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# Approach towards effective Coating Integrity surveys

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# ABSTRACT

This paper highlights some of the major findings from the field experience while carrying out the Coating Integrity Surveys specifically Direct Current Voltage Gradient Survey (DCVG). Some of the major factors which are not identified during Close interval potential logging Survey (CIPS) are the small coating holidays near to the CP station where the CPPSM units are installed and secondly due to high rating of the CPPSM units, minimal potential dips observed at the smaller holidays. Since no abnormality is observed near and at the CPPSM installed stations, such locations are not considered for DCVG/CAT. After studying various maintenance practices across the globe (available in public domain) it was felt prudent to carry out DCVG for the entire section. After carrying out such surveys and correlating with ILI it was observed that DCVG survey would be more effective, if it is done for the entire pipeline.

Keywords: CIPS: DCVG: CPPSM: ILI: CAT: HOLIDAY:

### INTRODUCTION

All underground pipelines are subject to corrosion where the protective coating is damaged and there are inadequate levels of cathodic protection (CP). A commonly used approach for the assessment of external corrosion risk of buried pipelines is based on the NACE RP502 standard often referred to External Corrosion Direct Assessment (ECDA). Work reported in this paper builds on an integrity assessment carried out on cross country pipelines. Corrosion due to coating defects is often the cause of pipeline failure potentially resulting in disasters causing damage and fatalities.

In existing approaches, it is opined that indirect measurements can provide data to reliably identify coating defects on the pipeline. One established indirect method to determine the condition of the pipeline coating is to use an above-ground technique, such as DCVG, to locate and estimate the severity of the any coating defects that may be present on a pipeline. This technique is very accurate and reliable.

In general it is preferred to carry out any two close interval surveys on the pipeline for indirect inspection under the ECDA four step evaluation procedures. Here In this case, the two selected indirect inspection tools are CIPS & DCVG.

#### Close Interval Potential Survey

Close interval potential survey (CIPS) is the mainstay of cathodic protection and is usually undertaken by a surveyor walking over the pipeline measuring the rectifier ON and Instant OFF (polarized) pipeto-soil potentials at regular intervals along the pipeline. Since the indicator of the polarized potential is the instant OFF pipe-to-soil potential, it is important that the rectifiers be interrupted synchronously preferably using the GPS system for synchronization. A properly conducted CIPS survey will indicate those areas of the pipeline that meet the criterion for cathodic protection (See NACE SP0169-2007 Standard).

CIPS technique achieves the functions below: (a) Identification of zones with inadequate cathodic protection levels. (b) Identification of zones with excessive cathodic protection levels. (c) Identification of zones with possible defects in coating quality. (d) Identification of zones affected by possible electrical interference. The procedure is indicated in Figure 1.



Figure 1: CIPS SURVEY

# **Direct Current Voltage gradient**

In a DCVG, a direct current (DC) signal is applied to the pipeline and the voltage gradient in the soil above the pipeline is measured. Voltage gradients, as measured between two calibrated reference electrodes spaced apart, arise as a result of the current pickup or discharge at pipeline coating holiday locations. Since delta V(ON) represents the soil-to-soil potential difference with current contributions from the pipeline's CP system as well as from all other sources (stray interference, foreign pipelines etc.), and, since delta V(OFF) represents the soil-to-soil potential difference with only the "other" current sources contributing, a DCVG reading will represent the soil-to-soil potential difference.

To sum up, DCVG technique accomplishes the functions below: (a) Accurate defect detection in coating. (b) Defect size evaluation. (c) Defect orientation (d) Current corrosion status evaluation in steel exposed by defects. (e) Galvanic anode detection. (f) Survey of zones with possible DC interference. Refer figure 2 for the procedure.



Figure 2: DCVG Survey

# OVERVIEW OF THE PROBLEM

In normal practice for cross country pipelines CIPS survey is done over the entire length of the pipeline by potential logging method and based on the survey report wherever there are noticeable changes in the ON/OFF potential, those locations are considered for further assessment and accordingly DCVG/CAT survey are being carried out. DCVG survey is carried out for verification and pin pointing the coating defects identified during close Interval Potential logging Survey.

As per the final report of the In-line Inspection (ILI) carried out for a 12" pipeline of 175Km in 2014, it was observed that there are some external metal losses. Upon Dig verification, coating holidays were evident. Questions were raised regarding the validation of DCVG survey carried out in 2012 for the same section. Upon detail analysis of the DCVG report it was concluded that the effected regions were not recommended for DCVG survey as per the CIPS report.

