DC VOLTAGE GRADIENT TECHNOLOGY & SUPPLY LTD

GLOBAL LEADERS IN DCVG / CIPS EQUIPMENT, ECDA & SURVEY SOFTWARE

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Principle Of The DCVG Technique

In Cathodic Protection when current flows through the resistive soil to the bare steel exposed at faults in the protective coating, a voltage gradient is generated in the soil. The larger the fault the greater the current flow and hence voltage gradient and this is utilised in the technique to prioritise faults for repair. The voltage gradient is observed by measuring the out of balance between two copper sulphate electrodes utilising a specially designed millivoltmeter. When the two electrodes are placed 1.5 meters apart on the soil in the voltage gradient from a coating fault, one electrode adopts a more positive potential than the other which allows the direction of current flow to be established and fault to be located. To simplify the fault location interpretation, the applied CP is separated from all other DC influences such as Tellurics, DC Traction, etc, by pulsing the local CP ON and OFF in an unsymmetrical fashion. The pulsing DC can be from the pipeline CP system itself, or from an independent source such as a portable DC generator or batteries utilising a temporary groundbed and impressed on top of a pipelines existing CP system.

In surveying a pipeline, the operator walks the pipeline route testing for a pulsing voltage gradient at regular intervals. As a fault is approached, the surveyor will observe the milli-voltmeter needle begin to respond to the pulse, pointing in the direction of current flow that is towards the fault.

When the fault is passed the needle direction completely reverses and slowly decreases as the surveyor moves away from the fault. By retracing to the fault a position of the electrodes can be found where the needle shows no deflection in either direction (a null). The fault is then sited midway between the two electrodes. This procedure is then repeated at right angles to the first set of observations, and where the two midway positions cross is the epicentre of the voltage gradient. This is usually directly above the coating fault.

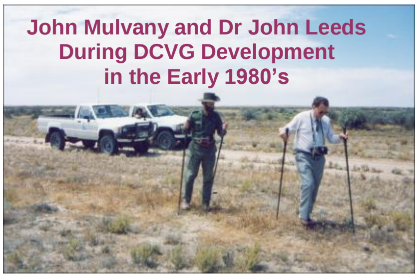
In order to determine various characteristics about a fault, such as severity, shape, corrosion behaviour etc, various electrical measurements around the epicentre and from epicentre to remote earth are made for interpretation. Finding coating faults is not difficult but the correct interpretation of survey data to identify what coating faults to cost effectively repair requires experience and the type of expertise that is available from DCVG Ltd.

BEWARE OF SO CALLED DIGITAL DCVG. IT IS NOT DCVG TECHNOLOGY AT ALL. IT IS INFACT LATERAL CIPS THAT IS A VERY CRUDE INACCURATE WAY OF ASSESSING COATING DAMAGE. THOSE OFFERING DIGITAL DCVG AS A TECHNIQUE OBVIOUSLY DO NOT UNDERSTAND THE TECHNOLOGY.

SEE www.dcvg.com click on DCVG on Home page then Sham DCVG for fuller explanation.

Second To None. Predominant (25YEARS) Expertise In DCVG Technology – “We Lead Others Copy”

DCVG was first discovered by **John Mulvany** an Australian ex Telecom Corrosion Engineer, who worked extensively with Dr. Leeds of DCVG Ltd. in developing the technique and its application in the early 1980’s. The technique was originally named DCVG by Dr Leeds when writing a technical paper about the technique with co Author Hans Borek the PASA Corrosion Engineer in 1982. This original work gives **DCVG Ltd. 25 years experience in DCVG Technology unparalleled by any competitor**. This expertise backed by the excavation and inspection of several thousand DCVG fault indications, plus the interpretation of DCVG electrical data to what is found during excavation is passed onto users of our DCVG Equipment through detailed Training Courses and ongoing e mail / telephone support.


