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TECHNICAL SPECIFICATION

Commissioning of VSC HVDC systems

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COMMISSIONING OF VSC HVDC SYSTEMS

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IEC TS 63336 has been prepared by WG 13: Commissioning of VSC HVDC systems, of IEC technical committee 115: High voltage direct current (HVDC) transmission for DC voltages above 100 kV. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
115/360/DTS	115/367/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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COMMISSIONING OF VSC HVDC SYSTEMS

1 Scope

This document, which is a technical specification, applies to the commissioning of voltage-sourced converter (VSC) high voltage direct current (HVDC) systems which consist of two converter stations and the connecting HVDC transmission line.

The tests are generally applied to all HVDC configurations and could require addition or deletion to match the given solution.

This document provides guidance on the planning of commissioning activities. The commissioning described in this document is implemented through on-site testing on the whole system functionality, including testing on the subsystem and system. This document provides the scope, procedures and acceptance criteria of the tests.

Factory system tests, on-site equipment tests, electrode tests, and trial operation are not included in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60633:2019, *High-voltage direct current (HVDC) transmission – Vocabulary*

IEC 62747:2014, *Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems*
IEC 62747:2014/AMD1:2019

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62747 and IEC 60633 as well as the following apply.

3.1 Test classification terms

3.1.1
factory system tests
FST
tests which are performed in a factory of HVDC control and protection equipment to verify the main functions and performances as well as the interface with VSC valve, optical measuring devices, etc.

Note 1 to entry: It is also referred to as a functional/dynamic performance test (FPT/DPT).

3.1.2
on-site equipment tests
electrical and mechanical tests which are performed on-site on a single equipment to verify that no equipment damage has occurred during transport and site assembly, and that installation has been correctly performed

3.1.3
subsystem tests
tests which are performed on-site to prove the correct interconnection and functioning of all individual items of equipment within a functional group (or subsystem) and that these items operate and interact correctly

3.1.4
system tests
tests verifying functions and performances of HVDC system as a whole as well as the interaction with adjacent AC systems on-site

3.1.5
converter station tests
tests verifying functions and performances of the converter unit disconnected from the HVDC transmission line on-site

Note 1 to entry: These are also referred to as STATCOM mode tests.

3.1.6
transmission tests
tests verifying functions and performances of HVDC system when transmitting power between both converter stations on-site

Note 1 to entry: These are also referred to as end-to-end tests.

3.1.7
point of common coupling
PCC
point of interconnection of the HVDC converter station to the adjacent AC system

[SOURCE: IEC 62747:2014, 9.25]

3.2 Other terms

3.2.1
PQ characteristic
capability of active and reactive power of a VSC HVDC converter unit, which is normally a closed and irregular region with active and reactive power in a two-axis graphical representation

3.2.2
Qac control
reactive power control mode of VSC converter to control the exchange of reactive power to a specified value

3.2.3
Uac control
reactive power control mode of VSC converter to control the AC bus voltage to a specified value

3.2.4
dynamic performance study
DPS
off-line investigation of the dynamic behaviour of various fault scenarios within the specified boundaries of AC system

Note 1 to entry: The result of the DPS should be the optimum set of control and protection parameters to achieve the best overall dynamic behaviour for the specific HVDC.

3.3
human machine interface
HMI
interface for a human operator to operate, monitor and maintain an HVDC locally at site or from the remote

Note 1 to entry: An HMI typically consists of a monitor, a keyboard and a mouse.

4 Stages, sequence and objectives of commissioning of VSC HVDC systems

4.1 Process of commissioning of VSC HVDC systems

During the commissioning and testing of an HVDC project, the HVDC equipment is verified in groups and in conjunction with the control and protection systems. Usually, this process can be divided into four major parts: factory tests, on-site equipment tests, subsystem tests and system tests as shown in Figure 1.

