

Paper No.
16817



Unmasking AC Threats on Petrochemical Pipelines

C. Baete
Elsyca nv
Vaartdijk 3/603
3018 Wijkmaal
Belgium

G. Haynes
Elsyca Inc.
7424 S University Blvd
Unit E #107, Centennial, CO, 80122
USA

Jonathan Marmillo
LineVision
Philadelphia,
PA,
USA

ABSTRACT

Buried pipelines installed in high-voltage corridors generally experience a continuous safety and corrosion threat.

Powerline data must be requested from different utilities, the ensuing data may be limited challenging or impossible to obtain. This often results in over or under design of the AC Mitigation systems. After installation, a pipeline operator 'hopes for the best' regarding acceptable powerline operating conditions. However, powerline loads, and phasing may unexpectedly change without notice, further exacerbating risks. These events might be detected during ad-hoc monitoring, assuming the equipment has been installed in the correct locations, but the power line circuit(s) responsible for the increased risk, remains unidentified.

A twin technology approach is presented, whereby a novel power line monitoring device records both the current load and powerline phasing. This data is fed into an advanced computational model that calculates the instantaneous AC interference levels on the entire collocated pipeline. A case study demonstrates how a pipeline operator remotely monitors and takes control of the AC safety and corrosion risks on the pipeline, whilst identifying the responsible powerline and its operator. The return on this investment and improvements to the operator's safety are unsurpassed.

Key words: twin technology, AC corrosion risk, pipeline integrity monitoring

INTRODUCTION

AC mitigation systems are generally designed based on the results of field surveys, which represent only a snapshot of constantly changing power line conditions. Requesting the power line information from the operators is often challenging, potentially costly and time consuming process and the ensuing data may be limited to the average and/or design values leading to an over- or underestimated design of AC mitigation systems. As a result, unexpected increases in the power line loading may adversely affect the pipeline integrity without any notice, since test stations are only installed at discrete locations and are not always constantly monitored.

A case study is performed for a 27 miles long FBE-coated pipeline in Oklahoma (US) in collocation with seven (7) high-voltage AC (HVAC) power lines. Insulation joints were installed at beginning and end of the line where it respectively leaves and enters a station. A third insulation joint was installed approximately halfway along the pipeline length, resulting in a western and eastern section. The pipeline was commissioned in 2010 and has sacrificial anode cathodic protection (SACP) system consisting of three Mg anode beds. An AC mitigation system was installed in 2017 in order to reduce the AC induced voltages in the western section.

Traditional methods for collection of the power line current loading and phasing consisted of directly requesting this information from the electric utility companies. This process can take a great deal of time and often yields less than ideal information as the inputs to perform AC interference studies. However, in this case study, a new technology called LineVision PACT[†] was utilized to take remote measurements of the AC power flows and phase configurations. The sensors are self-powered remote monitoring units that are placed in the shared right-of-way and collect samples of the electromagnetic fields emitted by the AC lines. These fields are then processed, and the corresponding current loading level and phase arrangement are produced.

A recent in-line inspection (ILI) run indicated minor corrosion attack which was attributed to AC interference. In this study, a twin technology approach is used, whereby a non-contact novel power line monitoring device generates power line current load data as input for an advanced computational modeling technology for pipeline corrosion integrity monitoring.

FIELD DATA

The following field data was used as an input for the study:

- 1) Results of the annual AC and DC potential surveys at the test stations along the pipeline taken in the year 2017, 2018 and 2019 respectively;
- 2) Monitoring data (AC and DC voltages and currents) from twelve (12) Metricorr[†] ER-probes installed along the pipeline. The time span is between February and August 2019, with one measurement per hour;
- 3) Data from powerline load monitoring devices installed at specific locations of the power lines. The data includes electromagnetic field (EMF), electric field and derived phasing and current load of the circuits, measured every 15 minutes during the period from February to August 2019;
- 4) Soil resistivity measured by a 4-pin Wenner method at 10 locations along the pipeline. The soil resistivity at the pipeline level varies between 3.5 and 94 Ω -m with the logarithmic mean value of 13 Ω -m.

