ID model for HVDC system/HVDC converter unit

Installation document model in accordance with the NRA Order no. 220 of 11.12.2019 approving the Notification Procedure for the connection of HVDC systems and direct current connected power park modules and verification of compliance of HVDC systems and direct current connected power park modules with technical requirements for connection to the public electricity networks

The Installation document (ID) for HVDC installation contains the following documents:

a) request for the energisation for the beginning of the testing period, elaborated with respect of the provisions of Annex no. 1 - section 1.1 from the NRA Order;
b) the electrical single line scheme of the HVDC system/HVDC converter unit;
c) an itemised statement of compliance by points relating to:
   (i) equipaments;
   (ii) reactive power exchange in the conmection point;
d) technical data according to the provisions of Annex no. 1 - section 1.1 from the NRA Order;
e) equipement certificates issued by an authorised certifier, for the HVDC systems/ HVDC converter units, if they are invoked as part of the evidence of compliance;
f) simulation models or equivalent informations provided in the connection technical Norm and required by TSO, which completely simulates the behavior of the HVDC systems/ HVDC converter units, in stationary and dynamic conditions, including for transient electromagnetic phenomena, exchange of active and reactive power in the connection point, power quality provided in the connection point, as appropriate. The format and calculation program in which the provided models, specified by TSO, are: Eurostag or PSSE. Other programs may be used with the condition that one of the three specified programs is provided for a converter. The content of mathematical models includes conditions / settings for permanent and dynamic regimes, network topology and single line diagram. The data shall be transmitted at least one month before the date predicted by the applicant for energisation for the beginning of the testing period.
g) studies demonstrating expected performance on a permanent and dynamic regime, including reactive power exchange studies in the connection point;
h) the tests program and the details of the practical method used in performing the verification tests of conformity, their performer and the technical data of the measuring equipment with which he performs the tests;
i) the results of the verification tests for the functioning of the communication path and the integration of the EMS-SCADA system;
j) documents attesting to the completion of the preceding works of the energisation for the beginning of the testing period, in conformity with the provisions in Annex no. 1 - section 1.1 from the NRA Order;

k) request for the issuance of the FON.

ANNEX 1

Section 1.1 Technical documentation of the HVDC system and HVDC converter units

(1) ATR copy;

(2) the establishment authorization granted by NRA, or, as the case may be, the commercial exploitation license;

(3) the contact details of the HVDC system and HVDC converter unit;

(4) the connection point;

(5) the expected date of the energisation for the beginning of the testing period;

(6) equipment certificates issued by an approved certification body for the equipment used by the HVDC systems/HVDC converter units, together with the tests results. These include:

(a) Checking the P - Q capability curve;

(b) fault-ride-through capability;

(c) operation of the HVDC system/HVDC converter unit in the frequency range (47,5 ÷ 51,5) Hz at a RoCoF of 2 Hz / sec for a 500 ms time window, of 1,5 Hz / s for a 1 s window and 1.25 Hz / s for a 2 s time window, the reduction of active power to the maximum active power produced in the case of a frequency drop below 49.5 Hz and 49 Hz respectively, the capability of providing limited response frequency capacities above the 50 Hz nominal capability, capability of providing limited response to frequency drops below the rated 50 Hz, ability to constantly maintain active power mobilized irrespective of frequency variations, within the power limit provided by the primary source, capability of automatic reconnection of the HVDC system/HVDC converter unit at voltage variations of (0,85 ÷ 1,1) Vn;

(d) electrical disturbances according to EN 50160 edition in force, communicated by the manufacturer of the builder unit, confirmed by bulletins issued by laboratories certified at European level or measured at the point of connection by an economic operator holding an A3 certificate issued by NRA. The power quality energy measurements shall be completed by measuring report, with the data extracted from the Class A quality analyzer;

(e) response mode to the setpoints of active and reactive power variations.

