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INFORMATION SHEET 24.

Inaccuracies & Limitations of Lateral or Trailing CIPS Techniques often called Combined Digital CIPS/DCVG.

THE TECHNIQUES

CIPS is not a coating fault locating technique but will indicate the present of large coating faults by dips in the observed potentials. On a severity scale of 0 to 100, CIPS generally will not indicate the location of those faults with a value less than 35. This lack of delineation of coating faults generally represents about 70 % of all coating faults on a buried pipeline that would not be identified. To try and improve the delineation of faults two variations of the CIPS technique have emerged. These are called Lateral and Trailing Combined Digital CIPS/DCVG and are in fact a scam practiced in UK and North America in attempts to combine two quite different technologies into a one pass survey technique. These scams have virtually no relationship to the **True Analogue DCVG** technique.

In all techniques synchronized Interrupters are used to pulse the DC rectifier(s) output. In the Lateral CIPS, the conventional CIPS electrode is sited directly above the pipeline and a second electrode system sited in a lateral position. In some cases the lateral electrode is sited at 2 metres in other cases it is in locations up to remote earth which is typically about 15 metres laterally from the pipeline but remote earth will vary depending on soil resistivity and how much CP current is flowing to coating faults on the pipeline.

In the trailing CIPS one half cell is behind the other separated by up to 10 metres In both techniques the potential difference between ON and OFF between the CIPS electrode and the second electrode system is recorded by a separate channel on the CIPS data logger. It is very important that the CIPS data logger has a synchronization system similar to that of the Interrupters so data can be recorded that avoids the Anodic and Cathodic spikes that occur as the CP system is switched ON/OFF.

ERRORS & LIMITATIONS

In the survey techniques ON and OFF CIPS and Lateral/Trailing potentials are recorded at regular intervals along the pipeline. The spacing of readings is determined by the Surveyor walking speed and the rectifier ON/OFF switching sequence. For example, a one to 1.5 metre spacing of readings at normal walking pace requires the ON/OFF switching sequence to be similar to that of **True Analogue DCVG**, 0.45/0.8 seconds. Any longer ON/OFF times for either technique has the surveyor waiting at each 1 to 1.5 metre spacing to make an observation or if the surveyor keeps walking the readings are not taken at the desired spacing instead they could be at anything up to 4 to 6 metres apart on for example a 3 / 2 second ON/OFF sequence. **Spacing is error 1**.

The CIPS and also the Training cable half-cells must be directly above the crown of the pipeline. None of the CIPS techniques actually locate coating fault epicenters at the time of the survey. Hence, above the crown is the best position in the absence of knowledge of where the coating fault epicenters lie. In practice the epicenters will not lie at the crown but at varying positions mostly either side of the pipeline resulting from the fact that most coating faults tend to be on the bottom or side of a pipeline. Hence to travel through the epicenters you need to know where the epicenters are (they are unknown during a survey) and this would take the surveyor on a zig zag path along the pipeline particularly on larger diameter pipelines. Ideally epicenter readings should be taken as these locations would reflect the least protected potentials. Deviations from taking readings at epicenters will lead to significant errors particularly on large diameter pipelines. **Epicentre location is error 2**.

As a survey progresses along a pipeline the trailing cable is moved from test post to test post. When this occurs particularly on poorly coated pipelines which have a lot of CP applied, steps occur in both the recorded ON and OFF potentials and can be 300 to 400 mV in size. These steps must be corrected for as the error they introduce will identify over or under protection depending whether the surveyor is walking towards or away from a rectifier. **Steps in the readings is Error 3.**

The distance between the Trailing or Lateral half cells and the CIPS half cell is important. This seems to vary depending on the equipment vendor. Lateral distances from 2 metres to remote earth are used. A distance of two

metres will allow only a portion of the lateral voltage gradient to be measured. For realistic readings that are meaningful the lateral half cell must be located at remote earth which can be 15 metres laterally. Any smaller distance introduces an error as only part of the gradient would then be measured. **Variable Lateral distance is Error 4**.

