DCVG Coating Survey Data Sheet

DCVG COATING DEFECT SURVEYS

Today, DC voltage gradient surveys have evolved as an accurate and economic means of locating coating defects.

When a DC current is applied to a pipeline in a similar manner to cathodic protection, ground voltage gradients are created due to passage of current through resistive soil. Well coated pipelines have a high resistance to earth. However, at locations where there are coating defects the resistance to earth is of such way that current can flow through the soil to be picked-up by the pipe. In the vicinity of these defects measurable voltage gradients can be detected at ground level. The larger the defect, the greater the current flow. Increasing the current flow also results in an increased voltage gradient for a given soil resistivity.

The application of DC current to a pipeline at a regular pulsed frequency using special developed interrupters enables coating defects to be distinguished by stray traction and telluric currents. Existing cathodic protection systems may be utilized to inject the required signal, or temporary earths may be established at convenient connection points along the line.

The defects found during a DCVG survey can size and be mapped by GPS coordinates and will fully documented on special developed defect sheets.

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Principle of survey

This survey technique utilises a dc current (either the impressed current CP system or a temporary system) which is pulsed by means of a current interrupter.

Current flow through the soil causes voltage gradient at coating defects that are detected using two earth contact probes and measured using a voltmeter.

The voltmeter incorporated in the survey equipment is a sensitive, centre zero instrument allowing location of defect to be determined by relative location of the probes and polarity of the reading.

Defects can be 'pin point' by obtaining a null reading when the two probes are located such that no voltage difference exists between them i.e. they are on an equipotential line.

Comparing the volt drop in the soil with the applied potential shift can assess severity of defects.

Site equipment

High sensitivity centre zero voltmeter.

Current Interrupter (suitable for current to be interrupted and with a switching speed compatible with the survey meter).

Reference (Ski) probes compatible with the survey meter.

Temporary dc current source and groundbed equipment (required if pipeline not protected by impressed current or system cannot be interrupted).

Survey procedure

Prior to commencement of any survey section a current interrupter is installed in the nearest existing cathodic protection station or temporary current source which may be established as necessary.

Typically, a minimum potential swing of 500-600 mV is sought and the current source output is adjusted accordingly. The application of a pulsed current enables coating defects to be distinguished from stray traction and telluric currents.

The difference between 'on' and 'off' potentials is recorded at the test point nearest the survey start point, and all other test points encountered, and the survey commenced.

The operator traverses the pipeline route using the probes as walking sticks. One probe is in contact with the ground at all times and for a short duration between strides both probes must be in ground contact. One probe can be on the centreline of the pipeline and the other maintained at a lateral separation of 1-2 m or probes can leap-frog along the centre line. If no defects are present the needle on the voltmeter registers no movement.

As a defect is approached a noticeable fluctuation is observed on the voltmeter at a rate similar to the interruption cycle. The amplitude of the fluctuation increases as the defect is approached and adjustment of voltmeter sensitivity is made as necessary. The swing on the voltmeter is directional, providing the probes are maintained in similar orientation parallel to the pipeline.

Thus, the defect is centred by detailed manoeuvre around the epicentre and the size of the defect estimated by considering signal strength at the defect, difference between 'on' and 'off' potential at adjacent test point and the distance from those points.

Data obtained

The DCVG survey provides an evaluation of each defect located. The defect can be sized by relating the signal voltage (or potential swing) to remote earth (mV1) to the signal voltage (potential swing) recorded at the nearest two test post (mV2,, mV3). The distances of defect to these two test posts (m1, m2) are also brought in account. In addition, it is also possible to determine whether active corrosion is taking place at the defect.

Processing and presentation of data

Coating defects are recorded defect sheets with reference to a fixed point marked on route alignment sheets and/or a stake placed in the ground.

Comments on signal strength should be recorded and the defect graded, where

$$\%IR = \frac{mV1}{mV2 - (m1/(m1+m2)*(mV2-mV3))}$$

Values greater than 35% IR require immediate attention, values between 16 and 35% IR require attention under general maintenance and less than 15% IR need not be repaired.

Manpower and Vehicles

One man who needs to be experienced in the survey technique to evaluate results in the field can undertake the DCVG survey. An assistant may be required in difficult terrain but only one vehicle would be necessary.

Advantages of the DCVG survey

• Survey technique can provide an assessment of coating condition over areas of difficult access i.e. road, rail and water crossing etc.

