Paper No.

CAP44

Interference & Corrosion due to HVAC power lines running parallel to cross country pipelines - Challenges in mitigation and way forward

MALLESH G

Manger (Elec.), NACE, CP-2, GAIL (India) Ltd-Cherlapalli, A.P, India

1) M. I. Md. Ammar

Manger (Elec.), NACE, CP-3, GAIL (India) Ltd-NOIDA, India

2) D. Phani kumar

Manger (Elec.), NACE, CP-2, GAIL (India) Ltd-G.Konduru,A.P, India

ABSTRACT

10"diameter, 3 layered PE coated LPG pipeline 8.7/6.4mm thickness & 300 km length was laid to transport the Liquefied Petroleum Gas (LPG).

During its first ILI run in year 2015, External corrosions was detected on 10" pipeline of 300kms. Nearly 350 no's of external corrosion defects were detected in which major defects were nearly 20 no's with a metal loss ranging from 10% to 50% and minor defects were 330 no's with a metal loss of below 10% of total pipe thickness. Dig verification was carried out at major defect locations for assesment. The defects observed were round shaped with holidays in coatings with 1 to 3 cm^2.

AC interference survey was under progress in the same pipeline few months before ILI run. Based on CP survey data, soil test at external corrosion site, lab test of corrosion material data and assessment of various factors such as presence of an AC voltage on the pipeline, presence of a coating fault (usually very small size – up to 3 cm^2), the shape of the corrosion (rounded pit like), low/very low soil resistivity, presence of a large disbonded area beneath the coating and calculations for Current Density found to be very much greater than> ~100 A/m^2) , conclusion was made that external corrosion was due to AC interference.

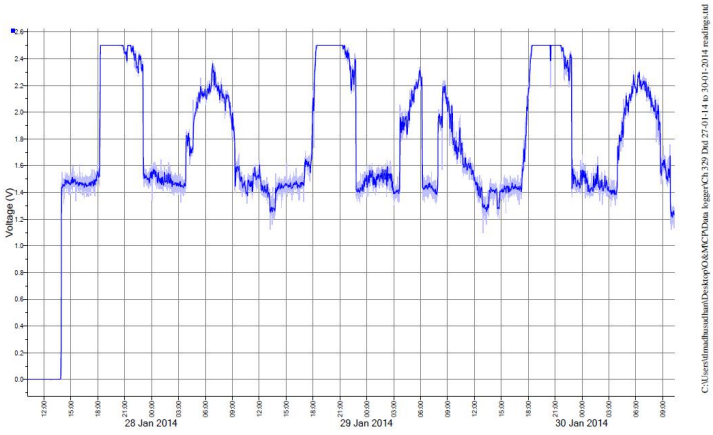
A major factor contributing for the conclusion was the fact that HVAC power lines are running parallel to the pipeline approximate of 70 Kms and having HVAC power lines crossings at 30 locations.

INTRODUCTION

There is an LPG pipeline of 578 KM length for transporting LPG having two sections (A & B) constituting of 12" Dia & 10" Dia with 3 layer PE coating with design code & grade of ASME B 31.4 / API 5L GR X-60 having thickness of 6.4, 7.1 & 8.7 mm.

The jurisdiction of this context of 10" Dia starts from 410. KM to 577.186 KM 6.4mm thickness pipeline with spur lines of 6" Dia of different lengths

Maintenance of these pipelines being done by adhering the guidelines, standards, SOPs etc framed in the company.



Interference was sensed in subject pipeline during monitoring activities. So the AC& DC data logging was done in Aug 2014 at different HT line crossing& parallel locations at some identified locations.

Based on the observations in PSP readings and logged data, job for interference survey and to carry out further mitigation measures was placed to a vendor on 6th January 2015.