John Mulvany and Dr John Leeds During DCVG Development in the Early 1980’s

D.C.Voltage Gradient Equipment. Full or Basic Sets


ANALOGUE DCVG

Equipment can be purchased as a FULL set or as a BASIC Set. All of our D.C.Voltage Gradient Equipment Sets are manufactured in UK to military specifications. A FULL set comes complete with everything (including spares) except a DC power source needed to survey a buried pipeline. The equipment which is a direct descendant from the original work carried out in Australia is packed into protective carry cases and has two main components, the Interrupter and the Survey Meter. During manufacture maximum emphasis has been placed on quality and robustness of construction, with the equipment kept as simple and as flexible as possible. Although the equipment comes with an instruction booklet, a very comprehensive **Training Course** is available to ensure Operators know how to gather data and to use and interpret results in order to gain maximum benefit from the technology transfer process. The BASIC set consists of the minimum components required to do DCVG surveys. There are no carry cases or spares in a BASIC set. All of our new equipment comes with a 6 month parts Guarantee.


INTERRUPTER

Equipment Spares

A full range of spares for D.C.Voltage Gradient Equipment is available ex stock together with many extras to extend equipment application to complicated or cold weather applications. A number of the DCVG spares are fully compatible with our Quantum CIPS data logging equipment. A full spares catalogue is available on request.


QUANTUM CIPS

Not Just Coating Fault Location But A Whole New Philosophy in Coatings, CP and Corrosion Control

The D.C.Voltage Gradient Equipment provides detailed information not readily available from other survey techniques, such as:

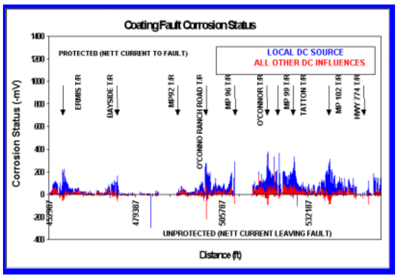
1.	*Fault location to within centimetres.*	8.	*Pipeline condition analysis.*
2.	*Determine the severity of faults.*	9.	*Fault severity analysis.*
3.	*Determine the corrosion characteristics of faults.*	10.	*Fault distribution.*
4.	*Identify from which DC source faults get their total CP.*	11.	*Fault Current Consumption.*
5.	*Identify DC Interference from trains, trams, other CP systems.*	12.	*Fault Corrosion Rate.*
6.	*Identify interfering structures.*	13.	*Fault Corrosion Index.*
7.	*Test electrical properties of insulating .*	14.	*CP Retrofitting.*
	flanges, cased crossings, sacrificial anodes, etc.	15.	*Coating Repair Needs.*

The beauty of the DCVG technique is that it utilises the existing pipeline CP system wherever possible and hence results reflect the intimate interaction between the protective coating degradation and the effectiveness of CP at individual coating faults. This is very powerful information in the fight against corrosion. No AC or Electromagnetic Technique offers such a direct study capability.

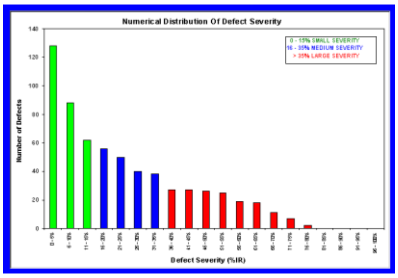
The DCVG Technique can be applied in City Streets, Process Plant and Refineries, across Rivers and Estuaries, Swamps, Parallel Pipeline systems, to Gas, Oil, Chemical and Water Pipelines. Also DCVG can be used to evaluate the protective coating on Power and Telephone Cables.

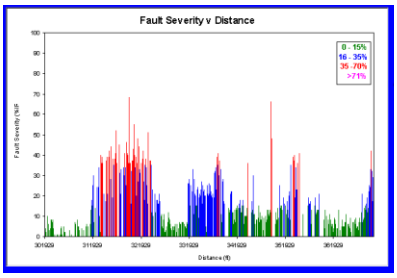
The detailed information provided by DCVG Technology when analysed with other information such as Pipe to Soil Potential, Soil Resistivity and Composition, pH, Temperature, Operational History, Inline Inspection Tool Data, etc through DCVG Ltd's ECDA or PRIMAS programs which enable pipeline rehabilitation requirements for the Steel, Coating and CP to be prioritised for the most cost effective repair to be determined.