• Estimates defect sizes in order to prioritise excavation and repair
• Minor defect: from 0% IR => 15% IR
• Medium defect: from 16% IR => 35% IR
• Large defect: from 36% IR => 100% IR

• Has already proven in use and accuracy

- One person can conduct survey, although 2 persons are recommended (progress, & safety).
- Provide data for cathodic protection adjustment/upgrading.
- Survey can be conducted in areas affected by stray currents and telluric effects in most soil conditions.
- Involves no trailing wires
- High accuracy in locating and pin-pointing defects
- Can be used in combination with other techniques
- CIP
- GPS Mapping
- Right-of-way-inspection
- Suitable to complex piping arrangements
- The technique is rapid and low in cost
- Has been proven successful in detecting disbanded coating

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UNDERTAKING THE DCVG SURVEY

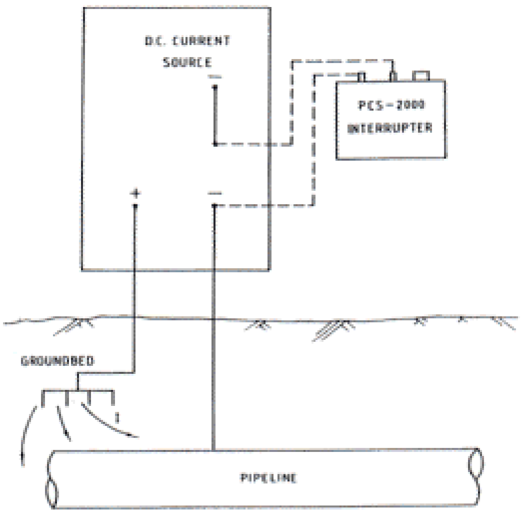
A DC voltage gradient survey involves the interruption of one rectifier to apply an identifiable signal to the pipeline. This is normally at a 1Hz frequency. Alternatively, output current from galvanic anodes or a temporary impressed current system may be interrupted. Signal strengths (difference between 'on' and 'off' potentials) are measured at all test points.

Current is greatest at the pipe coating defects. Voltage gradients are set up in the region of the defects due to current flowing through resistive soil. These gradients are detected by an operator traversing the pipeline with a pair of probes and a highly sensitive voltmeter.

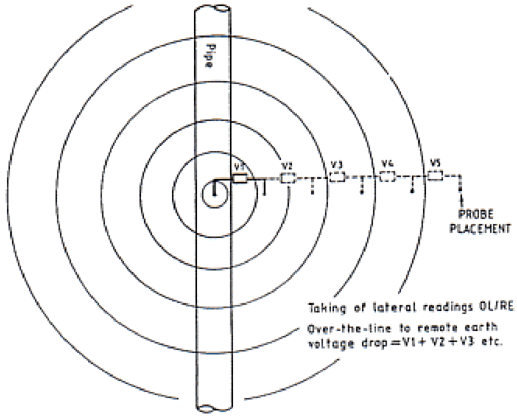
A pulsing signal is indicated by the voltmeter at a 1Hz frequency normally when the operator is within 3 to 10 metres of the defect. The strongest signal is noted when one probe is immediately above the defect. Instrumentation polarity indicates the defect direction and when the operator has walked past the epicentre.

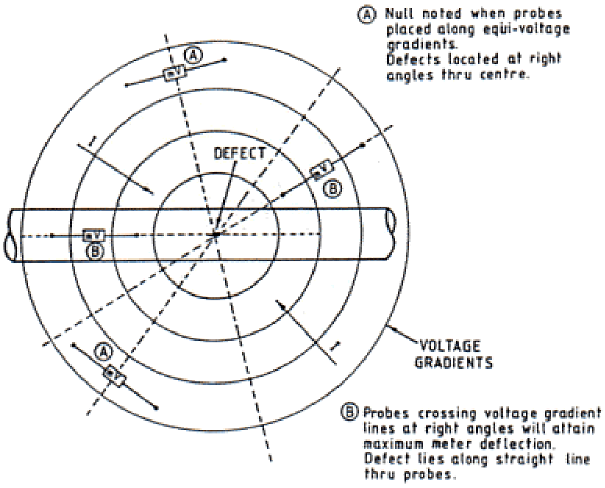
Once the gradient epicentre proximity has been determined, nulling along equi-potential gradients will rapidly locate the defect centre, which can then be pegged. An 'IR' drop to remote earth is measured by summing a series of lateral volt drops.
This overline to remote earth volt drop is used to obtain a benchmark factor (percentage IR) where:

$$\%IR = \frac{\text{Overline to Remote Earth Volt Drop x 100\%}}{\text{Signal Strength}}$$

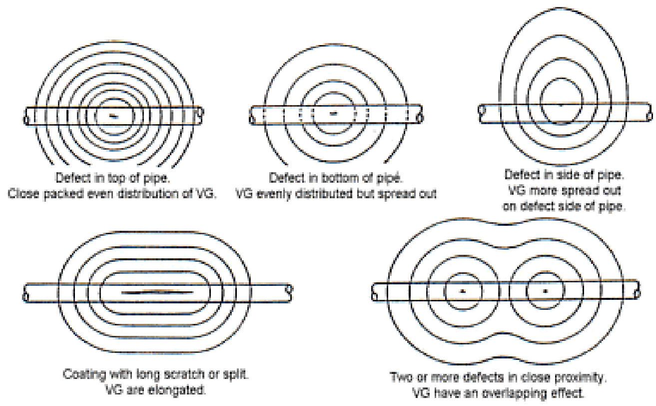


Interrupter set-up to inject signal





Locating defect centre.