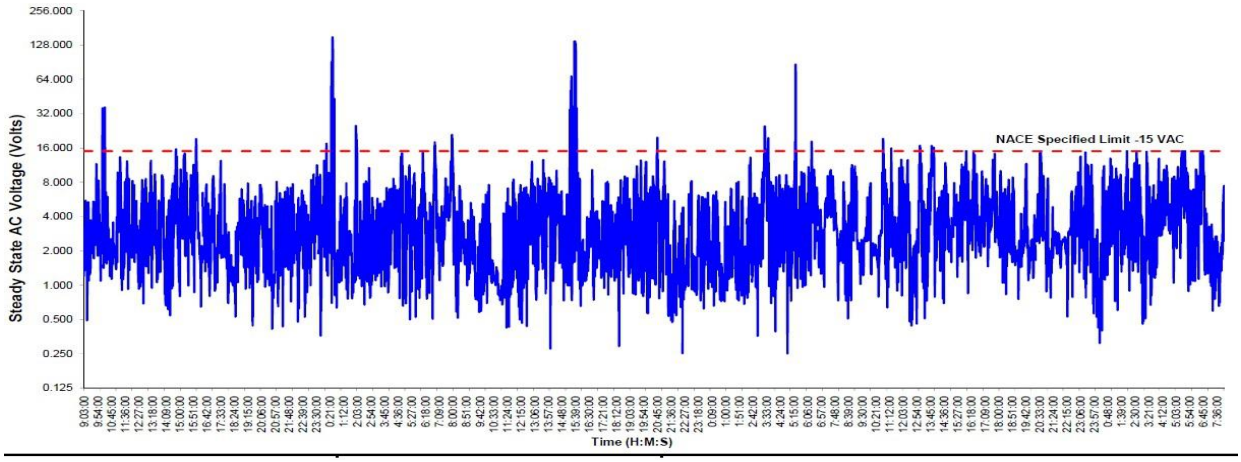
Very first time in the company, subject pipeline in section B found with 248no's External Defects as per ILI report dt 18th June 2016 from third party were identified through ILI pigging carried out in the month of March 2015. AC Interference Survey was carried out in the month of May-July 2015 & the following jobs were done:

Based on various surveys & tests for voltage, soil & material tests of corroded pipe analysis, it was found that,

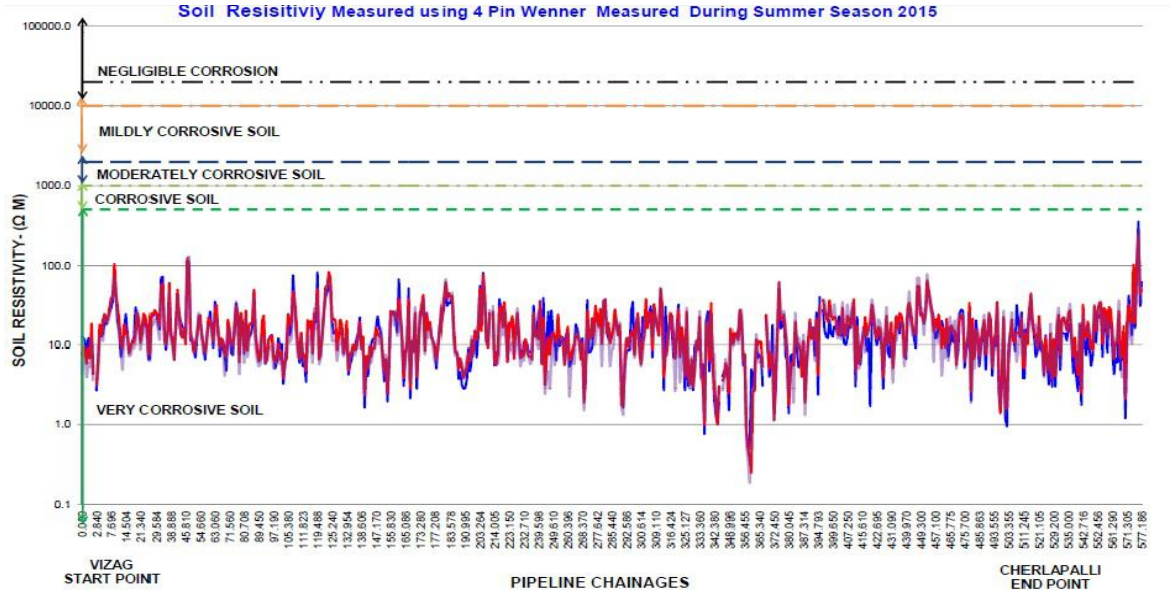
1. AC voltage data logging carried out at all HT crossing and at external corrosion defects sites. High AC Voltages of 0-30Vac recorded HT crossing and the peak

AC voltagesof 159Vac and 91 Vac on pipeline was found during evening peak load hours for some chainages as given below graph.

