CATH-TECH
Corrosion Control Equipment

Direct Current Voltage Gradient

DCVG

Survey Instrument

Model CTL3000

CATH-TECH Manufacturing Division of
Cathodic Technology Limited
15-1 Marconi Court, Bolton, Ontario
Canada, L7E 1E2
Phone (905) 857-1050 Fax (905) 857-3499 Email ctl@corrosion-rust.com

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Warranty

This precision instrument is warranted against defects in materials or workmanship for a period of 12 months from date of sale. This warranty does not cover wear and tear, abuse or misuse of the equipment. The CTL3000 is water resistant but not water proof and should not be subject to immersion in liquids or use in rain. For warranty claims, obtain a Return Goods Authorization Form (RGA Form) from Cathodic Technology Ltd. Carefully package the instrument to prevent shipping damage and ship the instrument prepaid with the RGA Form to: Cathodic Technology Ltd. 10 McEwan drive Bolton Ontario Canada L7E 1H1. On receipt of the instrument we will examine the instrument and determine if it is a valid warranty claim. If we find that the instrument has failed due to defective materials or workmanship, we will repair or replace at our option.

If the instrument has failed due to wear and tear, abuse or misuse, we will quote the repair cost. No repairs will be undertaken until the cost of repair, packaging and shipping are paid in full.

Testing

This instrument has been thoroughly tested and has undergone a burn in test. The instrument has been tested under actual field conditions and meets the quality control standards of Cathodic Technology Ltd.

Calibration

The instrument comes with a certificate of calibration traceable to the US National institute of Standards (NIST) or National Research Council of Canada (NRC). This certificate of calibration is valid for one year from date of purchase and should be renewed on an annual basis.

Unpacking and Inspection

On receipt of this precision instrument unpack carefully and examine for damage in transit. If damage is detected, file a claim with the carrier immediately. If damage is not detected verify that you received all of the pieces.

Battery Charger Carrying Strap CTL3000 Instrument

Half Cells (2)

Cables Under Instrument

Half Cell Extension Sticks (2)

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The CTL3000

Charging the Battery

The battery is the latest generation of rechargeable nickel metal hydride (NMH). NMH does not develop a memory, if looked after will provide many years of service. Do not allow the battery to freeze, likewise do not store in a hot location.

Initially charge the battery for 16 hours; thereafter charge overnight before each day's survey.

The nominal battery voltage is 12.0 volts and when charging may exhibit voltages as high as 14.2 volts. The battery is exhausted when the voltage drops to 11.0 volts.

The battery capacity is 2.0 amp hours and should run the instrument for several days.

Half Cell Care

The Copper Copper Sulphate Half Cells supplied are precision measurement electrodes. They should be kept clean and serviced regularly by emptying the old copper sulphate solution and refilling with fresh copper Sulphate crystals and distilled water. Keep the plastic cap on when not in use to prevent the tip from drying.

Instrument Assembly

Screw the Copper Copper Sulphate half-cells into the half-cell extension poles, connect the neck strap and waist strap to the CTL3000 and connect the cables between the half-cell sticks and the CTL3000.