Data Analysis

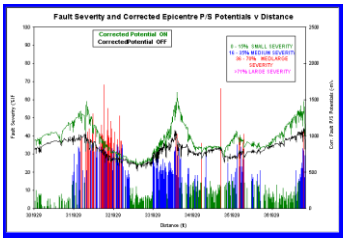


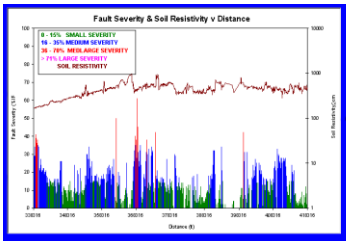
Not every Coating Fault or Metal Loss Location requires repair. In practice, for most pipelines 99+% of all coating faults have no metal loss but there is the potential for metal loss if there is a coating fault with weak CP in soil of low resistivity. Whilst the repair of critical metal loss is important, most pipelines are rehabilitated on the basis of the need to improve the protective coating in order to make the CP more effective. Remember Inline Inspection Tools detect the symptom of the problem, DCVG when combined with potential measurements detects the real cause of the problem that leads to metal loss. This real cause of the problem is a breakdown in corrosion control through coating failure and an inadequate CP system.





There is never enough money to repair all coating faults. Detailed analysis of data is required to identify large current consuming coating faults particularly those in low soil resistivity areas so these faults can be repaired releasing CP that then becomes available to improve protection of those faults not identified for repair.





The DCVG Ltd ECDA Software Program analyses data sets from many different types of surveys etc (including Inline Inspection Data) to identify Critical Coating Faults for repair. The ECDA Software handles all four stages of the ECDA Process, from Pre Assessment, Indirect Assessment, Direct Examination to Post Assessment. The ECDA program is built by Pipeline Integrity / Corrosion Engineers and is very user friendly and has been well tried and field tested by our Corrosion Engineers on more than 11,000Km of pipeline, all types of coating system involving more than 100,000 Coating Faults. Our ECDA program will also estimate the cost of the repair of the Steel, Coating and CP so faults can be prioritised, budgets can be prepared, matching the costs involved to the Companies ability to finance the Rehabilitation work.

Typical Applications of DCVG Technology

Coating/Cathodic Protection refurbishment prioritising.
Pipeline Operating license validation.
Pipeline installation coating warranty verification.
Cathodic Protection problem solving.
Interference testing and electrical continuity checks.
Submerged pipeline under estuaries and river crossings.
Difficult terrain surveying.
Survey areas which are impossible by other techniques, i.e. city streets, process plant, tank farms.
Multiple pipelines can be surveyed whilst still connected together.

Pipeline Survey Method Specifications (Available in Draft or Customised Format)

" Specification for the Method of Inspection of the Coating Quality on Buried Pipelines using the DC Voltage Gradient Technique."
" Specification for the Method of Inspection of the Coating Quality on Buried Pipelines using the Close Interval Potential Survey (CIPS)."
" Specification for the Method of Inspection of the Coating Quality on Buried Pipelines using the DC Voltage Gradient technique combined with a Close Interval Potential Survey."
" Specification for the Method of Inspection of Soil Resistivity surrounding Buried Pipelines using Electromagnetic Techniques."
" Specification for the Method of Inspection of the Coating Quality on Buried Pipelines using the DC Voltage Gradient technique combined with a Close Interval Potential Survey and co-ordinated with In-Line Metal Loss Inspection Tools."
" Technical Specification for Rehabilitation of the Coating to Operating Pipelines."
" Technical Specification for Quality Control During Rehabilitation of the Coating of Operating Pipelines."

