CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG [1]N° C4.55	**Name of Convenor: Akihiro AMETANI (Japan)** **Secretary: Jeewantha De Silva (Canada)**
Technical Issues #[2]: 8, 6	**Strategic Directions #[3]: 1, 2**
The WG applies to distribution networks[4]: No	
Potential Benefit of WG work #[5]: 3, 4, 5	
Title of the Group: EMC related very-fast transients in gas-insulated substations—EMC interferences, measured characteristics, modelling and simulations	

Scope, deliverables and proposed time schedule of the WG:

Background:

Electromagnetic interferences (EMIs) due to very fast transients (VFTs) in control circuits of gas-insulated substations (GISs) become a significant issue, resulting occasionally in power system operation problems of which measured results and experiences are reported in various publications including the CIGRE Technical Brochure (TB-535, 2013). The EMIs are caused by the very high frequency components from some MHz up to 100 MHz of the VFTs occurring in the main circuits (high-voltage side) including the outer conductors (pipe or tank) of GISs. A number of measured and electromagnetic transients programme (EMTP) simulation results of the VFTs in the main circuits were obtained. Measured results of the frequency components in the control circuits and associated EMIs are reported as well. However, only few simulation results of VFT related transient responses in the control circuits can be found in the literature. Further, it should be pointed out that most of the EMTP simulation results of the VFTs are based on the constant-parameter line model, which is clearly not appropriate at the considered frequencies.

Furthermore, VFTs cannot be rigorously handled in EMTP because their frequency content exceeds the applicable limit of the impedance and admittance formulas of overhead lines and underground cables implemented in the EMTP, which are indeed derived under the assumption of Transverse Electromagnetic (TEM) propagation mode when the frequencies are below some MHz. In case of the VFTs, higher order Transverse Magnetic (TM) mode along the GIS outer conductor should also be considered, although the wave propagation along the core is the TEM mode (coaxial mode) as is well-known.

For clarity, the GIS is an overhead cable composed of the inner conductor (core) and outer conductor (called pipe or tank). A VFT surge is initiated by a disconnector or circuit breaker operation inside the GIS, and the surge propagates along the core as a coaxial (TEM) mode. When the TEM mode wave arrives at a GIS boundary (receiving and sending ends and pipe grounding), the wave is reflected and refracted due to the boundary condition, and a part of the wave appears on the pipe surface. This wave propagates along the pipe as a surface wave mode which is a TM mode at a high frequency. Thus, the VFT surge is composed of the TEM (coaxial) mode and TM (surface wave) mode. This phenomenon cannot be observed on an overhead line and on an underground cable. Only the surface wave is observed on the overhead line at a high frequency as is well-known.

Scope:

The scope and expected outcome of the proposed working group is summarized as follows:

1. Survey the following items (one year):
   a) Field experiences of EMIs in GIS control circuits due to VFTs in the GIS main circuits and resulting disturbances of power system operation.
   b) Measured results of VFTs.
   c) Measured results of frequency components in transient responses due to the VFTs in the control circuits.
   d) EMTP modelling methods of VFT simulations.

2. Investigate the surveyed results (one year):
   a) Summarise the experienced EMIs and encountered system related issues
   b) Summarise the measured results of VFTs
   c) Investigate the measured frequency components of the transient responses in the GIS control circuits
   d) Investigate the EMTP modelling methods for VFT simulations in GISs and transient responses in the control circuits and compare with measured results.

3. Propose revised EMTP modelling methods and testing frequency in the IEC EMC related standards (one year):
   a) Based on the investigations in 2-(b) and 2-(d), clarify the applicability of existing EMTP models and along with their limitations, and propose a possible approach to deal with the VFTs in GISs and transients in GIS control circuits.
   b) Based on the summary of the field experiences and measured results in 2-(a) and 2-(c), propose revision of the existing IEC EMC related standards, especially the testing frequency.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra

☐ Electra Report

☒ Tutorial[6]

☒ Webinar[6]

Time Schedule: start: April 2019 **Final Report**: March 2022

Approval by Technical Council Chairman:

Date: January 21st, 2019

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3] See attached Table 2, [4] Delete as appropriate, [5] See attached Table 3,
[6] Presentation of the work done by the WG

Table 1: Technical Issues for creation of a new WG

1	Active Distribution Networks resulting in bidirectional power and data flows within distribution levels up to higher voltage networks
2	Digitalization of the Electric Power Units (EPU): Real-time data acquisition includes advanced metering, processing large data sets (Big Data), emerging technologies such as Internet of Things (IoT), 3D, virtual and augmented reality, secure and efficient telecommunication network
3	The growth of direct current (DC) and power electronics (PE) at all voltage levels and its impact on power quality, system control, system operation, system security, and standardisation
4	The need for the development and significant installation of energy storage systems, and electric transportation, considering the impact they can have on the power system development, operation and performance
5	New concepts for system operation, control and planning to take account of active customer interactions, and different generation types, and new technology solutions for active and reactive power flow control
6	New concepts for protection to respond to the developing grid and different generation characteristics
7	New concepts in all aspects of power systems to take into account increasing environmental constraints and to address relevant sustainable development goals.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics
9	Increase of right of way capacity through the use of overhead, underground and submarine infrastructure, and its consequence on the technical performance and reliability of the network
10	An increasing need for keeping Stakeholders and Regulators aware of the technical and commercial consequences and keeping them engaged during the development of their future network

Table 2: Strategic directions of the Technical Council

1	The electrical power system of the future: respond to speed of changes in the industry
2	Making the best use of the existing systems
3	Focus on the environment and sustainability
4	Preparation of material readable for non-technical audience

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.
7	Work addressing environmental requirements and sustainable development goals.