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Title: Foreign pipeline Interference and Detection of third party coating defect by ACVG A-frame survey - A Case Study

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ABSTRACT

Company A operates cross country Liquid hydrocarbon P/L of 1440 Kms length, and crosses various utilities along its length at different locations. Company A pipeline is running parallel with a company B product pipelines in some areas. Company B pipeline is having coal-tar coating.

Due to poor quality of coating, Company B foreign pipeline is protected by CP units after every 8 Kms. At some locations anode bed of foreign pipeline are laid towards the affected pipeline of Company A, which is the common source of interference.

During quarterly On/Off PSP monitoring, at chainage 617.419 & 618.43 Km of affected pipeline, off PSP were found less electronegative than 850 mV. Since the low polarization is observed first time without any major change in the conditions of two pipelines and their CP system, It is suspected that total circuit resistance between two pipelines at pickup and discharge location is reduced considerably, may be due to coating damage.

This paper describes the problems faced in finding exact discharge location and the approach followed in resolving the issue. This paper deals with the case of third party coating damage; due

to which interference gets aggravated in between two parallel running pipelines. The major concerns are:-

- Challenges in maintaining pipe to soil polarized potential.
- Finding the exact location of current discharge.
- Rectification and mitigation measures.

Keywords: Cathodic Protection, Pipe to soil potential (PSP), Casing to soil potential (CSP), Casing pipe, Carrier pipe, Casing insulator, Casing end seal, DFCCIL (Dedicated Freight Corridor Corporation of India Limited, Chainage, 3LPE (3 layer Polyethylene), ERF (Estimated Repair Factor), OD – Outer Diameter

PROBLEM FACED

Below schematic shows the location of CP unit foreign line w.r.t. affected pipeline. Two anode beds of foreign pipeline are laid towards affected pipeline.