D.C.Voltage Gradient Training Courses. Level 1 and 2

The detailed Training Courses prepare Surveyors for ECDA Inspection work by teaching how to survey properly including running DCVG, CIPS and Pipe Location simultaneously, how to match multiple data sets including ILI information, interpret data and be aware of technique strengths, weaknesses and any possible errors in Surveying and Data Analysis. (**All techniques have limitations and errors which in many survey techniques are ignored**). To carryout an effective ECDA Process, the gathering of Quality data is essential. The Level 1 course is five days long and by preference is held at the customer's premises with the practical work carried out on actual customers pipelines. The emphasis is to achieve maximum technology transfer hence the course is split into classroom and field activities. After initial 2 days training, operators use equipment to find faults, take electrical measurements, and analyse data for interpretation into actual refurbishment requirements. Level 2 is a 3day course and goes into Survey Organisation, Complex Surveys and Data Analysis in greater detail besides reviewing any student's survey work that they have done.

Accompanying the Training Courses are very detailed instruction manuals, which cover every aspect of DCVG Technology. These manuals are only available to attendees of the Training Courses. In addition DCVG Technology and Supply Ltd have available to customers the largest collection of published technical papers on the principles and applications of DCVG Technology. This coupled with ongoing research into the technology and other Coating/CP survey methods emphasises our leadership of the market place in the Inspection of Coatings and Cathodic Protection on buried pipelines. Remember, the corrosion of steel exposed at coating faults is recognised as one of the major causes of pipeline failure.

