Practical Application of EM Mitigation for Critical Infrastructures

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***Abstract*—**CenterPoint Energy embarked on an initiative to identify an effective, cost efficient solution for High-Power Electromagnetic (EM) mitigation for new and retrofit installations. The focus of mitigation efforts was substation assets used for the protection and control of the power delivery network. The design basis required the identified electromagnetic protection not compromise the reliability of existing substation functions, result in minimal increases to maintenance costs, and avoid significant changes in normal operating procedures. The development of a solution was achieved in 2018 and is rapidly progressing to the field pilot phase. The practical application of EM mitigation design practices in an unobtrusive method will speed the time for implementation, lower initial installation costs, and minimize ongoing maintenance. Each of the aforementioned achievements are realized while meeting the shielding effectiveness requirements of MIL-188-125.

I. INTRODUCTION

CenterPoint started investigating mitigation of EM on their system in 2010. A typical utility approach for EM substation mitigation is building a new 6 sided metallic control house with power filters and shielded cables. However, most existing substation facilities have little real estate to build a separate control house and existing cables do not use high-frequency shielding.

While investigating digital substation designs on a separate project, the feasibility of compressing the critical protection and controls into a single cabinet was recognized. By combining EM mitigation practices and digital substation design, efforts to pursue an EM module prototype that could not only work at new substations but also could be used as a retrofit for existing substations materialized.

II. DESIGN BASIS

The EM module design basis would have to protect against the two main threats: radiated and coupled energy. To solve the radiated threat, the use of a six sided enclosure that would be small enough to fit inside an existing control house was designed. For the coupled threat, the use of non-metallic communication controls to external devices is proposed. Only shielded copper cables are used to power external equipment via a HEMP filter. The designs must be cost effective and not interfere with day to day operations.

III. NEW TECHNOLOGY

The EM module will be installed as a backup protection and control system as well as online monitoring while the legacy protection and controls are still in service. If an EM event occurs, the mitigation system could be used in response. By having the system as a redundant parallel backup, the field technicians would not have to interface daily with the EM enclosure, which would help maintenance cost and ensure the integrity of the module. The field technicians also would not need to instantly change their skill sets learning the grounding, bonding and digital protection that would be required on a complete EM control house. Lastly, the EM module has enhanced data gathering and reporting capabilities for control center information which exceeds legacy systems.

From a financial perspective, the proposed solution is cost effective when compared to building a new EM control house. Based on initial estimates, a new EM control house will cost over one million dollars. The EM module enclosure would be less than 10% of a new EM control house.

In conclusion, utilizing a module based approach would be a cost effective retrofit solution to harden substations for EM events. By being a redundant system, the module also provides a backup for non-EM emergencies such as control house fire or flooding and it does not intrude on present protection and control systems.

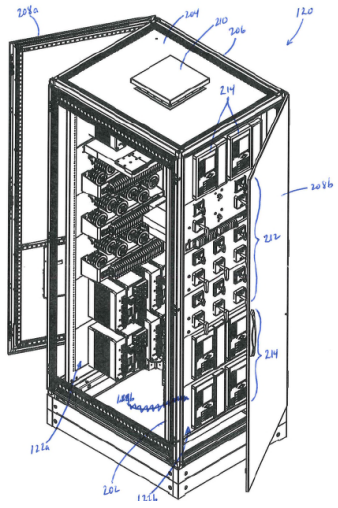

Figure 1. Example of EM Module