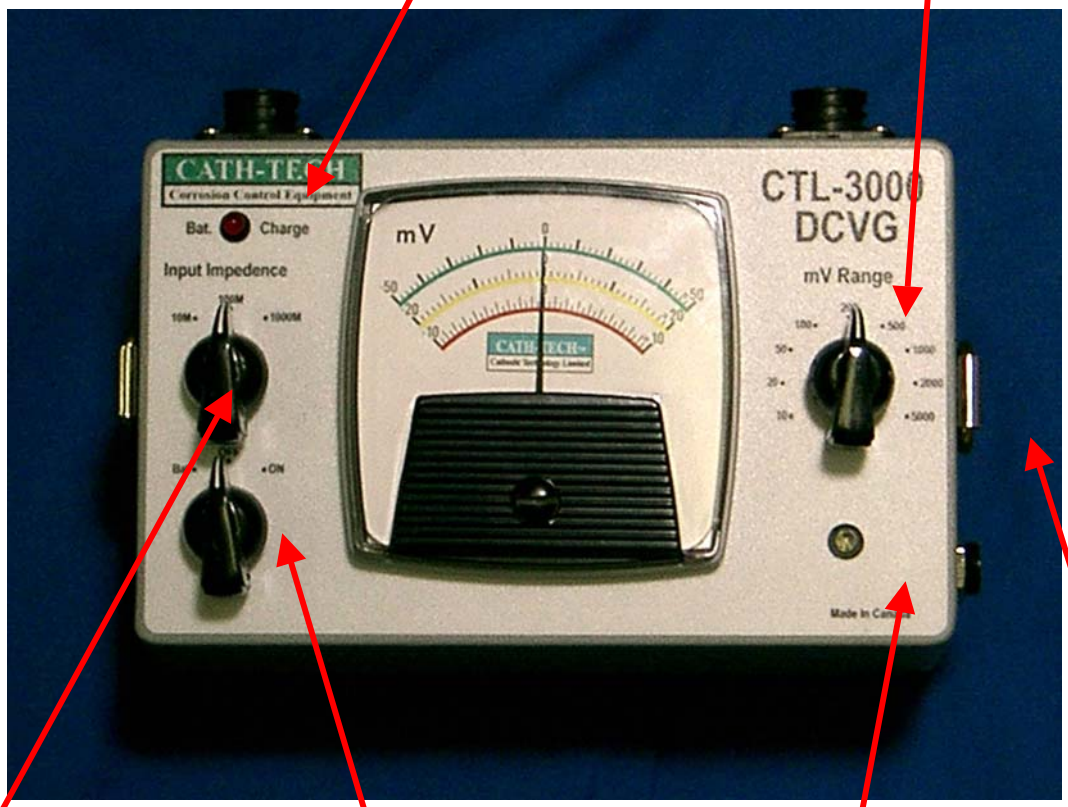
Half Cell Sticks

The length of the half-cell sticks is adjustable follow the instructions on the half-cell sticks for adjusting the length.

The CTL3000 Instrument

Battery Charge Indicator Light

mV Range Switch



Input Impedance Switch

ON/OFF Battery Test Switch

Auto Zero Indicator

Carry Strap D Ring

1/ Turn ON the instrument using the ON/OFF Battery test Switch

2/ Select the input impedance 10M Ohm for wet ground, 1000M Ohm for very dry or desert conditions

3/ Select the mV range, start with a high value and adjust down observing for voltage gradient pulse

4/ During the survey the meter may creep up due to soil chemistry, press the zero switch on the half cell stick to zero the meter, the auto zero indicator light will illuminate

5/ On red scale battery is fully charged at 10 and discharged at 9

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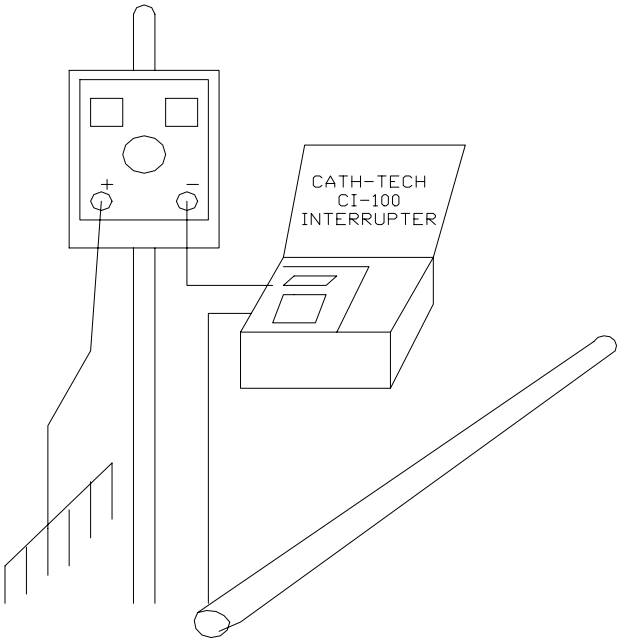
Getting Started

To sense DC voltage gradients, pulsed DC current is required, this can be provided by installing a current interrupter in the output of the cathodic protection rectifier. If the pipeline is protected by a sacrificial anode system then it will be necessary to install a temporary rectifier and ground bed to provide the necessary pulsated DC current.