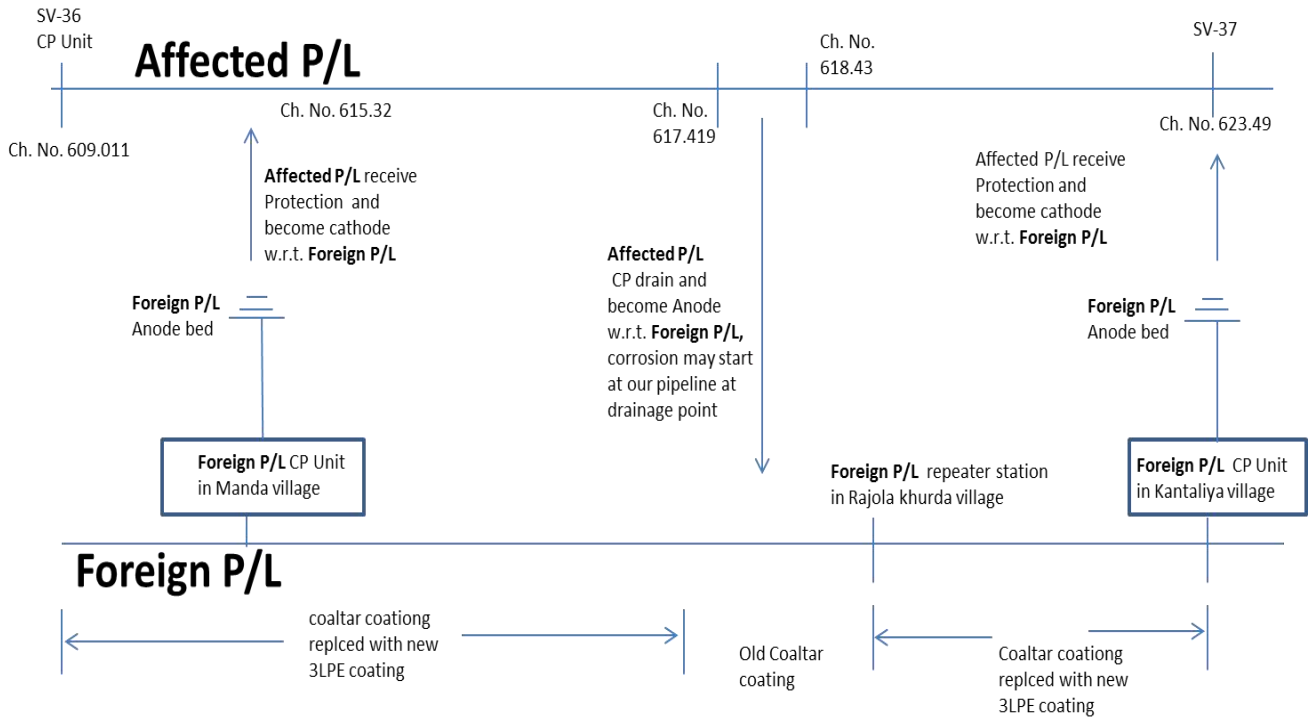

Fig.-1 Interference of Foreign pipeline with affected pipeline at Ch. No. 617-618

As per guideline pipe to soil potential (PSP) monitoring has been carried out quarterly and ON-Off PSP is done once in a year. During the PSP monitoring pipe to soil potential at two test stations were observed less electronegative than -850 mV.

Here, below mentioned table deliberates one of the locations & following were observed at chainage No.617.419.ON potential was -0.88V against the target PSP -1.40V, and off PSP is -0.69V which is less electronegative than the acceptable limit of -0.850V. Various exercises were done in coordination with foreign P/L CP engineer and the results are tabulated with various conditions.

Table-1

Ch. No.	ON PSP of Affected P/L	Foreign P/L Tr. Unit Status at Village Manda		Foreign P/L Tr. Unit Status at Village Kantaliya		Affected P/L SV-36 CP Unit status		Remarks
	(-Ve)	On/Off	O/P V & I	On/Off	O/P V & I	On/Off	O/P V & I	
615.32	1.38	ON	7 V, 3A	ON	4 V, 2A	ON	2.4V, 0.9A	Case-1
616.455	1.15							
617.419	**0.88**							
618.43	**1.05**							
619.492	1.12							
620.443	1.21							
615.32	0.989	ON	7 V, 3A	ON	4 V, 2A	OFF	NA	Case-2
616.455	0.886							
617.419	**0.69**							
618.43	**0.72**							
619.492	0.905							
620.443	0.901							
615.32	1.37	ON	7 V, 3A	OFF	NA	ON	2.4V, 0.9A	Case-3
616.455	1.15							
617.419	**0.89**							
618.43	**1.08**							
619.492	1.17							
620.443	1.23							
615.32	1.4	OFF	NA	OFF	NA	ON	2.4V, 0.9A	Case-4
616.455	1.32							
617.419	**1.15**							
618.43	**1.19**							
619.492	1.23							
620.443	1.29							

The results clearly suggested that Company-A P/L is suffered with foreign pipeline interference. Affected pipeline receives current from two anode bed of foreign P/L and the discharge current at chainage No. 617.419. Due to the discharge of current PSP is observed less electronegative than -850 mV. If the source of interference i.e. foreign pipeline CP unit is switched-off affected P/LPSP is improved by 270mV.

Further discussion with foreign P/L CP engineer, it is observed that they are replacing the old coal-tar coating with 3LPE coating in phase wise manner. It is also observed that foreign P/L having old coal-tar coating at affected location at Chainage No. 617.419.

Effects of Stray Current at Discharge Location

Considerable attention is given to identifying the site of current discharge in stray current investigations because this is where corrosion damage is most likely to occur on all metallic structures. When a current transfers from a metallic structure to earth, as depicted in Figure 3, it must do so via an oxidation reaction which converts electronic current to ionic current.