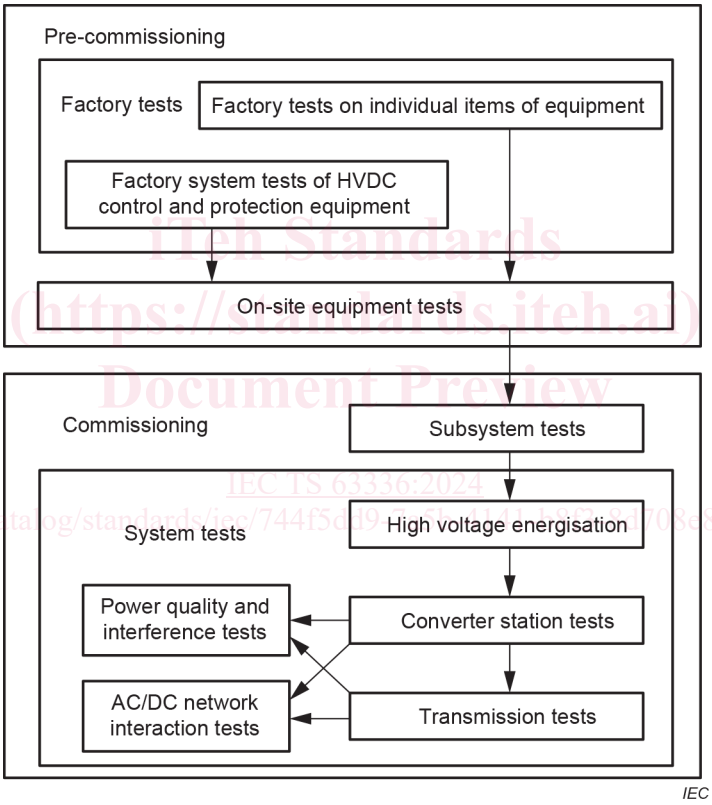

Figure 1 – Overview diagram of commissioning process of VSC HVDC systems

The structure and sequence of the VSC commissioning process require an understanding of the overall VSC HVDC system structure and a definition of various components within this structure. Figure 2 shows an example of two parallel VSC HVDC systems along with graphical designations used in this document.

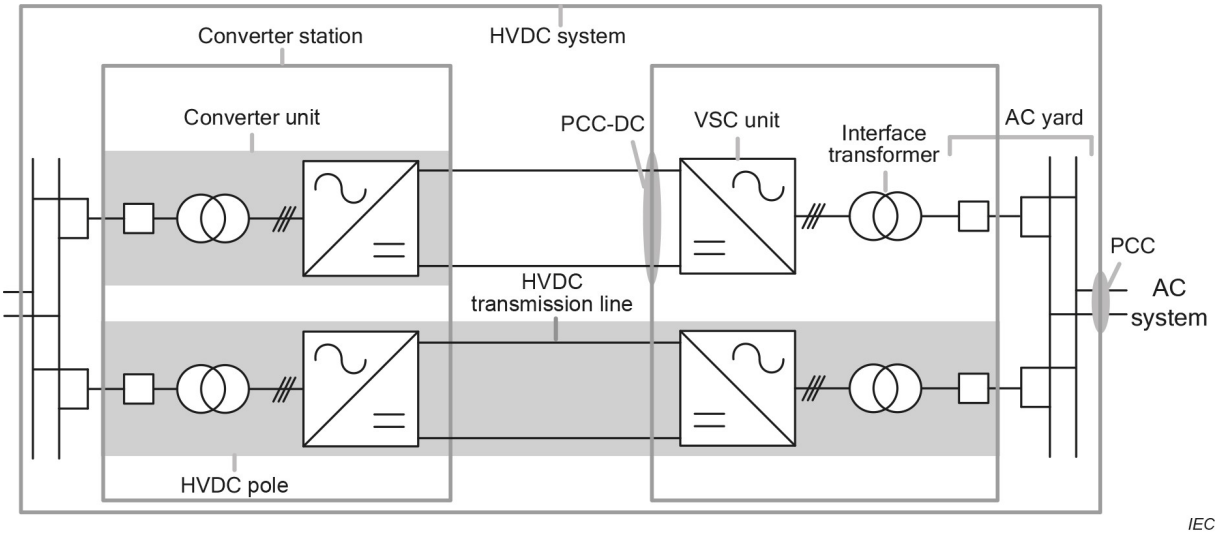

Figure 2 – VSC HVDC systems and designations

4.2 Pre-commissioning

4.2.1 Factory system tests of HVDC control and protection systems

Factory system tests cover the verification of internal connections within and in between the control cabinets and the functional verification of the software and are performed in the factory prior to the control and protection equipment being sent to site.

During the factory system tests, the complete control and protection systems are tested. External stand-alone equipment, such as external protection relays, are typically excluded. Where other external interfaces are present, the tests should be performed as completely as possible, to determine with as much confidence as is practical that the control and protection systems will operate correctly in terms of the expected input and output signals. Such external interfaces include auxiliary power systems, converter cooling systems, fire protection systems, etc.

Finding and correcting hardware and software errors in the control and protection systems is an important function of factory system tests. Such faults are easier to find and rectify in the factory than during on-site commissioning. Correcting such faults reduces the probability of disturbing the power system during the commissioning tests.

4.2.2 On-site equipment tests

On-site equipment tests are electrical and mechanical tests on a single installed item of equipment or plant. The primary purpose of these tests is to ensure, to the extent possible, that no equipment damage has occurred during transport and site assembly, and that the installation has been correctly performed.

The equipment supplier may in some cases specify particular checks and inspections that can help verify the equipment integrity.

4.3 Commissioning

4.3.1 Subsystem tests

A subsystem includes groups of main circuit equipment, associated measurement systems, control and protection systems, and/or auxiliary systems.