Interrupting the Rectifier

Installing Current Interrupters

Warning: Hazardous voltages can exist inside a rectifier case. Only trained personnel should install current interrupters in cathodic protection rectifiers. Turn OFF and lock out the AC supply while the interrupter is being installed.



Installation in Ground Bed Lead
Connect Red to Rectifier +
Connect Black to Ground bed

Installation in Pipe Lead
Connect Black to Recvtifier _
Connect red to Pipe lead

Connecting the Current Interrupter to the Rectifier to interrupt the negative pipe lead

DC Interruption

Where possible it is preferable to interrupt the DC output of the rectifier. Observe polarity when installing the interrupter. The red cable shall be connected to the positive terminal of the rectifier and the black cable to the ground bed lead. Where the negative pipe lead is to be interrupted connect the black lead to the negative terminal of the rectifier and the red lead to the pipe lead.

AC Interruption

Connect the interrupter in one leg of the AC supply to the rectifier, ensure that you use the AC interruption terminals

Millivolt Shift

It may be necessary to increase the output of the rectifier to achieve sufficient IR drop for voltage gradient detection. Ensure that the output of the rectifier does not exceed the capability of the current interrupter being used.

To perform a DCVG survey 500 – 600 millivolts of potential shift is required between the rectifier ON and OFF potentials. It is often necessary to increase the output of the cathodic protection rectifier to provide sufficient IR drop for DCVG measurement. To minimize polarization of the pipeline when the IR drop is increased by increasing the output of the rectifier, change the interrupter cycle to give a short ON and long ON cycle such as 300 milliseconds ON and 700 Milliseconds OFF.

CATH-TECH CI-100 GPS 100 Amp GPS Synchronized Current Interrupter

Temporary Rectifiers

It may be necessary to install temporary rectifier at the mid point between rectifiers to achieve sufficient IR drop for the measurement of the DC voltage gradient.

Where multiple rectifiers must be interrupted to perform the DCVG survey the interrupters must be synchronized to allow detection of voltage gradients in the soil.

Dry Soil Conditions

It may be necessary to wet the ground to achieve meaningful results. Where concrete is encountered, it must be wetted to allow for the measurement of the voltage gradient. DCVG surveys cannot be performed through asphalt unless holes are drilled for earth contact. A drip irrigation system may be necessary when surveying under dry conditions. A pressurized backpack water tank provides an excellent source of water.

DCVG Survey Procedure

To undertake a DCVG survey typically, a minimum potential swing of 300-500 mV is sought and the current source output of the rectifiers is adjusted accordingly. The application of a pulsed current enables coating defects to be distinguished from potential differences between the half-cells.