In the case of the Trailing half cell the separation distance is typically up to 10 metres. Unfortunately no "level playing field" like remote earth is available so providing the distance between the electrodes is kept constant which is very difficult to do when surveying, otherwise the variation in trailing gradients could be caused by variations in the separation distance rather than genuine variations in the gradient. **Variable trailing distance is Error 5.**

If there is poor synchronization between Interrupters and between Interrupters and CIPS data logger, the spike errors can influence the recorded potentials. **Poor Synchronisation is Error 6.**

Because all ON and OFF potentials are taken at locations at random with respect to actual epicentre locations the actual recorded values used to calculate severities etc will seldom represent the true lateral or trailing gradients. The decay of the lateral gradient from the epicenter is exponential. Failure to place one half cell on the epicenter by 20 or 30 cm can give a 40 to 50 mV (depends on current flowing to the fault) under estimation of the lateral gradient. Some written specifications quote that the deviation from top dead centre of the pipeline should not exceed 2 x the nominal burial depth. If the pipe is buried at a typical 1 to 1.5 metres deep the variation from top dead centre is 2 to 3 metres which would represent a big part of the total exponential gradient from the fault epicenter to remote earth. Hence any lateral gradients taken in such circumstances to calculate fault severity would grossly mis-represent the true value of the fault severity. Half cell and fault location is one of the most serious errors (**Error 7**).

It is very common in all CIPS/variations to have some measurements where there has been poor contact with the soil. This results in a poor mV reading that have to be discarded during the data analysis. The effect is that the two nearest readings would be 2 to 3 metres apart or more if the are several adjacent poor measurements. It is then very easy that coating faults would be missed **(Error 8).**

In the case of the Trailing CIPS if there is another coating fault within the 10 meter spacing of the electrodes then the gradients for the individual faults interfere. In the case of a small and a large fault the small fault can be hidden within the gradient of the large fault. Hence any trailing gradient would not represent the true status of individual faults so any severity calculation would be wrong. This is a serious limitation of Trailing CIPS and is **Error 9**.

The ability to delineate the location of coating faults depends on the sensitivity of the detecting technique and the level of Cathodic Protection as measured by the pipe to soil potentials or the pipe to remote earth DCVG signal amplitude. If the Cathodic Protection is poor then the difference between ON and OFF potentials from the pipe to remote earth becomes very small. Such small values observed for faults will be lost in the general chatter in data values that occur in any form of the CIPS type of survey tool. In the extreme when the CP is very poor, the ON and OFF CIPS potentials come together (no difference between them) and the Lateral or Trailing Gradients virtually vanish so it is not possible to delineate coating faults, **(Error 10**).

The net effect of all these errors results in the location and estimation of each fault Severity (or Size) being a poor representation of what is the state of the pipeline compared to Fault Severity values calculated from measurements obtained by using the **True Analogue DCVG** technique. In the **True Analogue DCVG** the fault epicenter is located to within a few cm during the actual survey and all electrical measurements are made from the fault epicenter not some random position that may be in the vicinity of a coating fault as in Lateral or Trailing CIPS.

After completing a Lateral/Trailing CIPS survey the data from the Lateral or Trailing CIPS data loggers are downloaded and graphical representations produced after efforts have been made where possible to correct for the various survey errors (many errors cannot be corrected as they are caused by the actual measuring method). It is only on downloading and looking at the data generally in graphical form that fault locations can be predicted. These then have to be converted into a distance from the nearest test post to define the location for any excavation. Data manipulation particularly when very unreliable distance measurement based on the amount of trailing wire dispensed can lead to significant errors in defining the actual fault location for excavation and excavations being in the wrong place or having to make the excavation larger than necessary to find the defined coating defect for repair. How do you then know you have the correct defect relating to the observed data?

In **True Analogue DCVG** where fault locations are taken by GPS using either DCVG equipment that has in built sub-metre DGPS (DCVG Ltd Maximus DCVG) or a separate sub-metre equipment (Trimble Pro XRS) or the data is taken into GPS/CIPS equipment when the two techniques (analogue DCVG and CIPS) are operated at the same time (DCVG Ltd Quantum CIPS) then relocation becomes easy. The predicted location is confirmed by setting up the Interrupter in the nearest rectifier and relocating the fault epicenter with **True Analogue DCVG**. The Analogue DCVG technique can then be used as a pair of eyes for the excavator to control the direction and extent of any excavation. The DCVG pulse vanishes when the fault is fully uncovered.

There is no comparison between the accuracy and information provided by the True Analogue DCVG and the Lateral/Trailing variations of the CIPS technique.