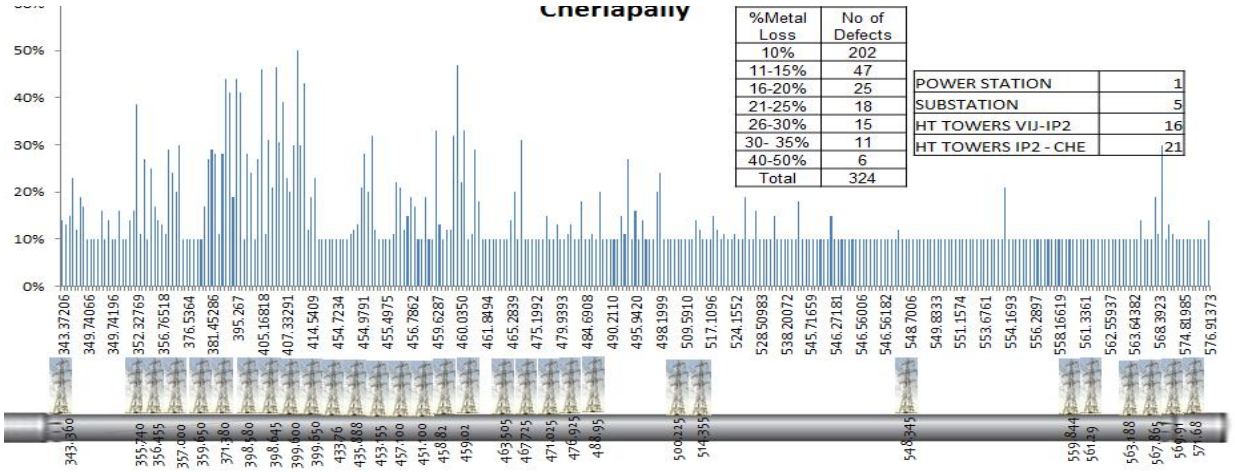
AC voltages are also found on pipeline where the pipeline is running parallel to the HVAC transmission lines for around 75Kms



Soil resistivity in PL is very low & corrosive i.e.100-1000 Ω-cm is shown below. Coating defects on pipeline are found of 1 to 3 cm^2 at time of digging at external corrosion locations.



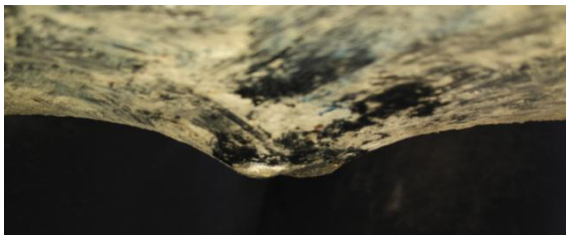
Dig verification was done at external defects sites as per ILI report and coating holidays were found defective at the corrosion locations.



Corroded material analysis & soil sample analysis got done in lab a per recommendation of SME (Subject Matter Expert) during his site visit on 05.06.2015 & analyzed that these coating defects were due to damage during lowering of pipeline in construction period.

Figures shown below for the external defects, coatings

External defect of 52% metal loss



Reports of soil sample at AC corroded areas:

Sample Particulars: Pig Recidue Sample, Batch No:VSPL P/L at IP2 Suryapet.

Qty.: 1 No, Packing: packed in polythene cover.
Test Reqd: Fe_3O_4, $CaCO_3$,$MgCO_3$, γ- Fe2O3,α- Fe2O3
Dt. of receipt of sample : 26th June, 2015.
Dt. of starting of analysis : 27th June, 2015.
Dt. of completion of analysis : 07th July, 2015.

TEST RESULTS

S.No	Test Parameters	UOM	Results
1	Mgnetite as Fe_3O_4	% by mass	47.22
2	γ- Fe2O3(Iron-III γ)	% by mass	100
3	α- Fe2O3(Iron-III α)	% by mass	Nil
4	Calcium Carbonate as $CaCO_3$	% by mass	Nil
5	Magnesium Carbonate as $MgCO_3$	% by mass	Nil

Test Method: IBM-Manual & **Instrument Used:**XRD
Note-1: The above result is as on received basis.
2:The report and results relate only to the samples/items tested.

Sample Particulars: Soil.

Qty.: 1 No. Packing: Polythene Cover.
Test Reqd: Complete Chemical Analysis.
Dt. of Receipt of analysis : 08th June, 2015.
Dt. of starting of analysis : 09th June, 2015.
Dt. of completion of analysis : 11th June, 2015.

