HVDC GIS cable connection assembly fully qualified for ±525 kV following dimensions of the HVAC standard interface

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ABSTRACT

Within a joint collaboration, a ±525 kV HVDC GIS cable connection assembly has now been fully qualified for the first time with a type test and a pre-qualification test according to CIGRE TB 852. The interface design of this gas-insulated cable connection assembly is based upon the dimensions used in the HVAC GIS standard IEC 62271-209. Using this standard will reduce risk during implementation due to the well-known scope split. The paper describes the cable connection assembly interface, the testing philosophies and the performed tests. All tests were performed successfully.

KEYWORDS

525 kV; Cable connection assembly; HVDC; HVDC cable; HVDC GIS; HVDC termination; qualification; XLPE

INTRODUCTION

With the increasing demand for higher transmission capacity and the integration of renewable energy, high-voltage direct current (HVDC) system voltage levels of up to U_0 = ±525 kV will be realized. HVDC gas-insulated switchgear (GIS) and HVDC cables for ±525 kV voltage level have been introduced to the market several years ago. Development and qualification of the required HVDC technology solutions need also to cover their combination and interfaces, e.g. the combination of cable systems and gas-insulated systems for the most space-saving HVDC installations.

“Compact gas-insulated metal-enclosed systems for high-voltage direct current applications (HVDC GIS) have been developed for HVDC projects in need of space-saving installations, such as offshore platforms, cable transition stations or multi-terminal switching stations.” [1] In 2018 the type tests of HVDC GIS up to rated DC voltages of ±550 kV according CIGRE TB 842 [2] and relevant parts of IEC 62271 series have been successfully passed [3].

With using HVDC GIS, the required space for HVDC switchyards can be reduced to a minimum compared to same-functional air-insulated switchgear (AIS). When using an HVDC GIS, the HVDC cable can be connected directly to the HVDC GIS using a gas-insulated HVDC cable termination. This solution required less allocated space in comparison to the alternative of an air-insulated outdoor cable termination and additional gas/air-bushing. Furthermore, the gas-insulated HVDC cable connection assembly, consisting of the HVDC GIS and the HVDC cable termination, also completely omits flammable insulating materials, resulting in a zero fire load. This allows the saving of a dedicated room for the DC switchyard and allows the integration of the DC switchyard into another technological room compared to the usage of possible oil-filled AIS outdoor cable-terminations.

Application examples of cable connection assemblies

The direct connection of an HVDC GIS with an HVDC cable is part of several HVDC solutions: converter stations, transition stations and switching stations.

The development of HVDC GIS in the past decade was mainly driven by the offshore grid connection systems. Gas-insulated switchgear design can reduce the volume of the HVDC switchyard to a twentieth resulting in a smaller offshore converter station decreased weight of the platform, lower resource consumption and lower CO_2 footprint. “Although, space constraints are less important for onshore than for offshore converter stations, DC GIS remain an attractive option for specific cases with strict space constraints, high risk of lightning strikes, or installations at high altitude.” [1]

Especially as a solution for long HVDC transmission lines, transition stations enable separation and safe earthing of each line section and can also include necessary measurement and analysis systems. Space-saving aspects usually correspond with the station's visual amenity. The actual achievable reduction may vary from station to station, depending on each particular project's boundary conditions and the whole station layout. Nevertheless, some examples, reported in [1], give an impression of the substantial space-saving possibilities of HVDC GIS applications: Only considering the primary equipment, footprint may be reduced by 90% for cable-cable transition stations.

Currently, many initiatives are developing concepts for multi-terminal offshore grids [4], [5]. These concepts include cable connected offshore HVDC switching stations and as such benefit from HVDC GIS implementation by reducing the required footprint.

CABLE CONNECTION ASSEMBLY AND ITS INTERFACES

The combination of cable systems and gas-insulated systems for HVAC application is standard in testing and operation since decades. The interface is described in IEC 62271-209 [6]. However, experience in development, testing and operation of such systems for HVDC application is limited. As reported in CIGRE TB 842 [2], there is a mismatch between the recommended test approaches for type testing and long-term testing of cable systems according to CIGRE TB 852 [7] and gas-insulated system according to CIGRE TB 842. The related technical challenges are currently assessed and evaluated in the