(7) in the case of equipment used for which a certificate has not been received, information (tests and their results, carried out by approved certification bodies, etc.) shall be

provided in accordance with the instructions given by TSO, relevant to the technical requirements applicable in force, specific to HVDC system/HVDC converter unit;

(8) the detailed technical data of the HVDC systems/HVDC converter units, according to Table no. 1-HVDC as well as the technical project to show: the lengths and technical characteristics of the cables and the connection to the TSO substation / cell, the connection mode of the HVDC systems/HVDC converter units and the auxiliary installations as well as the single line diagram;

(9) modeling requirements for permanent and dynamic regime system studies, mathematical models of HVDC systems/HVDC converter units, as follows:

(a) for the calculation of stationary and short-circuit currents are required:

i. the electrical scheme and the system connection substation;

ii. the length of all LEA or LES between the HVDC system/HVDC converter unit and the system connection substation;

iii. electrical parameters specific to all cables and lines: type, R_+ [Ω/km], R_0 [Ω/km], Rm_0 [Ω/km], X_+ [Ω/km], X_0 [Ω/km], Xm_0 [Ω/km], C_+ [μF/km], C_0 [μF/km], S [mm], V_n [kV] etc.

iv. for transformer units: rated winding power, nominal voltages, loose losses, copper losses, short-circuit voltage, idle current, connection unit, voltage setting (type of adjustment, including the number of the nominal plot, the maximum plot number), neutral treatment;

v. data on the reactive power compensation system (e.g. if capacitor batteries are installed: the number of steps, the power installed on each step) and the indication on the required electrical circuit of the installation location of the compensation system;

vi. data on HVDC systems/HVDC converter units: the nominal active power, the P-Q diagram, the rate of change of the active power;

(b) for calculating the dynamic regime are required:

i. logic operating diagram of the HVDC system/HVDC converter unit;

ii. the mathematical model of the HVDC system/HVDC converter unit and its parameters;

iii. electrical control system: control schemes and parameters for active power control and reactive power control and, where applicable, voltage at terminals or at the connection point;

iv. the mathematical model of the HVDC system/HVDC converter unit and the

model of the central level control system in the form of diagrams (including mathematical functions) and the corresponding set of parameters. Alternatively, you can specify assimilation with a generic model from one of the PSSE v32 applications (".dll" will mandatory be provided) or Eurostag v4.5 for which the parameters are provided. If the model includes additional control functions or specific features, these will be mentioned and graphics will be added;

v. Protection against voltage variations: "fault-ride-through - low voltage" (LVRT, ZVRT);

vi. other special functions: "low voltage power logic", participation in frequency control etc;

vii. the dynamic equivalent of the HVDC system/HVDC converter unit;

(10) studies conducted by the HVDC system/HVDC converter unit owner, including model simulations, to demonstrate the steady-state and dynamic performances, including the use of measured factory values during testing at the level of detail required by TSO;

(11) the active power regulation, reactive power diagrams, in detail, at the HVDC system/HVDC converter unit, in order to highlight the way in which:

(a) active power and reactive power setpoints are taken and modified;

(b) the reactive power measure at the HVDC system/HVDC converter unit level is taken;

(12) the network study for calculating the reactive power requirement at the connection point to meet the reactive power requirements at the connection point (0.9 inductive ÷ 0.9 capacitive) across the entire active power range, with zero reactive power exchange with the system when the active power produced is zero. Attach the P-Q diagram of the HVDC system/HVDC converter unit at the connection point and the V-Q / Pmax diagram;

(13) the dynamic regime study of the HVDC system/HVDC converter unit and of the area to determine the measures to avoid its insularity;

(14) the data required for the calculations of protection adjustment, which are sent to the TSO at least one month before the date when the energisation for the beginning of the testing period is requested:

(i) complete technical project;

(ii) the own protections for internal and external defects, adjustments and response times, the electrical characteristics of HVDC systems and related transformers;

(iii) the electrical characteristics, the own protections with the related settings and the automations of connection/disconnection of the reactive power compensation elements;

(15) the technical characteristics of the power quality analyzer to be mounted at the connection point. The analyzer must be Class A certified PSL and be capable of transmitting "SQL", "PQDIF", ".txt" or ".xls" files to the structure required by TSO's electrical quality monitoring system. It integrates into TSO's electricity quality monitoring system.

