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Mitigation of Spectrum Analyzer Emissions in a Portable E-Field Measurement System

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***Abstract*—Development of a portable system to measure broadband electromagnetic emissions in underground mines poses many challenges, the most significant being mitigating the contribution of spectrum analyzer electric field emissions to the composite electromagnetic environment of a survey area. This paper presents a novel method to mitigate a spectrum analyzer's electric field emissions.**

I. INTRODUCTION

To investigate potential electromagnetic (EM) compatibility issues of critical mine electronic devices and systems, researchers from the National Institute for Occupational Safety and Health (NIOSH) are conducting surveys of EM emissions in underground coal mines [1]. Development of a system to measure EM electric field emissions (E-field emissions) in underground mines posed many challenges and constraints, the most significant being the mitigation of the contribution of the spectrum analyzer's E-field emissions to the composite EM environment of a survey area.

The typical method to limit instrument E-field emissions—a portable radio frequency (RF) shielded test enclosure—was not a practical solution for mine use due to size and weight constraints for transporting in a mine [2]. A more compact and lighter form of a Faraday cage was needed.

II. METHODOLOGY

A modified aluminum toolbox advertised by Quantum Harvest, LLC as a Faraday cage to protect against an electromagnetic pulse (EMP) was evaluated as an RF shielded test enclosure. To provide an EM seal, the Faraday cage (toolbox) used a knitted wire mesh gasket on the lip that sealed against copper foil tape on the lid. NIOSH researchers further modified the toolbox to include Type N and BNC bulkhead connectors. The spectrum analyzer was sealed in the toolbox during measurements using the type N bulkhead to connect to an external antenna and the BNC bulkhead to connect to an external triggering device. Figure 1 shows an R&S® FPL1007 battery-powered spectrum analyzer placed in the toolbox.

Evaluation of the shielding effectiveness of the toolbox was conducted in an ETS-Lindgren Series 81 RF shielded enclosure by sequentially switching bands among one active monopole and three biconical antennas which together covered the frequency range of 10 kHz to 6 GHz. The spectrum analyzer was connected to an antenna using a 6-m length of LMR400UF coaxial cable.

A baseline set of measurements were first made with the spectrum analyzer's screen facing the antennas which were placed 1 m away and set to a height of 1 m with vertical polarization. The spectrum analyzer was triggered to perform a preset number of sweeps for each antenna band using the external device to trigger a measurement.

A second set of measurements was then made under the same conditions with the spectrum analyzer sealed in the toolbox.

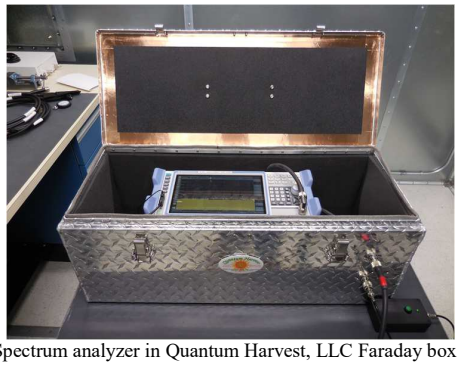

Fig. 1. Spectrum analyzer in Quantum Harvest, LLC Faraday box

III. RESULTS AND CONCLUSIONS

As shown Fig. 2, the toolbox provided excellent E-field emissions shielding across the full measurement span closely matching the ambient environment of the ETS-Lindgren RF shielded enclosure, with a >60 dB reduction at 200 kHz.

These results demonstrate that a compact and lightweight RF shielded test enclosure can be improvised to mitigate a spectrum analyzer's E-field emissions as part of a portable E-field measurement system.

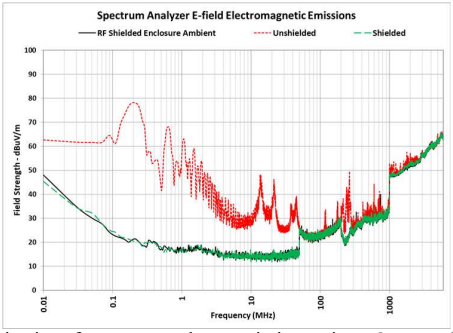

Fig. 2. Mitigation of spectrum analyzer emissions using a Quantum Harvest, LLC EMP Faraday box as an RF shielded test enclosure

IV. DISCLAIMER

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC). Mention of any company name or product does not constitute endorsement by NIOSH.

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