MODELING SAFETY AND CORROSION THREATS

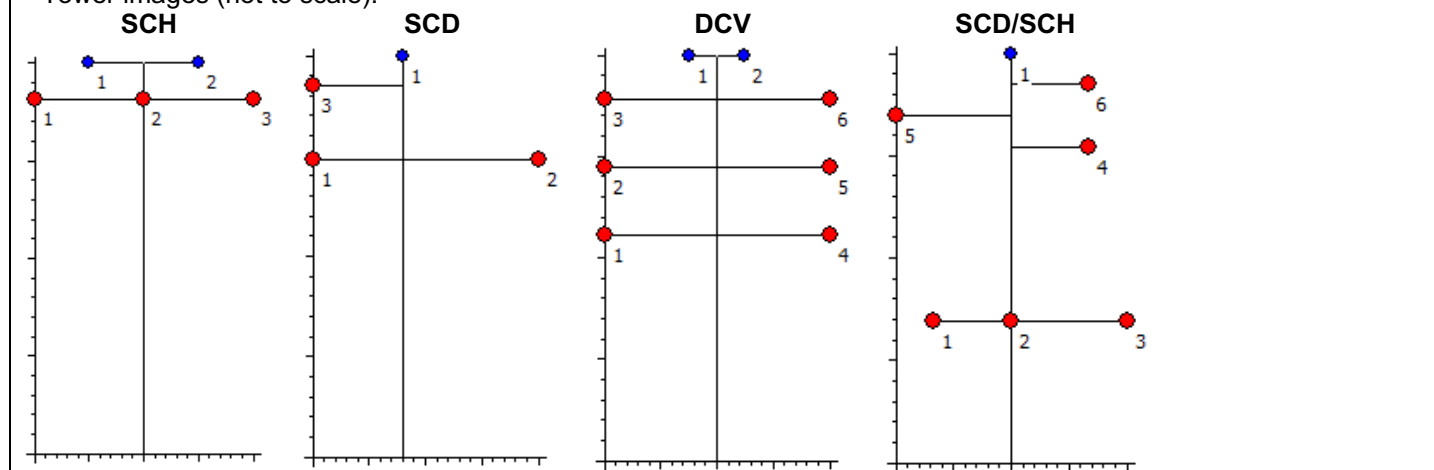
A computational model was built in Elsyca V-PIMS[†] software for the 27 miles long FBE-coated pipeline section. The pipeline routing is split into two sections by an insulation joint installed at MP 15.98. Two additional insulation joints are installed at the pipeline launcher (MP 0) and pipeline receiver (MP 27).

The pipeline is in collocation with seven (7) high-voltage power lines. Two of them (HV01 and HV07) have sections running parallel with the pipeline for a length of 2.14 and 0.99 mi respectively. Other high-voltage power lines cross the pipeline at angles between 45° and 90°. The power line routing, tower configuration and tower dimensions were derived from Google Earth Imagery and used to build the model. Minimum, maximum and average loading of each power line was extracted from the on-line powerline load monitoring data of the EMF devices is listed in Table 1.

Table 1 – Main characteristics of the power lines with SCH: single circuit horizontal, SCD: single circuit delta, DCV: double circuit vertical

Power line ID	Voltage rating [kV]	Tower type*	Type of collocation	Current load [A]		
				Minimum	Average	Maximum
HV01	345	SCH	parallel for 2 mi	25	231	621
HV02	138	SCH	crossing at 60°	13	86	337
HV03	138	SCH	crossing at 90°	20	171	471
HV04	69	SCD	crossing at 90°	5	45	544
HV05	345	DCV	crossing at 45°	90	652	1411
HV06	345	SCH	crossing at 45°	20	195	739
HV07	69/distribution	SCD/SCH	parallel for 1 mi	34	292	608

* Tower images (not to scale):



The section west from the insulation joint at MP 15.98 has an existing AC mitigation system installed between MP 7 and MP 10, which consists of five (5) single or double horizontal groundings connected to the pipeline via solid state decouplers. The power line HV01 and HV07 runs parallel to the pipeline while the others are mainly crossing. The section east from the insulation joint is protected by two (2) sacrificial Mg anode beds at MP 15.98 and MP 26.38 draining off a part of the AC current as well. It was assumed that a CP system was installed in the western section at MP 9.75 but no details of the system were provided.

