Future Standardisation of DC Voltages

UK Joint B3 Liaison meeting with A3

cigre
For power system expertise

Future standardisation of DC voltage levels

Drivers

- OEMs need to standardize on voltages to facilitate DC grids
- Optimisation and economy of production and product assessment and testing
- HVDC a massively expanding sector requiring some element of design and safety coordination
- Engineering resource constraints – need acceptable design margins

Recent Technical Brochures & Standards

- IEC TS 63471:2023 - DC voltages for HVDC grids.
- TB 684 - Recommended Voltages for HVDC Grids (April 2017)
- TB 842 - Dielectric testing of gas insulated HVDC systems (Sept 2021)
- TB 852 - Recommendations for testing DC extruded cable systems for power transmission at a rated voltage up to and including 800 kV. (published Nov 2021)
- IEC 63014 - High voltage direct current (HVDC) power transmission – System requirements for DC-side equipment

Ongoing CIGRE Working/Task force activity

- JTF B4B1B3C4D1.95 Harmonization of voltage designations and definitions across different HVDC component technologies (convenor Bruno Bisewski - CA)

IEC TS 63471:2023 DC voltages for HVDC Grids

Scope

- IEC TS 63471:2023 provides a recommended DC voltage series for HVDC grids with a DC voltage above 1,5 kV.
- It concerns the selection of a nominal DC voltage of multi-terminal HVDC power transmission and distribution systems and meshed HVDC networks, grids, rather than a rated DC voltage or highest DC voltage.

Guidance

- There is no stringent requirement to consider this DC voltage series for the DC voltage selection for any stand-alone (not forming part of DC Grid) HVDC projects, e.g. a point-to-point HVDC power transmission and distribution system.
- However, in order to facilitate the later progression towards larger HVDC systems in the future the use of standardized DC voltages is very useful.

Table 1 – Recommended nominal DC voltages for HVDC grids with a DC voltage above 1,5 kV

Pole-to-earth voltage (kV)
3
6
10 [a]
20
35
50
100
160 [a]
200
250
320 [a]
400
500 / 525 [a]
600
800
1 100 [b]

[a] Preferred values.

[b] Economic feasibility of this voltage level needs to be evaluated.

