Real-time Substation Shielding Compromise and HPEM Event detection

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Abstract—CenterPoint Energy completed an effective, cost-efficient solution for High-Power Electromagnetic (EM) mitigation [1] to be used in electric substations. The EM module design exceeds the shielding effectiveness test levels of MIL-188-125-1. Following the development of the EM mitigation module, efforts focused on real-time shielding compromise and event detection for EM threats. For threats, the HEMP/IEMI detector uses magnitude and frequency to determine the need and appropriate level of alert. Additionally, shielding compromise is evaluated using a differential measurement from an on-board tone generator. The detector allows for real-time detection and alerts, reduces the need for technician field visits by regularly testing for shielding compromise, as well as provides forensic data for post-event analysis.

I. INTRODUCTION

Based on a system-wide deployment strategy and an annual shielding effectiveness test per location, costs of an on-site IEEE std 299.1 testing program was determined cost and logistically prohibitive. The use of a once annual testing program may also leave extended time periods of ineffective shielding, diminishing EMP resiliency. Alternatively, EMP response and resiliency would be greatly improved by the situational awareness gained from event detection. For localized IEMI events, security and operational personnel can use alerts to initiate response plans for specific substations. In the event of wide-area HEMP effects, the detection would signal control room staff to initiate an appropriately scaled response. In order to meet all operational requirements, the device had to be capable of detecting external EM threats and compromised shielding, transmitting real-time alerts as well as capturing EMC waveform data. The development of a multi-function detection and alert solution was achieved in 2019 and has been successfully deployed in field applications.

II. DESIGN BASIS

QinetiQ Ltd. Were engaged by CenterPoint Energy to adapt their Totem® detector [2] to the dual purposes of HPEM event detection and the additional feature of Shielding compromise detection. The event detection aspect was already fully operational but the shielding compromise part created new design challenges. Given cyber, security and spectrum licensing considerations, the team opted to consider a conducted shielding compromise test method over a radiated test method. A prototype was built and demonstrated and found to be capable of detecting uncontrolled apertures (door ajar) and cable penetration shield violations.

III. OPERATIONAL DEPLOYMENT

Prior to substation deployment, testing was completed on a mock enclosure to ensure the differential method would meet all operational requirements. It was critical the tone generator did not disrupt substation protection and control equipment while testing was in progress. Testing proved the low-order signals used for testing were safe for both equipment inside and outside the EMP mitigation module with no anomalous events detected.

Figure 1. EM Module with Detector Installed

REFERENCES

[1] E. Easton, K. Bryant and W. Radasky, "Design Approach for HPEM Mitigation for Electrical Substations," in press for APEMC 2020, Sydney Australia, May 2020.

[2] R. Hoad and D. Herke, 'Electromagnetic Interference Indicator and Related Method', Patent Application, International Publication Number: WO 2017/125465 A1, International Publication Date: 27th July 2017