TEST RESULTS

Sl. No	Test Parameters	Results (%by mass)
I	P^H (5% aqueous Solution)	8.15
II	Inorganic Elements	
1	Silica as SiO_2	76.50
2	Iron as Fe_2O_3	0.25
3	Aluminum as Al_2O_3	10.22
4	Calcium as $CaCO_3$	3.19
5	Magnesium as $MgCO_3$	1.25
6	Total Bi-Carbonates as HCO_3	0.90
7	Manganese as MnO	0.04
8	Titanium as TiO_2	0.37
9	Sodium as Na_2O	0.94
10	Potassium as K_2O	1.67
11	Vanadium as V_2O_5	<0.01
12	Phosphorous as P_2O_5	0.16
13	Loss on Ignition	4.32
14	Sulphates as SO_4	<0.01
15	Chlorides as Cl	0.01

EXPERIMENTAL PROCEDURE

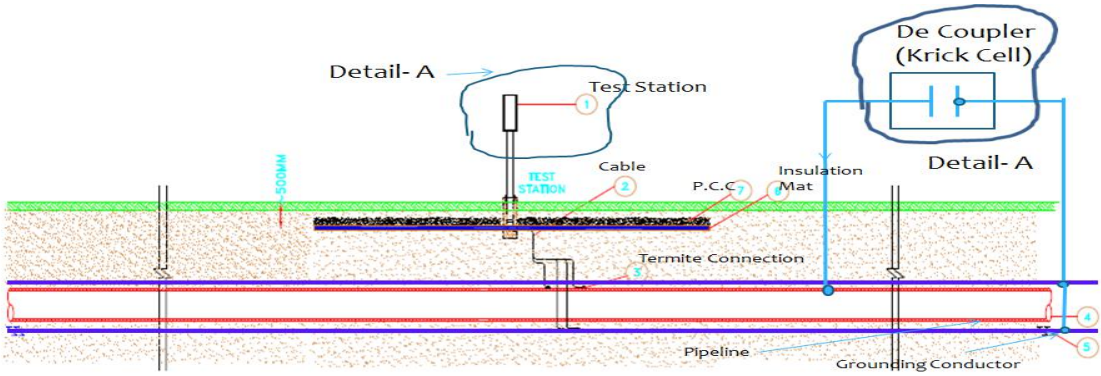
To avoid further external corrosion following mitigation measures were implemented

(A) Mitigation at Sectionalising Valve (SV) Stations -

With a view to ground the induced AC voltages & currents, low resistance ground system created by laying of grounding conductor and connecting it to the pipeline through DC decoupler (Polarisation cell). With this, the induced AC voltage at SV Stations dropped.

(B) AC interferference mitigation by installing polarisation cells, PVC mat, PCC slab with grounding conductor -

Grounding the AC voltages by installing of polarization cells in SV's with earth pits (constructing dedicated earth pits in SV's for polarization cells) and by installation of polarization cells at HT crossings with 8mm PVC mat, PCC slab with 80mm thickmess and grounding conductors for reduction of inductive and conductive coupling interferences.

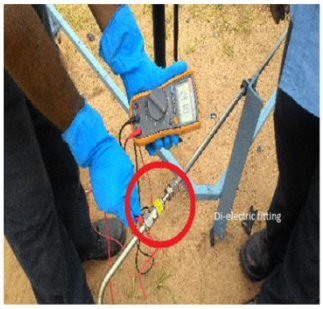


Schematcic drawing shown above for mitigation of AC volates at HT crossing includes 1.Test station 2.Insulating case for grounding cable 3.cable connections on pipe 4.Pipeline 5.Grounding conductor 6.PVC mat 8mm thickness 7. PCC slab 80mm thickness

(C) Installation of Dielectric fittngs at Pressure Transmitters (PT) piping

There are PTs fitted with piping drawn out from underground pipeline to measure the pipeline pressure . As these PTs are electrically connected with Pipeline, there is a draining of CP currents from pipeline through PT body to cable armour to panel ground. Also there is a risk of availability of hazardous potentials with PT and chances of sparking at gaps.

UP Stream Potential



Down Stream Potential

Inorder to avoid draining of CP currents & the risk of hazardous voltages at PT during maintenance jobs by operators, dielectric fittings were installed that isolates electrical continuity from underground piping to PT.

