CIGRE Study Committee C4/B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP[1]

JWG N° C4/B4.52	**Name of Convenor:** Chandana Karawita (Canada) **E-mail address**: ckarawita@tgs.biz	
Strategic Directions #[2]: 1 and 2		**Technical Issues #[3]: 3 and 8**
The WG applies to distribution networks[4]: Yes		
Potential Benefit of WG work #[6]: 1, 2 and 3		
Title of the Group: Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems		

Scope, deliverables and proposed time schedule of the Group:

Background:

Sub-synchronous Resonance (SSR) and Sub-synchronous Torsional Interaction (SSTI) effects have been known to power system engineers since 1970s. A great deal of enthusiasm on understanding the issue was triggered by two events in Arizona State that resulted in breaking the shafts of turbo-generators. These phenomena are well documented in literature. The industry adopted several tools to study the risk of SSR and SSTI. The most common tools are the frequency scanning, unit interaction factor (UIF) calculations, small signal stability, and electromagnetic transient simulation. Due to the limited computing power available at that time compared to today, some simplifying approximations have been necessary.

A resurgence of concern over Sub-Synchronous Oscillation (SSO) phenomena has happened in the recent times due to the increasing trend of the presence of heavily compensated transmission systems, power electronic converters associated with HVDCs, FATCS devices and wind and solar power plants. Especially, the sub-synchronous frequency controller interactions introduced by these devices create a need for more comprehensive studies to identify the sub-synchronous oscillation risk. When multiple devices with sub-synchronous oscillation vulnerabilities are present in a tightly coupled system, the identification process becomes even harder. The traditional practices of studying SSR and SSTI were not developed for the current technologies and trends, resulting in the situation that there are no commonly accepted methods of analysis available to meet the new challenges. Furthermore, it is necessary to consider different approaches at the design levels and during the operations based on the available information. It is therefore necessary and timely to develop procedures to analyse and design countermeasures for sub-synchronous oscillations in power systems.

Scope:

1. Review of sub-synchronous oscillation/interaction phenomenon related to modern power systems:
   For conventional power systems, the issue of sub-synchronous oscillations is well understood. The conditions under which it manifests, methods of assessing the risk, and how to mitigate them are well documented in literature. There are some gaps in these study methods and procedures when it comes to heavily series compensated systems (including the situations where line tripping results in the effective level of compensation to go up). Power electronic converter based renewable energy integration also expands the field of sub-synchronous oscillations. A comprehensive review will be conducted and reported in a technical brochure. Reclassification of SSO phenomena with their complete definitions will be covered.
2. Review recent industry experiences of sub-synchronous oscillation/interaction

WG form 2017-V5

phenomenon, and remedial actions taken:
Power industry has witnessed sub-synchronous oscillations in wind energy integrated power systems and long series compensated systems. Some of the observations have been contrary to the conventional wisdom. Weakening the AC systems has created controller instabilities in some HVDCs and FATCS devices. A survey of these experiences will be done and reported along with an analysis to understand the conditions that created these situations.

3. Review of study procedures adapted by the industry and their applicability for modern power electronic dominated power systems:
   Some of the study procedures used in the industry need revisions to accommodate the evolving power system. In addition to this new tools and procedures may be required. The applicability of new tools and methods proposed in literature will be reviewed under this task.
4. Recommend a standard procedure for assessing the risk of sub-synchronous oscillations:
   The study procedures that can be adapted at various stages of a project (development stage and operational stage) will be proposed considering the available data and the model for the studies. The following steps will be considered.
   a. Screening Studies: simple and fast assessment techniques considering large number of operating conditions and contingencies (avoid false dismissals while allowing false alarms)
   b. Detailed Studies: In-depth analysis of sub-synchronous phenomenon for the cases screened out in step (a) above.
5. Mitigation measures and methods for developing them:
   Evaluation of available mitigation measures and their advantages and disadvantages and methods of implementing the solutions will be discussed.

Liaison from SC A1 will be requested.

Deliverables:

☒ Technical Brochure and Executive summary in Electra

☒ Electra report

☒ Tutorial[5]

Time Schedule: start: January 2019 **Final Report**: January 2021

Approval by Technical Committee Chairman:

Date: November 14th, 2018

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

Table 1: Technical Issues of the TC project "Network of the Future" (cf. Electra 256 June 2011)

1	Active Distribution Networks resulting in bidirectional flows
2	The application of advanced metering and resulting massive need for exchange of information.
3	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
4	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
5	New concepts for system operation and control to take account of active customer interactions and different generation types.
6	New concepts for protection to respond to the developing grid and different characteristics of generation.
7	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
9	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
10	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

Table 2: Strategic directions of the TC (ref. Electra 249 April 2010)

1	The electrical power system of the future
2	Making the best use of the existing system
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 or economic benefit 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 direction
5	Guide or survey related to existing techniques. Or an update on past work or previous Technical Brochures
6	Work likely to have a safety or environmental benefit