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Join the Grounding & Lightning Interest Group (GLIG) for a Webinar:

Surge Arrester Mitigation of Grid Geomagnetic Disturbances

Presentation by: Dr. Alberto Ramirez Orquin, Resilient Grids

Geomagnetic Disturbances, whether originated from solar flares or purposely man-made, known as Electromagnetic Pulse (EMP), poses a potentially serious threat to the ever more critical electric power infrastructure; that has been asserted by the EMP Commission of the United States Congress and other concerned institutions for several years now. While the solar phenomenon has been dealt with in the industrialized world for many decades with a relative success, mostly constrained to operational procedures, it is EMP the one that has now come to the forefront of interest for the significant reason of societal security. Indeed the power grid, and in particular its major transformers, exhibit non-resolved inherent vulnerabilities to this kind of shock waves. Yet, such an exposure is not limited to these apparatus, but extends to other essential hardware of the electric network, such as control centers, substation hardware, distribution lines and transformers, etc.

It is well known that mitigation devices, for quite some time now, have exhibited risk and cost-effectiveness challenges which have undoubtedly wavered or delayed their prospect for real industrial consideration/application. Consequently it seems imperative to focus on the most relevant issues causing this shortcoming; in that sense a basic comparison of GIC blocking concepts is discussed, looking at key elements affecting their performance.

On the other hand, notorious fact about the arrester device can be revealed and demonstrated by a comprehensive magnetic/electric circuit analysis, as related to typical grid autotransformers. This paper presents apparatus grounding-coefficient invariance after device deployment; accordingly, it is proven the zero-sequence circulation through the unit as fundamentally sustained. It ought to be recalled that such grounding coefficients relate to the flow of sequence currents through grid components, as IEEE defined, by the high-to-low transfer sequence-reactance ratios; those being independent of the actual zero-sequence flow mechanism i.e. ampere-turn equilibrium with/without neutral circulation, conduction, a combination of both, etc. These findings enable a plausible benchmarking of these functionalities for blocking concepts.

Nonetheless, an additional question for most devices is the one associated to both the GIC detection and switching. As well known, these currents being of a quasi-DC nature pose, for severe EMP shocks, a major current-interruption challenge, as required following their detection. Indeed, while present low-voltage DC-breaker technology could be considered mature, stemming from the needs of solar-panel switching, that is not the case for the medium-voltage class at all. Finally, this paper introduces an innovative approach to effectively deal with this important predicament.

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Dr. Alberto Ramirez Orquin

Dr. Ramirez Orquin has an electric utility experience spanning over four decades, starting as a Niagara Mohawk Utility trainee, followed by five years as an application and research engineer at the General Electric Company/AC Transmission Engineering Operation in Schenectady, NY, where he was also certified on Surge Arrester Technology. Moreover he practiced for several years in Canada, Brazil, Bolivia and Argentina where he notably served as Senior Advisor to the Secretary of Energy to conduct its National Grid Planning. As an IEEE Senior Member, he was distinguished at the institution's Centennial Meeting by the plenary T&D Committee for his leadership in the emblematical 500 KV Transmission Project. Furthermore, he had a key role as a co-author and general reviewer of the first edition of the EPRI/Edison Electric Institute's EHV Transmission Line Reference Book 345 KV And Above which has since become a world standard reference; likewise contributing to the books Operation and Control of Electric Energy Processing Systems (Wiley/IEEE 2010) as well as to the one sponsored by the Task Force on National and Homeland Security entitled Apocalypse Unknown: the Struggle to Protect America from an Electromagnetic Pulse Catastrophe. Additionally, he has extensively published Transactions and Journal Papers and holds several U.S. Patents on mitigation technology for grid security. In 2007, the U.S. Department of Homeland Security certified Dr. Ramirez Orquin as an Outstanding Researcher. Currently, he serves as a Member of NERC's Geomagnetic Disturbance Task Force serving in its Mitigation-Device Team, as well as a holding membership at Maine's PUC GMD-EMP Risk Working Group and the Florida State Congress EMP Working Group. Dr. Orquin holds a ME from the Rensselaer Polytechnic Institute (RPI), a Ph.D. from the University of Texas (UTA) and currently teaches at the University of Puerto Rico at Mayaguez.

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