(16) documents on the technical characteristics of the communication path and of the integration equipments in EMS-SCADA system, as well as contracts for the realization and maintenance of the communication path;

(17) the results of the verification tests for the functioning of the communication path and integration of the new installation in EMS-SCADA system;

(18) static and dynamic stability studies or system integration, if applicable and if they were not performed at the stage of establishing the connection solution to the electrical network;

Table no. 1-HVDC: Data for the HVDC systems and HVDC converter units

Description of data	**Measuring units**	**Data category**
Absorbed power	**MW**	**D, S**
Frequency:		
Frequency range in which the HVDC system/ HVDC converter unit remains operational	Hz	D
Nominal frequency	Hz	D
Dependence of absorbed power depending on network frequency	kW/df	
Operational time depending on the frequency range	min	D
Voltage:		
Nominal voltage	kV	S, D
Minimum/maximum voltage which the HVDC system/ HVDC converter unit remains operational	kV	D
Dependence of absorbed power depending on network frequency		
Operational times depending on the voltage range	kV	D
Data control and acquisition system:		
Communication channel (type, technical performance etc.)	Text	D
Remote control and transmitted data	Text	D
Current metering transformers	A/A	D
Voltage metering transformers	kV/V	D
Characteristics of the metering system	Text	R
Metering transformers - details of testing certificates	Text	R
Network configuration:		

Diagram of electrical circuits for existing and new installations, including arrangement of busbars, neutral treatment, switching equipment and operating voltages	Single-line diagram	S, D, R
Radial structure of the TSO system at the connection point to the RET	Single-line diagram	S, D, R
Network impedance:		
Positive, negative and zero sequence impedance values	Ω	S, D, R
Short-circuit currents:		
Maximum short-circuit current	kA	S, D, R
Transformers in the connection point:		
Saturation curve	Diagram	R
Data on transformer units (number of taps, voltage ratio, tap change mode etc.)	Diagram, text	S, D, R
AVR data/logical diagram for transformers with automatic on load tap changer		

1. The owner of the HVDC system has the obligation to transmit to the TSO the technical data provided in table 1 in accordance with the provisions of this technical norm.
2. In the notification procedure, the TSO can ask for additional data for each notification and verification conformity stage.
3. The standard planning data (S), communicated in the connection request and used in the solution studies (forms) represent all the general technical data which characterise the HVDC system and HVDC converter units.
4. The detailed planning data (D) are technical data enabling special analysis of static and transient stability, the sizing of automation installations and protection control, as well as other necessary data for operative scheduling; the detailed planning data (D) are transmitted to the TSO by minimum 6 month before commissioning.
5. The data validated and filled in upon commissioning are confirmed during the verification of conformity with the connection requirements (R).

Section 1.2 Documentation demonstrating the performance of preceding works of the energisation for the beginning of the testing period for the HVDC systems and HVDC converter units

The documentation contains:

(1) evidence of an agreement on the protection schemes applicable at the connection point between the TSO and the HVDC system/HVDC converter unit owner;

(2) the documents attesting the implementation of the aggregation and integration solution in EMS-SCADA system agreed with TSO, as appropriate. The integration refers at least to the integration of the measures P (active power), Q (reactive power), V (voltage) and frequency as well as the P, Q, V setpoints;

(3) the program of energisation for the beginning of the testing period of the HVDC system/HVDC converter unit, and the expected date for the energisation of the HVDC system/HVDC converter unit, up to the ATR approved specific to the specific phase in ATR / staged, for the HVDC system/HVDC converter unit.

(4) the operating agreement between the TSO and the HVDC system/HVDC converter unit owner, the dossier of the installation manual and the minutes that confirm receipt at the completion of the work on the connection installation;

(5) the document proving the existence and the mounting of the reactive power compensation facilities at the connection point, if this emerges from the reactive power study;

(6) evidence of setting up a local central dispatcher;

(7) evidence of obtaining an investment order;

(8) evidence of registration in the energy market.