Figure 1 shows the Google Earth imagery of the pipeline and power line routings and the locations of the ER-probes and EMF devices. Details on the two sections paralleling power line HV01 (east) and HV07 (west) respectively are shown as well. One or more ER-probes are installed within the parallelism.

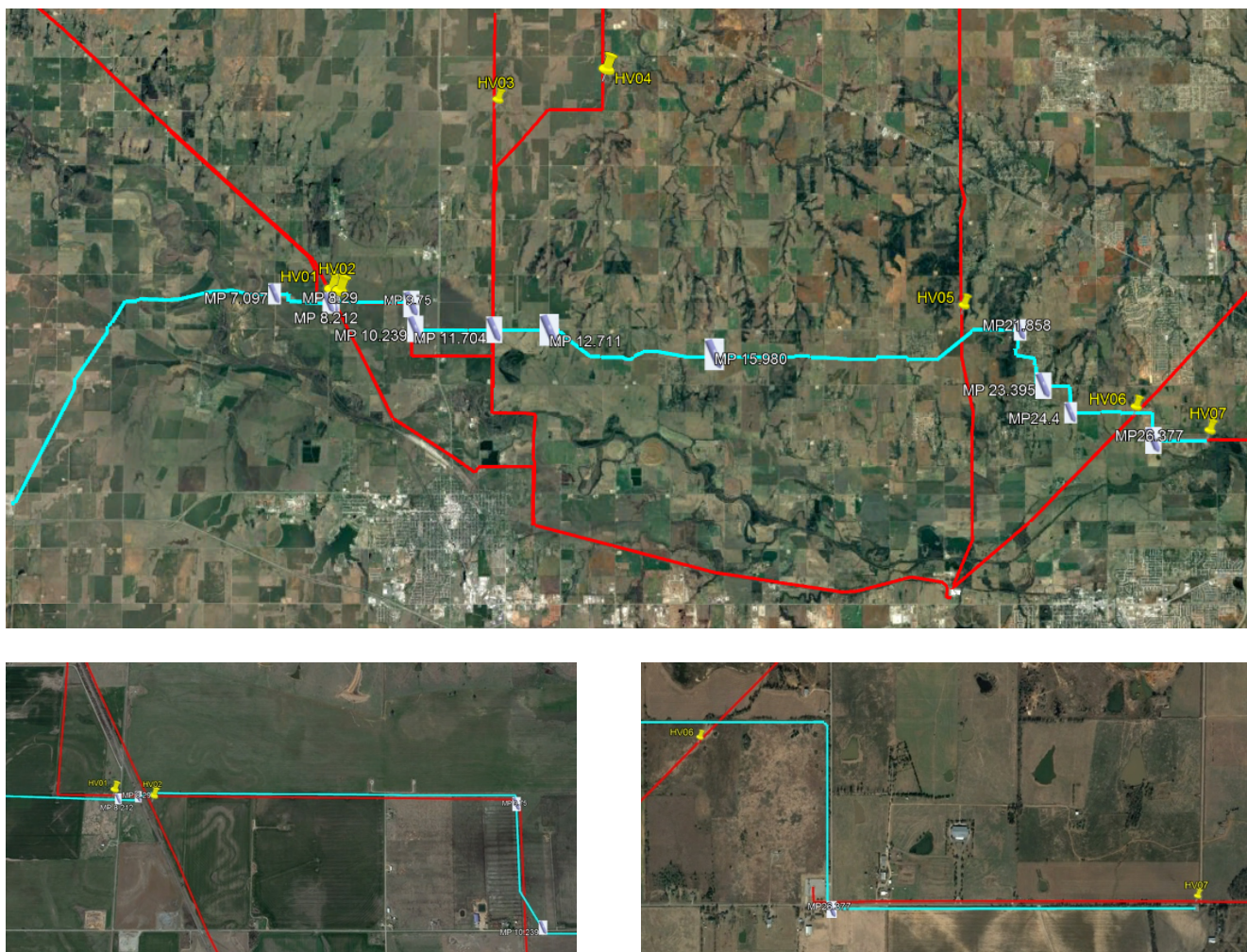


Figure 1: Pipeline and power line routing with locations of ER probes and EMF devices

The corresponding computational model is shown in Figure 2. The model allows for the computing both the CP and AC conditions on the pipeline.



Figure 2: Pipeline and power line routing with locations of ER probes and EMF devices