LEVEL 1	LEVEL 2
Session 1. Course Introduction and Organisation. **Fundamental Electrochemistry.** 1. The requirements for Corrosion. 2. The Pourbaix Diagram. 3. Cathodic Electrochemical processes. 4. Cathodic Protection and Cathode Films. 5. Organic and Inorganic Coatings. **Session 2. Practical Electrochemistry** 6. Pipe to Soil Potential- measurement and limitations 7. The relationship between Coatings and CP. 8. The limitations of CP. 9. Typical CP current demands for different coating quality. 10. Pipeline Failure through Metal Loss, Stress Corrosion Cracking etc. **Session 3. Coating Failure Mechanisms** 11. General Discussion. 12. Tape Coatings. 13. Asphalt and Coal Tar. 14. Thin Film coatings (FBE). 15. Other Coating systems. **Session 4. The DC Voltage Gradient Technique** 16. Fundamentals of the DCVG technique. 17. Detailed explanation of DC Voltage Gradient equipment 18. The DCVG Pulse (Meter Indications). Practical Class demo. 19. DCVG Signal electrical circuit 20. DCVG Coating Fault detection method **Session 5. DCVG Electrical Measurements.** 21. Understanding the DCVG Signal Amplitude. 22. Taking Electrical Measurements to determine the Severity of Coating Defects 23. Defining the Coating Fault shape using iso-potential plots. 24. Determining the Corrosion Behaviour of Faults. 25. Determining where Faults get their CP from 26. DC Traction and other Interference effects. 27. Typical DCVG results **Session 6. Special uses for DCVG Technology.** 28. Surveying parallel pipelines 29. Complex pipeline networks 30. Using DCVG to investigate CP systems 31. Test Posts, Insulating Flanges, Cased Crossings 32. The use of DCVG to control Cathodic Protection **Session 7. Other Survey Techniques** 33. Pipe to Soil Potential measurement. 34. Close Interval Potential Survey technique. 35. Limitations of the CIPS technique. 36. Limitations of the DCVG technique. **Session 8. Organising a Field Survey.** 37. What information do I need from Records? 38. Setting Up the Interrupter. 39. What Initial DCVG Signal Amplitudes to measure? 40. Starting the survey and how to locate 41. What data to record? How should data be recorded? 42. Distance measurement techniques to use and their limitations. 43. Preparing the data for analysis. **Session 9. Field Work. Locating Coating Faults** 44. Setting up conditions for a DCVG Survey. 45. Measurement of the DCVG Signal Amplitude. 46. Location of Coating Faults. **Session 10. Electrical Measurements at Coating Faults.** 47. Anodic/Cathodic Corrosion Behaviour. 48. Electrical measurements and Fault Severity. **Session 11. DCVG Data Analysis.** 49. Calculation of Fault Severity. 50. Assessment of results obtained. 51. Effect of Depth of Burial and Soil Resistivity on Fault Severity. 52. What Faults to repair. 53. Computerised Data Analysis techniques using the DCVG Ltd ECDA program. 54. General Discussion. 55. Revision and Question Time. **Session 12. Written Examination.** 56. A 90 minute, 10 question written examination 57. General Discussion. 58. Assessment of the DCVG Training Seminar.	**Session 1.** **Review and Critique of any Student Survey Work Carried Out.** 1. Discussion of Student Problems. 2. Client Education and Contracts. 3. Preliminary look at ECDA Specifications. 4. Detailed DCVG Survey Specification. Client Education. What does the Client want ? **Session 2.** 5. Survey Team Composition. 6. Surveyor Selection and Education. 7. Equipment Required and Plans to Handle Field Work and Data Analysis. 8. Planning a Survey. 9. Managing your Survey Team. Multiple Teams. **Session 3.** 10. Survey Set up and Methodology, Gathering Field Data. Auditing CP Hardware and ROW. 11. Discussion on Rectifiers and Temporary CP Systems, Problems and Limitations. 12. Surveying. Permits, Land Owner Co-operation, Client Co-operation. **Session 4.** 13. Survey Problems. Fences, Electric Fences, Streams, Rivers, City Streets. No Test Posts. 14. Parallel Pipelines, Complex Pipeline Networks. 15. Client Reporting, Daily, Weekly, Monthly. Use of e-mail for Reporting. 16. Errors and Limitations of DCVG Surveys. Equipment Problems and Maintenance. **Session 5.** 17. Review of Type of Data Collected During a Survey. 18. Distance Measurement Techniques Including GPS. 19. Data Transfer From Field to Office. 20. Error Correction and Avoidance. 21. Other Methods for Above Ground Surveys. **Session 6.** 22. The CIPS Technique. Different types of CIPS Equipment and Methodology. 23. CIPS Set Up, Errors and Limitations of the Technique. 24. Combined Surveys, DCVG and CIPS. What Type of Data is Collected. ECDA Requirements. **Session 7.** 25. Organisation of Combined Survey and Data Collection. 26. Co-ordination in Field of Different Types of Surveys including Soil Resistivity, Inline Inspection Pigs for Metal Loss, Guided Wave Ultrasonic Inspection, Acoustic Emission. 27. Importance of Soil Resistivity. **Session 8.** 28. Matching Survey Data Sets. DCVG/CIPS/Soil Resistivity/Metal Loss etc. Correlation Points. 29. Coating Fault Specific and Non Specific Data. The Usefulness of Different Types of Data. **Session 9.** 30. Data Analysis. What do you want from the Analysis to meet Client Requirements? **Session 10.** 31. Current American External Corrosion Direct Assessment (ECDA) Techniques and its Limitations. A Close Look at Type of Data Input to the ECDA Process. 32. How Poor Data can Defeat the ECDA Process. **Session 11.** 33. Data Analysis Programs and How they Work. 34. Advanced Applications of DCVG Technology. SCC Studies. 35. Detailed look at Sham DCVG Techniques. 36. DC vs AC Techniques. Errors and Limitations. **Session 12.** 37. Converting ECDA Analysis into a Rehabilitation Program. 38. Defining Pipeline Rehabilitation Requirements, Metal Loss, Coating and Cathodic Protection. 39. Pipeline Rehabilitation Techniques including Relocation of Fault Areas. 40. Review of Course Contents, Discussions on Application of ECDA and Repeat Surveys. Review of Student Critiques of Sample Survey Report - Limitation Report Problem Discussion