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Study Committee A3

Transmission and Distribution Equipment

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Sizing and testing of HVDC disconnectors from the dielectric point of view

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Motivation

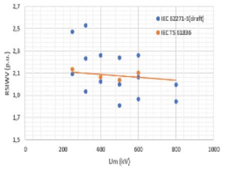
- Evolution of the HVDC network
- Maturity of air insulated HVDC disconnector
- Rationalization of Um
- Optimization approach for the air insulated disconnector

Basic Insulation Coordination

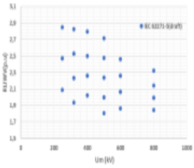
The "highest DC voltage" Um that is the highest value of d.c. voltage for which the equipment is designed to operate continuously.Um depends on the nominal voltage of the Scheme, normally dictated by the customer requirements. It is determined by steady-state studies considering the DC Power Flow, harmonics present due to the operation of the converter and voltage drops depending on the location of each disconnector. The peak of that superposition is considered as Um.

Objects of Analysis: Stresses

DC insulation coordination is presently under the responsibility of IEC TC 99. The last working document draft IEC 60071-11 defines the "nominal DC voltage" as the mean value of the DC voltage required to transmit nominal power at nominal current, Un the "highest DC voltage" as the highest value of d.c. voltage for which the equipment is designed to operate continuously, in respect of its insulation as well as other characteristics, Um



RSIWV values proposed in IEC 60071-11 IEC 62271-5 IEC 61936



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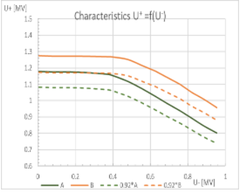

A: U50 withstand voltage ring-ring pedestals d=3m H=6m Hg=2.5m

B: U50 withstand voltage disconnector d=4m H=6,5 Hg=3m Uw=U10sw=0.92×U50sw

Data from the experiences

As a support to define the required insulation levels, analysis of the values of RSIWV, RLIWV adopted for various projects in the world has been made, the analysis concerned 23 line commutated converter LCC projects and 14 voltage source converter VSC projects, made by different companies in different times

	RSWV avg [min-max] [p.u.]	
	LCC	VSC
V < 500kV	2.32(2.11-2.58)	2.15(1.55-2.91)
500kV < =V <= 600kV	2.08(1.84-2.31)	1.90(1.73-2.04)
V > 600kV	2.04(1.95-2.15)	-
Total project n°	23	14

	RLIW avg [min-max] [p.u.]	
	LCC	VSC
V < 500kV	2.77(2.61-2.83)	2.55(1.75-3.6)
500kV < =V <= 600kV	2.52(2.04-2.83)	2.20(2.09-2.62)
V > 600kV	2.47(2.20-2.75)	
Total project n°	23	14

The above data data confirm a trend to use lower values for VSC than for LCC and decreasing values for higher Um values

The conclusion is that the approach in IEC 60071-11 gives a picture of all the solutions adopted in the world, without a critical and rationalizing approach. A more rational approach which could facilitate equipment standardization. would be to analyze the experience in more detail, considering the applicable values based on the most recent knowledge and design evolution and the needs for the different project types (e.g., LCC or VSC), with the aim to reduce the number of insulation levels

Discussion & conclusion

- the required phase to ground and longitudinal insulation clearances are derived for system voltage up to the UHV
- **Sizing of phase to ground insulation** is determined by the **SI** performance for disconnectors **for indoor application**
- **For outdoor applications the sizing is determined** in most of the cases **by the need** to comply **with the pollution performance.**
- The **size of the open disconnector gap is determined** by the **SI performance in the EHV UHV range**
- **LI tests are not necessary to verify the adequacy of the open gap size.**
- Considering the complexity of combined Impulse-DC tests (Bias tests), the Disconnector applications for which a DC voltage should be foreseen **are to be clarified and delimited, limiting the need to generalize complex and costly combined impulse-DC tests (bias tests)**.

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