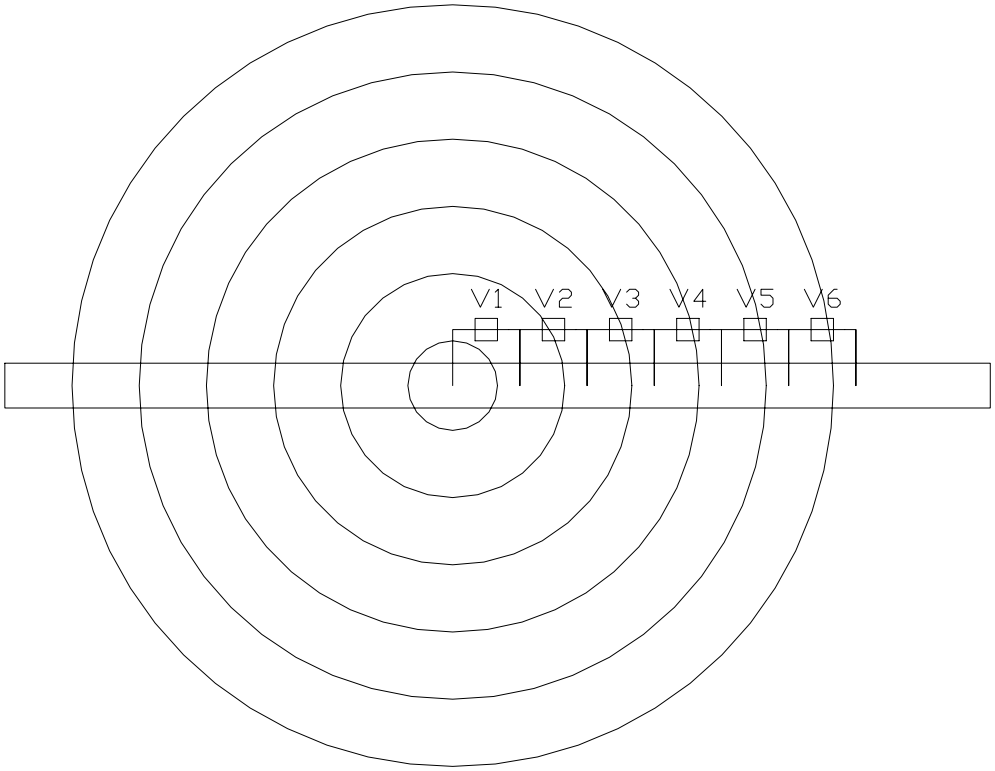
The difference between 'on' and 'off' potentials is recorded at the test point nearest the survey start point, and all other test points encountered, and the survey commenced. The operator traverses the pipeline route using the probes as walking sticks. Both probes must be in contact with the ground to measure the voltage gradient. 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 leapfrog along the centre line.

Measuring The Pipe-to-soil Potential at a test station or appurtenance on the pipeline

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



Over the Line to Remote Earth Voltage Drop

Voltage Drop + V1 + V2 + V3 + V4 + V5 + V6

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.

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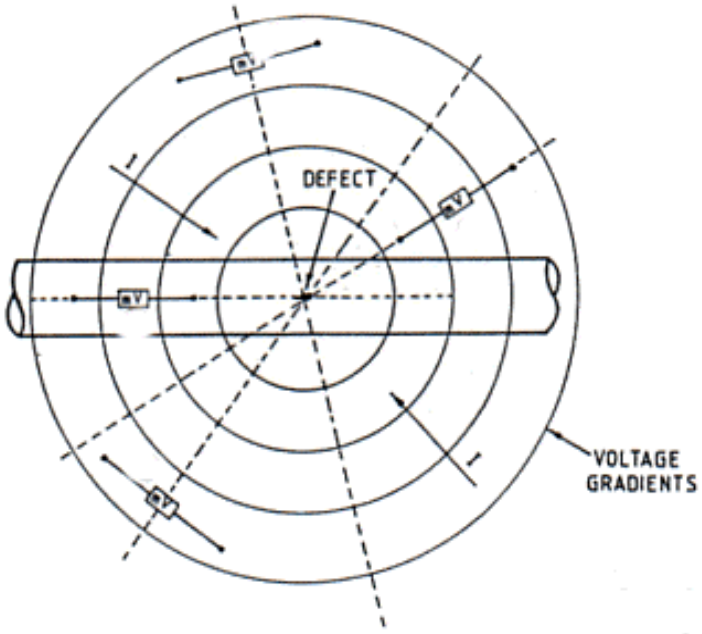

Probes crossing voltage gradient lines at right angles offer the maximum meter deflection

