CIGRE Study Committee A1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG N° A1.63	**Name of Convenor:** Juergen R. Weidner (GERMANY) **E-mail address**: Juergen.R.Weidner@siemens.com	
Strategic Directions #[2]: 2		**Technical Issues #[3]: 2**
The WG applies to distribution networks[4]: No		
Potential Benefit of WG work #[6]: 1		
Title of the Group: Turbo Generator Stator Winding Bushings and Lead Connections – Field Experience, Failures and Design Improvements		

Background:

The terminal bushings of stator windings of large turbine generators have to conduct high winding current of several thousand Ampere through the generator housing and in addition have to seal the inner cooling gas atmosphere to avoid hydrogen gas leakage. These neutral and phase side bushings of the winding are connected to the circuit rings inside the generator and to phase bus ducts outside the generator housing. They are a vital part of each turbine generator with extremely high energy concentration which is assumed to operate for many years without any maintenance.

A defect at a main bushing of a large hydrogen cooled generator with gas pressure up to 6 bar could result in a severe hydrogen explosion if not detected in time. Broken current connections inside or outside the generator housing such as flexible links could generate high energy arcing with conductive copper plasma resulting in a 2- or 3-phase short circuit and serious stator and rotor damage.

There are different types of bushing designs on the market which experienced failures due to various reasons. The influence of increased flexible operating conditions, longer maintenance intervals due to risk based maintenance strategies, production cost reductions and cost driven design changes seem to increase the frequency of bushing failures.

Scope:

This project work will be focused on the following topics:

(1) Form a WG team consisting of generator users, manufacturers and service providers

(2) Prepare a Questionnaire focused on operational field experience with HV bushings and connections of different designs – description of significant weak points, accelerated aging, test procedures and experienced defects

(3) Influence of volatile peak load operation on bushing and connection performance; indications of accelerated wear and aging

(4) Description of design features of different types of air-cooled, hydrogen-cooled and direct water-cooled bushings

(5) Pros and cons of different bushing designs for rated generator voltages between 10,5 kV and 27 kV

(6) Different designs of flexible links between bushings, stator windings and phase bus

(7) Experience with long term behavior of different types of flexible links

(8) Preparation of a Technical Brochure which includes in addition to the above topics also

some recommendations for save and reliable long term operation of bushings

Deliverables:

☒ Technical Brochure and Executive summary in Electra

☐ Electra report

☐ Tutorial[5]

Time Schedule: start April 2018 **Final Report**: November 2020

- TOR approval → April 2018
- Preparation of draft questionnaire → July 2018
- Comments by members and experts → Aug 2018
- Final questionnaire for distribution → Sept 2018
- Survey report of answers → Jan 2019
- Draft Technical Brochure (TB) → May 2019
- Comments by members and experts → July 2019
- Final discussion of TB → Cigre meeting Sept 2019
- TB Reviews and Approval → January 2020
- Release of final TB and Electra summary → July 2020
- Electra publication → November 2020

Approval by Technical Council Chairman: M. Waldron

Date: 20/04/2018

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