Recommended voltages for HVDC Grids – TB 684

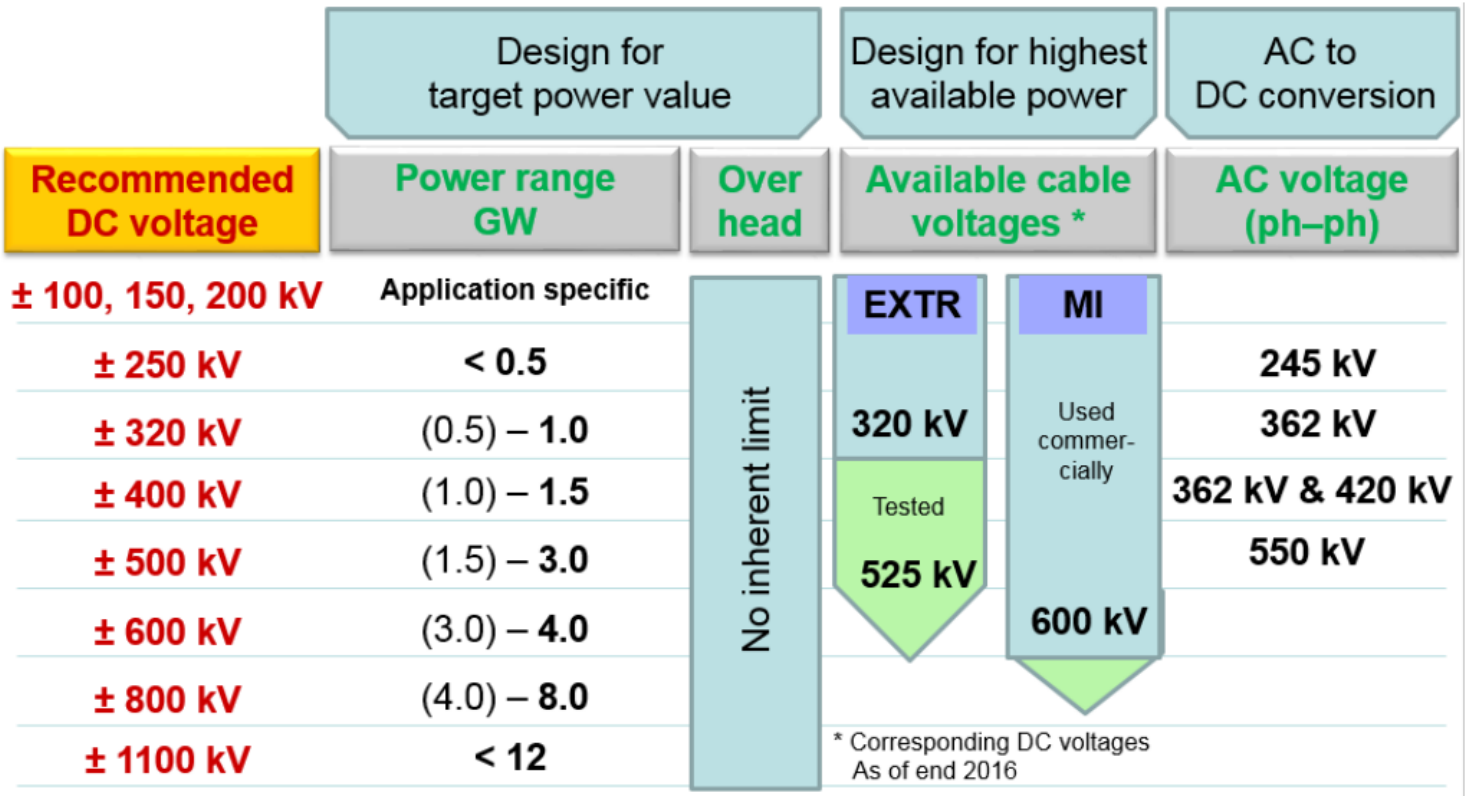

Fig 30: Recommended DC voltage levels & possible DC power transfer range

Recommended voltages for HVDC Grids

Joint Working Group

- B4/C1.65 Recommended Voltages for HVDC Grids
- TB 684 “Recommended Voltages for HVDC Grids” (April 2017).

Drivers

- Limiting the need of DC/DC conversion equipment and associated costs (CAPEX, losses)
- Rationalization of spare parts
- Reduction of maintenance time and improvement of reliability
- Reduction of qualification costs
- Optimization of DC converter and line design, with the subsequent reduction in capital and operating costs

Voltage levels

- Upto 1100kV DC

DC Gas Insulated Switchgear (GIS)

Joint Working Group

- Joint Working Group JWG D1/B3.57 ‘Dielectric testing of gas insulated HVDC systems’.
- TB 842 - Dielectric testing of gas insulated HVDC systems (Sept 2021)

Drivers

- The impact of DC voltage stresses due to trapped charge.
- Die to the nature of most DC networks which are DC cable – the Switching impulse has a large impact on the dielectric strength
- Superimposed voltage test established to caters for the pre-stress due to DC voltage and the incident transient voltages
- Testing of the interface between DC cables and gas-insulated DC systems is a key issue as these will appear more and more often as gas-insulated DC systems are connected directly to DC cables to save space
- The testing philosophy for cables and gas-insulated systems and the test objectives are different. But the TB proposes a method for dielectric testing of these critical interfaces.
- Voltage levels
- Upto 550kV DC

DC Extruded Cables

Joint Working Group

- B1.62 Recommendations for testing DC extruded cables systems at a rated voltage up to 800 kV.
- TB 852 - Recommendations for testing DC extruded cable systems for power transmission at a rated voltage up to and including 800 kV. (published Nov 2021)

Drivers

- More flexibility required to allow for different test methods (like impulse test configuration with both blocking capacitor and sphere gaps method), leveraging of the significant test experiences cumulated by the industry.
- The emergence of new grid configurations (point-to-point, radial and meshed) introduces new types of transient overvoltages (TOVs) and the standard switching and lightning impulse wave shapes might not cover typical voltage stresses anymore.
- Work coordinated with JWG B4/B1/C4.73 to evaluate the new waveshapes and new testing methods included in the Technical Brochure

Voltage levels

- Upto 800kV DC

Medium Voltage DC Distribution Systems

Joint Working Group

- C6/B4.37 Medium Voltage DC Distribution Systems - Convenor James Yu (UK)
- Presents the potential advantages of a DC approach (MVDC networks incorporating DER) as an alternative to AC distribution systems.
- Technical Brochure 875 (July 2022)

Drivers

- A massively expanding sector requiring some element of design and safety coordination
- MVDC Distribution Planning: There is currently no international standards on MVDC.
- Comprehensive operational and protection requirements: power management and coordination of DER
- Future MVDC networks will be the middle layers interconnecting the HV and LV systems (not only DC but AC systems).

Voltage levels

- 400V to 55kV DC

Harmonising DC voltages across equipment groups

Joint Task Force

- JTF B4B1B3C4D1.95 ‘Harmonization of voltage designations and definitions across different HVDC component technologies’
- SC B1, B3, B4, C4 and D1 have agreed to form a joint task force with B4 leading to address the issue.

Drivers

- Differences in voltage designations and definitions between HVDC cable systems and HVDC gas insulated systems (GIS) HVDC substations & HVDC Converter stations have come to light.
- These differences lead to confusion during system integration, thus increase the possibility of interface compatibility issues, and should ideally be avoided.
- This situation was recognized and described in TB 684 - Recommended voltages for HVDC grids’ and potential solutions were proposed.
- Urgent need to harmonize the different voltage designations and definitions across major HVDC components, to reduce the risk of potentially costly misunderstandings, and to simplify HVDC grid integration and support the uptake of multiterminal and multi-vendor systems.
- How to recognize ‘grandfathering’ with new standards

Voltage levels

- Upto 550kV DC