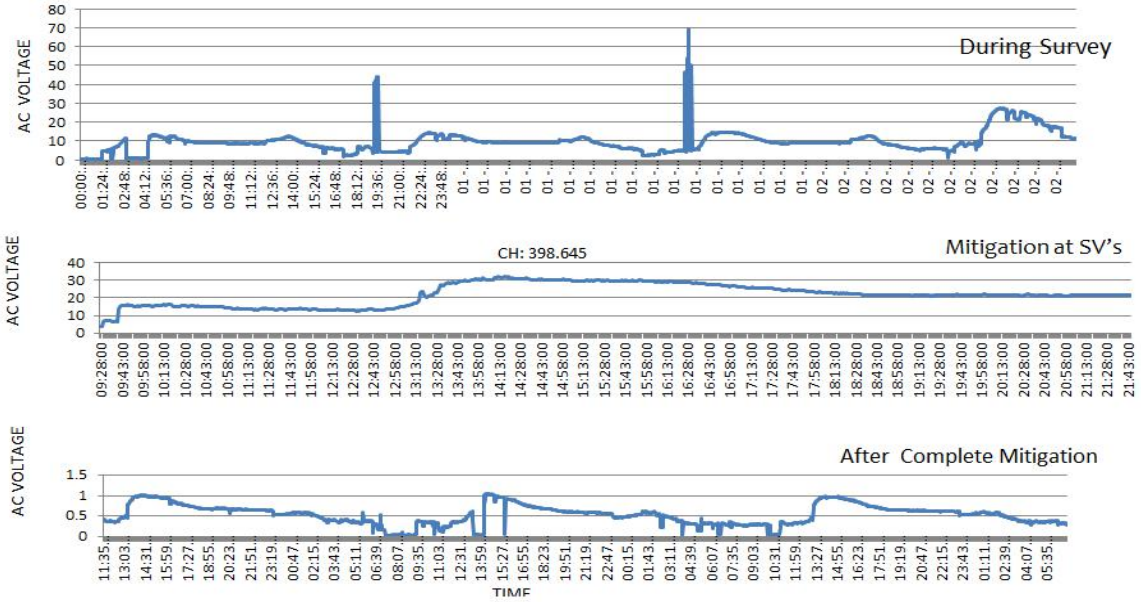
(D) Installation of composite sleeve for reinforcement

As a precautionary measure installation of composite sleeve for reinforcement and coating repairs for all major external corrsion were carried out, where the meatal loss was higher than thirty percent.

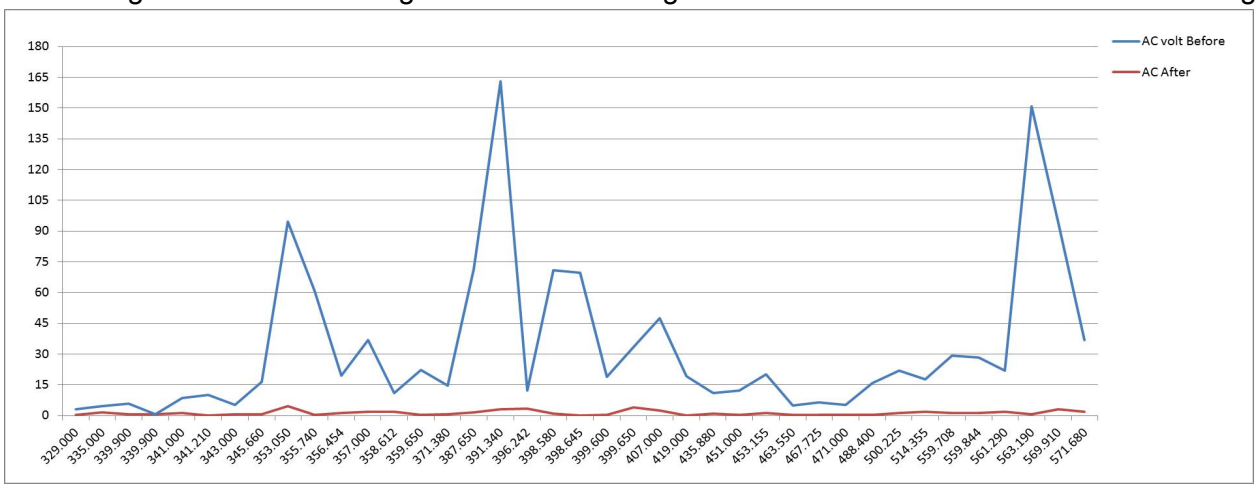
Sl.No	Pipeline Chainage	DEFECT SIZE (TDW PRELIMINARY REPORT	ACTUAL SIZE AS PER DIG VERIFICATION (EIL/TDW REPORT dated 08/06/2015)		REMARKS (BASED ON FFP/RR REPORT) EXTERNAL DEFECTS – DIG VERIFICATION DONE AND CLOCK SPRINGS INSTALLED
		DEPTH %	DEPTH %	EXT / INT	
1	459.23	33	39	External	Clock Spring installed on 08/07/2015. As per FFP Report predicted repair year is 2030 (Criteria D 80%)
2	459.63	42	53	External	Clock Spring installed on 05/06/2015. As per FFP Report predicted repair year is 2022 (Criteria D 80%)
3	460.52	32.6	47	External	Clock Spring installed on 08/07/2015. As per FFP Report predicted repair year is 2030 (Criteria D 80%)
4	460.94	29.2	37	External	Clock Spring installed on 09/07/2015. As per FFP Report predicted repair year is 2033 (Criteria D 80%)
5	469.66	31	52	External	03no. Of clock springs installed due to defect is near to girth weld (45mm from weld joint) on 10/07/2015. As per FFP Report predicted repair year is 2032 (Criteria D 80%)

