coating defect epicentre.

The Cath-Tech™ Hexcorder™ Millennium can also measure the voltage gradient in the ground associated with current flow to a defect. This measurement is made in exactly the same way as the analogue DCVG instruments except that the voltage measured is converted into a digital value for display and storage. By measuring and recording the voltage between the two half cells with the rectifier on and off voltages due to chemistry of the soil and other factors can be eliminated by subtracting the rectifier off voltage gradient from the rectifier on voltage gradient, the resultant being the direct current voltage gradient.

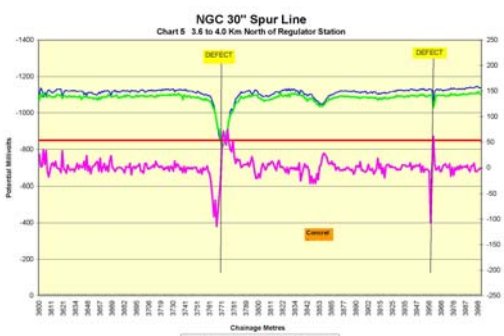
With analogue equipment it is necessary to take several readings in series adding each value to the previous to obtain the maximum voltage gradient associated with a defect. With the Hexcorder ™ Millennium and two surveyors the maximum voltage gradient is automatically measured by spacing the two surveyors 5 to 7 meters apart (Photograph 4).

By combining the CIPS and DCVG survey the direct current voltage gradients are correlated with the pipe-to-soil potentials eliminating spatial errors.

Photograph 4 Two Surveyors Performing a Combined CIPS and DCVG Survey

Further the instrument stamps each reading set with the chainage and GPS coordinates making it easy to relocate coating defects for direct examination.

When the results of a combined CIPS and DCVG survey where both surveyors are over the pipe are graphed even small coating defects are readily apparent due to the sinusoidal waveform produced by the voltage gradients associated with a coating defect.



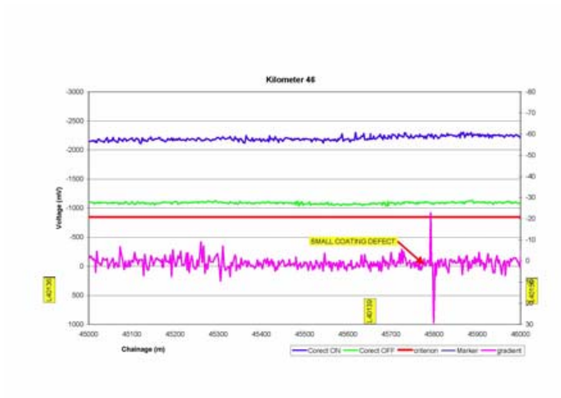
Graph # 1 Showing Results Of a Combined CIPS and DCVG Survey

There are two very evident coating defects shown on Graph 1. The defect at 3765 metres is significantly affecting the pipe-to-soil potential and corrosion may be occurring. The defect at 3960 metres is affecting the pipe-to-soil potential, but, the instant off potential is above –1000 mV, indicating the pipe is cathodically protected from corrosion.

By combining both CIPS and DCVG surveys the corrosion engineer receives valid data that is time correlated and free from spatial errors. With combined surveys the corrosion engineer can interpret the results of the effect of coating holidays on the ability of the cathodic protection system to prevent corrosion of the pipe. Coating defects that are not receiving sufficient current for adequate levels of cathodic protection ie: the polarized pipe-to-soil potential is less negative than –850 millivolts, can be easily located and excavated if necessary.

Photograph 5 Small Defect Detected by Combined CIPS and DCVG Survey

Even with low cathodic protection current flows that are experienced on three layer poly coatings, coating defects can be easily found using the two-surveyor technique. Photograph 5 shows a small defect detected by the two-surveyor technique. Two surveyors allow for a greater spacing between the half cells used to measure the DC voltage gradient, resulting in the total IR drop at a defect to be captured. Further, if the two surveyors walk over the pipeline, then a distinctive sinusoidal voltage pattern will be recorded as the surveyors approach and pass the coating defect. The Graph 2 shows the sinusoidal waveform associated with this defect. Note the pipe-to-soil potential is unaffected by this small holiday.



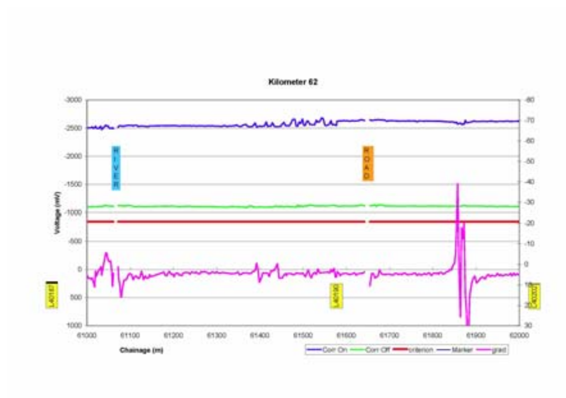
Graph 2 Showing a Sinusoidal Waveform at a Coating Defect

The sinusoidal waveform becomes distorted where the defect consists of several defects close together or is of odd shape and size. Photograph 6 shows several defects on a pipeline probably caused by a backhoe bucket.

The IR drop associated with this defect is approximately 40 millivolts and the potential shift on the pipeline is approximately 1000 millivolts. The %IR is approximately 4%, well below the threshold for day-lighting, however this is a defect that should be examined due to the potential damage to the pipeline wall. The distorted sinusoidal waveform is depicted in Graph 3.

Photograph 6 Multiple Defects

There was no evidence of corrosion at these defects shown in photograph 6 and Graph 3, the pipe-to-soil potential was in excess of -1100 millivolts with reference to copper copper sulphate, indicating adequate level of cathodic protection. The exposed steel is coated with a calcareous deposit indicating cathodic protection current flow to the defects.



Graph 3 Showing Pipe-to-soil Potential Correlated with DC Voltage Gradients at multiple Defects

Conclusion

The combined CIPS and DCVG survey meets the requirement of NACE International standards RP502-2002 for indirect survey methods and NACE International SP207-2007 for combined

CIPS and DCVG survey techniques. The data gathered in the combined survey improves the accuracy of over the line CIPS and DCVG surveys resulting in accurate data without spatial error. Since each reading is stamped with the GPS coordinates any defect or low potential area can be quickly and accurately located for further investigation or day-lighting. The combined survey gives the corrosion engineer accurate reliable time sensitive data on a pipeline allowing proper engineering decisions to be made.