Tracing of VG reveals useful information about the defect.

Voltage Gradients (VG) Resulting from
Different Types of Defects

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In summary, the survey results may be used to determine the following:

1. Locate Coating Defects

The DCVG method is the most accurate and sensitive survey method developed to locate coating defects. It has also been refined to test pipelines in built up areas using a technique refined with over 20 years experience. The survey method is extremely rapid. On an average, two operators can survey 16kms (10 miles) of pipeline per day.

2. Defect Size

Experience has shown that where a pipe is buried at a 1-1.5 metre depth, a 5% IR represents approximately 12cm^2 defect. Pipe depth varies the signal strength measured at the surface. Coupons connected to the pipe with known bare areas enables the defects to be calibrated. Permanent Potential Electrodes (PPE) or Electrical Resistance Probes (ERP) are suitable.

3. Continued Coating Deterioration

Percentages IR are permanent defect benchmark figures which will be noted on subsequent surveys to increase if the coating deteriorates further.

4. Reduction in Protection

The overline to remote earth potential drops can be used directly to determine drops at defects.

5. Priority for Refurbishment

Defects with the largest percentages IR are given first priority for recoating. The cathodic protection system should be able to protect the smaller defects. Small defects should be investigated where the pipe is experiencing coating disbondment. Plotting of the defects enables easy assessment of the coating condition and acts as a good management reporting format.

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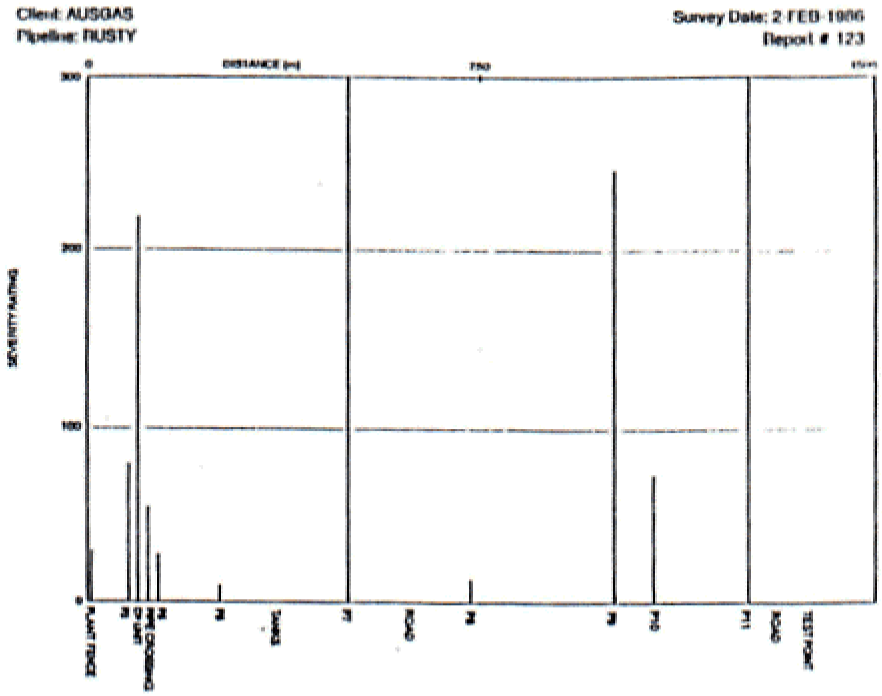

6. Cathodic Protection System Adjustment or Upgrade

The survey, together with test point potentials, identifies sections with under-protection or over-protection. The latter is frequently found at impressed current system drain points where current outputs have been regularly increased due to reducing protection levels. This is a self defeating practice as it can lead to further coating damage. It may be necessary to provide supplementary protection between rectifier stations in order to even out the spread of protection.

DCVG surveys are unaffected by:

- Induction from overhead powerlines;
- Stray DC traction and telluric currents;
- Close vicinity of other buried structures.

Shorts to other structures and casings can be located by tracking and tracing voltage gradients. A split along the coating or a number of closely spaced defects can be identified from the voltage gradients.

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