RESULTS & CONCLUSION:

By carrying out aforesaid mitigation activities, we have obtained a positive results by reduction of AC voltages at the points where earlier a significant AC voltages were recorded



AC volatges data befor mitgation & after mitigation shown below for all HT crossing



As AC volatges has been mitigated at HT crossing and volatges after mitigation are <3 V AC.

However HVAC power lines are running parallel to our LPG pipeline (approxmitately 75Km parallasim). Where in high AC induced voltages exists in pipeline as per data logging reports carried out at HVAC parallel lines.

Detailed modelling and simulation study for HVAC interference is proposed and mtigation on the pipeline will be done as per the results of the study.

3. Indentifiaction of cluster coating defects & repairing of densed coating defects on pipeline where external corrosion with <15% thereby reduing the external corrosion.

Analysis for External corrosion densed				
From	to	Total no's	% depth	Highest %
545.71585	545.71820	6	10%	
546.21711	546.21781	3	10 to 15%	1-15%
546.55939	546.56182	13	10%	
549.58920	549.59122	4	10%	
551.15403	551.15741	5	10%	
556.28917	556.29154	4	11%	1-11%
562.92194	562.92458	5	12%	1-12%
576.13713	576.14687	4	10%	
Total		44		

Severity Analysis and Ranking for AC Interference	Severity Ranking for HVAC Interference			
	High	Medium	Low	Very Low
Soil Resistivity- ρ (in Ohm-Cm)	ρ < 2500	2500 < ρ < 10000	10000 < ρ < 30000	ρ > 30000
Phase Load Current-I (in Amps.)	I > 1000	500 < I < 1000	200 < I < 500	I < 200
Separation Distance-D (in Meters)	D < 30	30 < D < 500	500 < D < 1000	D > 1000
Paralleling Length - L (in Meters)	L > 1000	500 < L < 1000	50 < L < 500	L < 50
Crossing Angle -ɵ (in Deg)	ɵ < 30	30 < ɵ < 60	ɵ > 60	60 ɵ < 90

4.As per severity matrix evaluation is being carried out and if any of the parameter ranking falls above 'Very Low' category, then the deatil study of pipeline section is being carried out for mitigation of AC corrosion.

REFERENCES

Based on various standard & guidelines given below, methodology for mitigation of AC corrosion is being considered for safety & integrity of pipeline from external corrosion.

- NACE SP 0177 – 2014, Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems.
- IS 8062 – Part II - Code of Practice for Cathodic Protection of Steel Structures - Underground Pipelines
- Canadian Standard C22.3 No.6M 91 (2003) – Principles and practices of Electrical Coordination between pipe lines and Electric Power Lines.
- BS EN 15280 – 2013 – Evaluation of AC corrosion likelihood of buried pipelines applicable to cathodically protected pipelines.
- ISO 18086 – Corrosion of Metals and Alloys – Determination of AC Corrosion – Protection Criteria
- NACE CP 3 & CP 2 –Cathodic Protection Technologist Course Manual.