CIGRE Study Committee B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG B4.90	**Name of Convenor:** Les Brand (Australia)
Strategic Directions #[2]: 1, 2, 4	**Sustainable Development Goal #[3]:** 9
The WG applies to distribution networks: ☐ **Yes** / ☒ **No**	
Potential Benefit of WG work #[4] : 1, 2, 5, 6	
Title of the Group: Operation and Maintenance of HVDC and FACTS Facilities	

Scope, deliverables and proposed time schedule of the WG:

Background:

High Voltage Direct Current (HVDC) technology has been around since the mid-1950s. Up until the late 1990s, HVDC transmission was provided through the use of Line Commutated Converters (LCC) utilising initially mercury arc-valves and then moving on in the 1970s to the use of thyristors During this period, and beyond, a significant amount of operational experience has been gained in the operation and maintenance (O&M) of these facilities, but there is very little detailed information available in the public domain documenting this experience. Some information is available in various places, including TB 649 "Guidelines for life extension of existing HVDC systems" – which includes a fair amount of useful information on maintenance practices for HVDC equipment.

Similarly, there exists decades of experience on the O&M of other Flexible AC Transmission System (FACTS) devices, such as Static Var Compensators (SVCs) and Static Synchronous Compensators (STATCOMs), that share very similar primary, secondary and auxiliary systems as HVDC and often require the same strategies and methods applied as HVDC facilities.

Voltage Source Converter (VSC) technology has been used since the late 1990s and has gained traction and popularity particularly over the past decade, a large part because of the various applications for which VSC technology is ideally suited. While there is only about two decades of O&M experience with this technology, many items of equipment and plant are similar to LCC from an O&M viewpoint. There are exceptions though, including the inclusion of the IGBT units and submodules, which is topology dependent and continuing to evolve – and larger and a greater focus on auxiliary systems, particularly valve cooling systems.

While applicable to both VSC and LCC HVDC systems and FACTS, control and protection systems have also developed over time, and there are now also a few decades of operational experiences with the microprocessor-based systems.

Another trend in the development and implementation of HVDC and FACTS systems, particularly over recent years, is that these systems are more and more being developed, installed, operated and maintained by smaller companies, private developers and often single-entities that do not already have established O&M networks, staff and facilities. This is very different to the early days of HVDC development where the HVDC projects were built, owned and operated by the established transmission utilities. For the FACTS devices, these are being increasingly installed along with renewable energy generating systems, and therefore built, operated and maintained by generation companies and developers. For these smaller, non-utility or unestablished companies, the process of establishing the O&M philosophy, what skills are required, what activities should be insourced vs outsourced and the timing of how these are developed and established (i.e. a roadmap) are unknowns.

IEC TR 63065 covers the O&M of LCC HVDC systems at a fairly high level. As with every standard, the document provides information related to O&M that is consistent enough to be considered “standard”. IEC TR 62978 provides guidelines for the asset management of HVDC installations. Detailed O&M plans shall be based on the risk profile adapted in the Asset Management strategy,

However what is lacking in the public domain is detailed experiential information and practical requirements for the establishment and performance of the O&M functions and the presentation of options and alternatives and guidelines on how to establish a fully functioning O&M system for a HVDC system.

During the development of the CIGRE Green Book “Electricity Supply Systems of the Future”, Chapter 8 “DC and Power Electronics” included a section on “Operation and Maintenance of FACTS and HVDC Facilities”. The chapter is high level and covers many topics – but in the drafting of this chapter it was clear that there are many questions left unanswered within that chapter which would require a larger TB guideline document to adequately cover.

Given the lack of any detailed O&M guidelines in the public domain, and the expected increase in demand for this type of information, particularly from individuals and organisations with little to no experience in the O&M of such facilities, there is an identified need to create a working group that can collate and evaluate the 60+ years of operational experience, covering LCC and VSC technologies and all equipment types and develop easy to follow guidelines for the O&M of HVDC and FACTS facilities.

These guidelines should include a description of the essential O&M requirements for each type of equipment found within HVDC converters and FACTS facilities and provide good practice recommendations on how the O&M requirements can be met. In addition, the guideline should also provide information on the required skills and expertise, where and how these are typically acquired and suggest strategies for providing the required skills, expertise and support for new HVDC and FACTS projects and facilities and a roadmap on how this can be achieved in time for the HVDC or FACTS facility’s first operations.

Scope:

The Working Group will seek to develop a Technical Brochure which provides guidelines for the O&M of HVDC converter station and FACTS facilities. The guidelines will cover both LCC and VSC systems.

1. Review the work done by CIGRE, IEC and other relevant bodies related to the O&M of HVDC and FACTS systems (e.g. TB 649, the section in the CIGRE green books - Electricity Supply Systems of the Future and Green Book on FACTS, other relevant CIGRE working groups (e.g. B4.89), IEC standards with a view to identifying gaps in the existing standards and guidelines and, in the case of other CIGRE technical brochures, books and papers, to collate potential content.
2. Collate and combine the existing knowledge and prior experiences of WG members, across a number of countries and from different perspectives, along with the content of existing standards and guidelines to develop practical, detailed guidelines for the O&M of HVDC and FACTS facilities covering:
    a. Typical performance issues experienced, and methods for the inspection, monitoring and maintenance of the equipment to address these issues.

b. Current best practices and recommendations for the O&M of all primary, secondary and auxiliary systems, equipment and plant commonly found in HVDC converter stations and FACTS facilities.

c. Expected asset life cycle, refurbishment/replacement strategies, taking into account that AC equipment has a larger supply chain than DC equipment, which is much more customized for HVDC systems.

d. Tracking, recording and reporting on O&M issues.

e. Analysing the criticality of performance issues on the HVDC or FACTS availability

3. Provide guidance and recommendations on essential O&M requirements in the preparation, readiness and mobilisation for the O&M of new HVDC and FACTS facilities including:

   a. Operating philosophies.

   b. Control and monitoring location selection.

   c. Insourcing vs outsourcing.

   d. O&M team structure, roles and responsibilities.

   e. Integration into existing utilities and utilising common (AC) services and facilities.

   f. Training requirements.

   g. Spare part strategies and spare part consumption management policies.

   h. Required infrastructure, facilities and systems to support the O&M activity.

   i. A roadmap to O&M preparedness in parallel with project delivery.

4. O&M documentation requirements.

5. Case studies – the technical brochure will provide a number of case studies, documenting actual O&M strategies and philosophies applied for various HVDC and FACTS facilities, covering a wide range of applications including examples of utility owned and privately owned, LCC and VSC, national and international HVDC systems, SVCs and STATCOMs etc.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra
☒ Electra Report
☐ Future Connections
☐ CSE
☒ Tutorial
☒ Webinar

Time Schedule: start: December 2020 **Final Report**: October 2023

Approval by Technical Council Chairman:

Date: October 6th, 2020

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3] See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work. [4] See attached Table 3

Table 1: Strategic directions of the Technical Council

1	The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

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.