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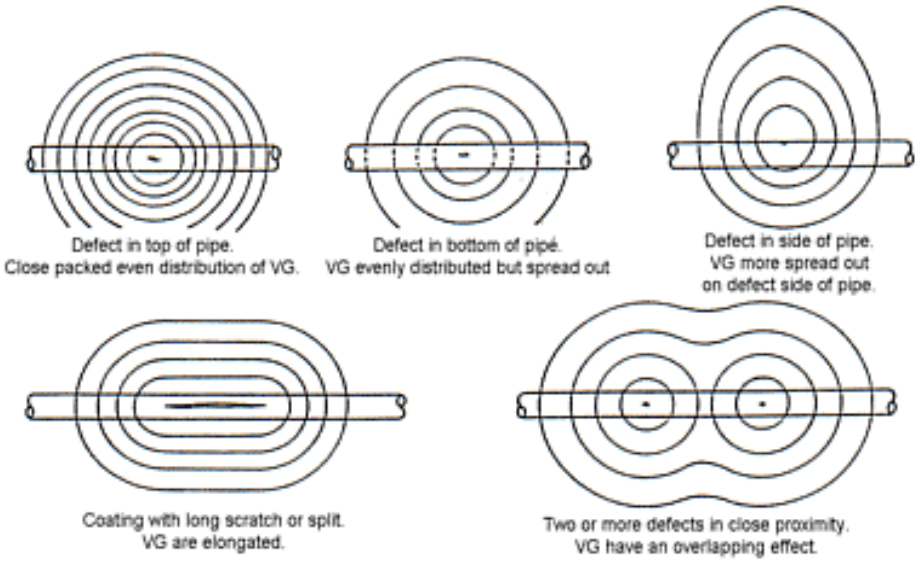

Voltage gradient lines resulting from different types of defects.

DCVG Calculations

Coating defects are recorded on defect sheets with reference to a fixed point marked on (route) alignment sheets and/or a stake placed in the ground. The following formula assumes uniform soil resistivity and cathodic protection current attenuation.

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

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

mV1 = Voltage swing at pipe
mV2 = Voltage swing at last test station
mV3 = Voltage swing at next test station
m1 = Distance to last test station
m2 = Distance to next test station

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Cathodic Protection and Coating Defects

All coating defects that exhibit potentials below the criterion for protection require attention. Adjustments or upgrading of the cathodic protection system are indicated at all locations where the pipe-to-soil potential is sub criterion. Repairing holidays or defects in the coating can result in accelerated corrosion if adequate levels of cathodic protection are not maintained. Significant improvements or upgrading of a cathodic protection system can be performed for the cost of one excavation to repair a coating defect or holiday. The application and maintenance of an adequate cathodic protection system is a proactive method of corrosion control unlike internal inspections, which are reactive corrosion control, whereby excavation and repair or replacement is made to corrosion damaged pipe.

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Care and Maintenance

Half cells

- Clean and refresh copper sulphate solution often to prevent contamination of the half-cells
- When not in use cover ceramic tip with plastic cover to prevent drying
- Replace ceramic tip when worn

CTL3000 Meter

- Keep battery charged
- Keep clean and store in carrying case
- Check cables for damage frequently, replace as necessary
- Protect the instrument from rain

Current Interrupter

- Keep battery charged
- Keep clean and store in carrying case
- Check cables for damage frequently, replace as necessary
- Check antenna cable for damage replace as necessary
- Protect the instrument from rain

Fault Finding

Problem	Possible Reason	Solution
Low Signal Strength	Insufficient current output	Increase current output Install temporary rectifier Change ground bed location
	Testing on pipeline appurtenance Which is painted	Test at a different location
	Large defect at test location	Test at different location
	Short to foreign structure	Clear short
Low Battery Indication	Batteries require charge	Charge Batteries
Major Loss of Signal	Existence of large defect	Increase current output
	Short to foreign structure	Locate and clear
	High Resistance Ground	Increase input impedance
		Use water drip or spray
Unable to centre defect	Long defect such as scratch	Trace voltage gradients
	Several defects closely Spaced	Trace voltage gradients
Unable to obtain reading	Dead battery	Charge battery
	Dry half cells	Refresh with copper sulphate distilled water
	Damaged or broken cable	Replace cables
	Interrupter stopped	Check interrupter
Erratic Operation	Wet cables and connector’s	Dry cables and connectors

Notes:

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Cathodic Technology is your ECDA Headquarters, with CIPS and DCVG survey equipment, Smart Loggers, Data Loggers, GPS synchronized Interrupters, RMU's etc.

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