**A Novel Data-driven Auto Compensation Algorithm for Pulsed Eddy Current Inspection of High Voltage Feeder Cable Pipe**

**Xuhui Huang1, Petter Wehlin2, Vijay Srinivasan3, Josephine Aromando3, and Yiming Deng****1,\***

1Department of Electrical and Computer Engineering, Michigan State University

428 S. Shaw Lane, East Lansing, MI 48824

­­2ARIX Technologies, Houston, TX 77040

­­3Consolidated Edison of New York, Inc., New York, NY 10003

(517) 884-0926; \*dengyimi@egr.msu.edu

ABSTRACT

In this study, we introduce a novel auto compensation method designed to enhance the accuracy of Pulsed Eddy Current (PEC) measurements, crucial for Nondestructive Testing (NDT) in assessing the integrity of critical infrastructure such as electric transmission feeder pipes. Despite the established utility of PEC methods in detecting pipe corrosion through the analysis of characteristic decay time, challenges persist. These include inaccuracies stemming from the assumption of uniform magnetic permeability along the circumferential and longitudinal directions of the piping, which is disrupted by magnetic fields from internal current-carrying cables, leading to misleading PEC readings and false metal loss indications. To overcome this issue, we developed a new methodology to systematically counteract the effects of localized permeability variations. This is achieved through a series of steps that encompass initial data gathering, calibration for PEC signal decay time baselining, creation of simulated decay timetables using 3D Multiphysics simulations for PEC+Pipe+Cables models, and assembling permeability distribution tables to accurately account for the effects of non-uniform magnetic fields. This study includes further innovations such as a data-driven permeability adjustment scale, a compensated wall thickness model merging empirical data, 3D Finite Element Modeling (FEM), and neural network driven Deep Learning tool, Transformers. This comprehensive strategy enables specified analysis of how variations in relative permeability influence simulated decay times, with the Transformers model playing a critical role in decoding the nonlinear interrelations among variables, thereby enhancing the fidelity of our model and compensation algorithm adjustments. Validated against field data, our method has shown significant improvements in the precision of PEC pipe inspections in terms of wall thickness estimation. Through addressing the complexities introduced by internal magnetic fields and leveraging advanced analytical techniques for sensitivity analysis, this study not only improves the accuracy of PEC technologies but also sets a new benchmark for material integrity assessments, ultimately enhancing the safety and durability of vital industrial assets in demanding environments using advanced NDT.

**Keywords:** finite element modeling, pulsed eddy current, compensation algorithm, sensitivity analysis, electric transmission feeder pipes

Disclaimer: This paper is the result of independent consulting research work sponsored by Consolidated Edison Company of New York, Inc. ("Con Edison"). The authors wish to clarify that all research, findings, and conclusions herein were developed without the use of any facilities, resources, or support from Michigan State University.