Further analysing, the holidays detected in ILI were near to the cathodic protection stations in the pipeline and the defects are very small in nature such as less than 1cm2. Some of the major factors which are not identified during CIPS survey are the small coating holidays near to the CP station where the CPPSM units are installed and secondly due to high rating CPPSM units no potential dips

observed at the small holidays less than 1cm2. Since no abnormality is observed near and at the CPPSM installed stations along with small holidays across the pipeline such locations are not considered for DCVG/CAT. After studying various maintenance practices cross the globe it was felt prudent to carry out DCVG for the entire section. In view of the AC interference being a major cause of concern in the recent years due to exponential growth of new HT lines across the pipelines, it was felt prudent to carry out DCVG survey especially at the sections where HT line is in parallel to pipeline. By eliminating the Holidays at the parallel sections we can reduce AC corrosion to certain extent.

# **Experimental Procedure**

Considering the above limitations in the surveys it was decided to carry out DCVG survey for entire section of the pipeline. The economics were high but safety concern is much more prioritised than the cost of the survey. Accordingly DCVG survey was initiated with certain factors to be maintained all along the section of survey.

### Pipeline specifications:

Name: 12IN,CH 0.00KM (DT) to CH 176.50KM (IP01) Pipeline Start-Up Year: 2004 Diameter: 12in (323.85mm) Length: 176.5 km Contents: LPG Pipeline Type: Buried, Coated, Cathodically Protected Steel Pipeline. Coating Type : 3-Layer PE Material API : 5L X60 Nominal Wall Thickness : 6.4mm (137.249km) Design Pressure: 98 kg/cm2 (96.11 bar) MAOP: 92 kg/cm2 (90.22 bar) Design Factor: 0.72 (all wall thicknesses)

# The Equipment details:

DCVG Survey meter



Figure 3: DCVG equipment

Figure 4 Soil-Soil potential figure 5 Pipe-soil potential

For obtaining strong signal strength it was decided to maintain PSP at the TR/CPPSM unit at -2500mV CSE .Figure 3 displays the DCVG meter .The signal strength was around 1400mV.As per the DCVG manual, strength of 250mV to 1500mV is required for survey. Figure 4 shows the DCVG survey personnel carrying out the survey in the field and Figure 5 show the methodology for checking the upstream and downstream ON /OFF signal strength. By maintaining such high signal strength minor defects will also be identified easily. With these stringent parameters many minor defects were identified. At locations where the required strength could not be achieved temporary power source along with interrupter and grounding network were installed to achieve the parameters. At all the crossings these parameters were strictly adhered to identify the defects, because at crossings the depth of the pipe is more and DCVG survey signal strength is most important parameter. In continuation to the DCVG survey it was observed that there is significant drop in strength at the sectionalizing valve stations due to the underground valves and stem raisers. So we have carried out the coating of the entire piping network in the SV station including the mainline valve and the bypass valves which are underground. Figure 6 shows one of the SV stations where the underground station piping is applied with cold tape coating and the valves along with bends are applied with R-P5 epoxy solvent



Figure 6 SV station underground valve coating

# <u>Results</u>

After carrying out the DCVG survey with above mentioned Parameters some fascinating results have been achieved those are illustrated below

At Chainage 26.200 Km two defects have been observed. Figure 7 shows the site photograph of the defect identified after the dig verification. These defects fall under the minor category and were not detected in CIPS survey. The table 1 indicates the DCVG detail report on the defect. The signal strength maintained was 1100mV. Since the location was adjacent to Cathodic protection power station module the defect was not identified in the CIPS as the defect is small and does not vary during the ON-OFF survey of CIPS. But these defects are potential dangerous considering the soil in the area is highly corrosive nature based on the soil resistivity. Such defects could be potential points for AC corrosion. The table 2 show the CIPS survey details indicates no abnormal shift in ON-OFF survey in CIPS at the defect location.