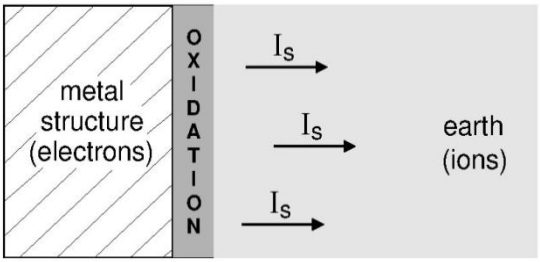

Figure2:CurrentDischarge from a Metal Structure to Earth via an Oxidation Reaction

The oxidation reaction is the corrosion of the steel is

$$Fe^{o} \rightarrow Fe^{++} + 2e^{-}$$

Stray current discharge from a metallic structure may not cause corrosion attack if the structure is receiving cathodic protection as in Figure 4.

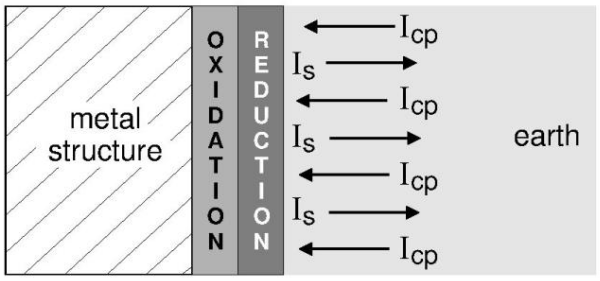

Figure3:Current Discharge from a Cathodically Protected Metal Structure to Earth via an Oxidation Reaction

Cathodic protection current transfers across the metal/earth interface via a reduction reaction that produces hydroxyl ions in either of the two following reactions:

$$O_2 + 2H_2O + 4e^{-} \rightarrow 4OH^{-} \quad [1]$$

$$2H_2O + 4e^{-} \rightarrow H_2 \uparrow + 2OH^{-} \quad [2]$$

In the presence of a high concentration of hydroxyl ions a possible oxidation reaction is given in Equation 3 involving the oxidation of hydroxyl ions to oxygen and water.

$$4OH^- \rightarrow O_2 + 2H_2O + 4e^- \quad [3]$$

This latter reaction does not consume metal atoms and therefore there is no corrosion damage. Hence as long as the polarized potential at the structure/electrolyte interface is not driven more electropositive than the cathodic protection criterion (e.g.-850 mVcse), then corrosion would not be expected.

ACTION TAKEN TO REDUCE THE INTERFERENCE PROBLEM

Since the polarized potential is observed abnormal first time without any major change in the conditions of two pipelines and their CP system. It is suspected that total circuit resistance between two pipelines at pickup and discharge location is reduced considerably, may be due to coating damage by third party.

Step-1: As the low polarized potential was observed at chainage No. 617.419, It has been decided to perform ACVG A -frame survey current pick up and discharge location. ACVG A-frame survey can be perform by normal pipeline locator PCM+. A-frame survey performed between Ch. No. 615.32 to 616.455 and No defect was found. Further ACVG, A-frame survey performed between Ch. No. 617.419 to 618.43.During A- frame survey two coating defects has been detect at Ch. No. 617.550 to 617.600.

Step-2: Excavation was carried out at the locations identified in ACVG A-frame survey. Coating defect was found at two locations as per survey reports. Pipeline & coating was suspected to be damaged by third party activities also damage by third party.

Fig.- 4 Coating & pipe damage at Ch. 617.550 Fig.-5 Coating & pipe damage at Ch. 617.600

DEFECT VERFICATION AND COATING REPAIR

It was suspected that during the operation of the excavator by the third party, the pipe also got damaged along with the coating at both the locations at Ch.617.550 and 617.600Km. Both the locations were excavated and coating was removed on the pipeline up to the extent of the coating damage. At first location Ch.617.550Km, it was observed that the excavator pressed a penetration tooth down on the pipe until the front of its tracks lifted off the ground then dragged the tooth along. Due to this, two numbers gouge were created with axial groove from 12'O clock position towards 3'O clock position (in Fig.6). At second location, the excavator bucket was wedged against the back wall / inside of the excavation and levered against the pipe(Fig-7).

Pipelines are designed to withstand internal pressures well above their operating pressure. This 'design pressure' is one factor that determines the wall thickness of the pipe. As the pipe wall thickness decreases and so does the pressure rating of the pipeline. It requires determining of safe operating pressure and ERF (Estimated Repair Factor). The following NDT tests were done on the first location. DPT test, MPT test and UT test were applied for detecting surface and sub-surface cracks and other anomalies if any. The maximum depth found on the first location is 28% and it was within the maximum allowable length i.e.80mm.At second location, visual inspection and thickness test was done around the defect and the maximum depth is below 10%.It was confirmed all parameters were within the limit.

Fig. -6 At Ch.716.550Km – Location 1

Fig.-7At Ch.716.600Km – Location 2

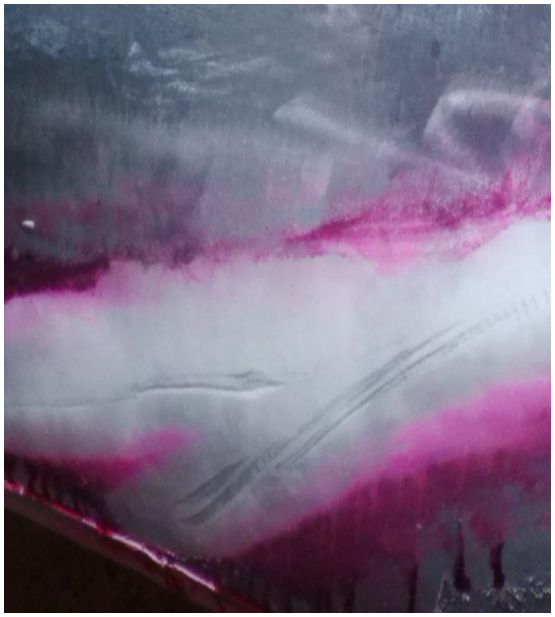

Fig.-8 DPT TEST

Fig. - 9 MPT TEST

Fig. - 10: UT TEST

BENEFITS OF RECTIFICATION OF COATING DEFECTS

After rectification, final values of PSP & CP unit parameters are as under;

Table-2

Ch. No.	ON PSP of Affected P/L	Foreign P/L Tr. Unit Status at Village Manda		Foreign P/L Tr. Unit Status at Village Kantaliya		Affected P/L SV-36 CP Unit status	
	(-Ve)	On/Off	O/P V & I	On/Off	O/P V & I	On/Off	O/P V & I
615.32	1.37	ON	7 V, 3A	ON	4 V, 2A	ON	2.4V, 0.81A
616.455	1.31						
617.419	1.13						
618.43	1.16						
619.492	1.21						
620.443	1.28						
615.32	0.989	ON	7 V, 3A	ON	4 V, 2A	OFF	NA
616.455	0.866						
617.419	0.86						
618.43	0.876						
619.492	0.905						
620.443	0.901						

The above parameter shows that the ON and OFF PSP is improved and more than the minimum protection level required as per the guidelines.

Further we are planning to install two additional test stations at either side of change No. 617.419 and Mg anode will be install at all four test stations to increase the protection level at stray current discharge location. Foreign pipeline operator now replaced old coal-tar coating with 3LPE in remaining area hence interference is further reduced and polarized potential improved to -950mV.

CONCLUSION & RECOMMENDATION

Large coating defects makes very difficult to maintain the pipe to soil potential of pipeline, especially at the location where pipeline is suffered with foreign pipeline interference. It is also increase the output current at CP unit. Less negative, than - 0.850V, potentials of pipeline make it under polarization which may result into beginning of corrosion activity. The drainage of CP current makes the pipeline vulnerable to corrosion & could result failure of the pipeline. It is recommended to analyze the PSP monitoring reports with utmost care and immediate action is required if the protection level of pipeline is falls below the required level. Daily foot patrolling is required to avoid the third party damage.