Figure 7 defect at Chainage 26.200Km

Table -1 DCVG findings :

CHAINAGE FROM (KM	CHAINAGE ) TO (KM)	TOTAL LENGTH OF SURVEY (KM	SIGNAL IN mV UPSTREAM Y TLP	SIGNAL IN mV DOWN STREAM TLP	DIFECT LOCATION CHAINAG E	DISTANC E OF UPSTREA M TO DEFECT	DISTANC E OF UPSTREA M TLP TO DOWN STREAM	OLRE AT DEFECT LOCATI ON IN WV	PRE AT DEFECT LOCATION	% OF IR = OLRE X 100 / PLRE	ANALYASI S OF DEFECT	MARKING OF DEFECT LOCATION
26.730	25.750	0.980	1200	1100	26.2	530	1050	20	1149.52381	1.74	Minor	Defect foud at nr. Warning Marker Ch.26.841

Table -2 CIPL (2012) findings are:



While carrying out the DCVG survey it was decided to carry the survey with high signal strength and while the survey was in progress a defect was identified as Minor and was near the High tension tower line. So it was decided to immediately carry out dig verification and ascertain the type of defect due to the small defects causing AC corrosion on the pipeline. But the outer appearance of the defect as displayed in Figure 8 looks major holiday. The DCVG report as per table 7 for Chainage 64.166Km indicate minor holiday defect. The CIPS report refer table 8 also does not show any abnormal dip in the potentials. After carryout the dig verification the defect indicated that the coating was peeled off and the adhesive was intact and hence the bare metal of the pipe was not in contact with the soil. But this was major finding to avoid severe holiday at latter stage and also HT tower near the line. This location was also indicated in the In Line inspection tool report refer table 9. As per the Ili report in table 9 indicates external metal loss of very minor percentage.



Figure 8 defect at Chainage 64.166Km

Table 3 DCVG findings are:

CHAINAGE FROM(KM)	CHAINAGE TO (KM)	TOTAL LENGTH OF SURVEY(KM)	SIGNAL IN mV UPSTREAM TLP	SIGNAL IN mV DOWN STREAM TLP	DIFECT LOCATION CHAINAG E	DISTANC E OF UPSTREA M TO DEFECT	DISTANC E OF UPSTREA M TLP TO DOWN	OLRE AT DEFECT ON	PRE AT DEFECT LOCATION	% OF IR = OLRE X 100 / PLRE	ANALYASI S OF DEFECT	MARKING OF DEFECT LOCATION
64.648	64.148	0.500	800	750	64.166	482	500	15	751.8	2.00	MINOR	Defect found in field Nr.TLP NO.85





# Table 5 ILI findings:

Identifier	Girth Weld	Absolute Distance (m)	Relative Distance (m)	Joint Length (m)	Nominal Wall (mm)	Feature Type	Anomaly Dimension Class	Surface Location	Length (mm)	Width (mm)	Peak Depth (%)	Orientation (hh:mm)	ERF	Ріре Туре
40015322	55140	64521.776	11.568	11.990	7.10	GROUP	PITT	EXT	18	17	10	10:12	0.618	ERW
20016081	55140	64521.776	11.568	11.990	7.10	PIT		EXT	18	17	10	10:12	-	ERW

One of the defects observed in the DCVG survey was that moderate fault was observed in the pipeline at Chainage 111.121Km .Upon dig verification (refer Figure 9) the fault was at the 7 O clock position ,The DCVG signal strength was maintained at around 1100mV and the soil at the location was very corrosive . The defect was near to the CPPSM station and as per the report refer table 6 DCVG re[port the defect was moderate. There was no significant dip in potential during the CIPS survey refer Table 8. The reason was due to high polarization of the pipeline which is near to the CPPSM station.



Figure 9 Defect at Chainage 111.121Km

#### Table 6 DCVG findings are:

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CHAINAGE FROM (KM	CHAINAGE ) TO (KM)	TOTAL LENGTH OF SURVEY (KN	SIGNAL IN mV UPSTREAM I) TLP	SIGNAL IN mV DOWN STREAM TLP	DEFECT LOCATION CHAINAG E (KM)	DISTANC E OF UPSTREA M TO DEFECT	DISTANC E OF UPSTREA M TLP TO DOWN STREAM	OLRE AT DEFECT LOCATI	PRE AT DEFECT LOCATION	% OF IR = OLRE X 100 / PLRE	ANALYASI S OF DEFECT
111.084	111.814	0.730	1300	1200	111.121	37	730	107	1294.930	8.22	Moderate

Table 7 CIPL (2012) findings are:



### CONCLUSION

By carrying out DCVG for the entire pipeline we could achieve the following:

- 1. All the minor defects have been identified.
- 2. Minor defects near the parallel HT line have been identified and rectified to avoid AC corrosion.
- 3. Integrity of coating defects of pipeline has been achieved.
- 4. Coating defects near the CP station has been identified.
- 5. ILI report also needs to be verified for carrying out the DCVG.

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