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| ±800kV, 6000MW HVDC Raigarh – Pugalur<br>Terminals<br>Raigarh - Pugalur | Document number, revision<br>1JNL355427, B |                  | Page<br>1 of 5       | Language<br>en |
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| Title<br>Mechanical Requirements for Apparatuses Terminals for HVDC     |                                            |                  |                      |                |

Summary

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## 1. General

Each high voltage apparatus on a HVDC-station shall have terminals for connection to main circuit apparatus, bus bars, grounding grid, or other equipment. The terminals shall comply with the requirements in this specification.

The purpose with this specification is to standardize terminals for HVDC-apparatus and to minimize the quantity of different terminal connectors used in a HVDC-station.

A terminal is a conducting part of a device to which a terminal connector is fastened. Bolts are used to make the connection separable. In a bolted type connector the contact between the two parts is made by pressure exerted by one or more clamping bolts.

A terminal with a terminal connector must:

- Function well without maintenance during a long period of time.
- Be designed to secure an unbroken transmission of current.
- Have low contact resistance to avoid overheating.
- Withstand different mechanical loads and stresses.
- Have sufficient corrosion resistance.

Terminals for current carrying connections and voltage connections are of two types:

Terminal with rectangular shape with two or more holes.

Terminal with cylindrical shape.

Terminals for earthing connections shall have a rectangular shape with two holes.

Changes compared to the NEA800-project requirement specification are highlighted in yellow.

## 2. Standards

The terminals shall be designed to meet the requirements in IEC TR62271-301 [1]

## 3. High Current/Voltage Connections

In this specification a current carrying connector is defined as a separable, stationary, non-movable connection between a terminal and a terminal connector, having the primary function of transmitting power.

### 3.1 Material

Terminals for high current connections shall be manufactured of aluminum alloy with the following data.

- Copper content shall be below 0,1 % to prevent internal corrosion.
- Hardness requirement for aluminium in electrical use: > 60 HV
- Recommended standard qualities are ASTM 6061-T6 (SS aluminium 4102-06), ASTM 6063-T6 (SS aluminium 4104-06) and ASTM 6351-T6 (SS aluminium 4212-06), which are alloyed and hot aged.

- Recommended cast qualities are ASTM B 26-84, 356.0-T6 (SS aluminium 4253-04) and ASTM B 108-82b, 356.0-T6 (SS aluminium 4253-07).

Terminals of aluminum shall not be treated. The alloy shall have almost the same cracking constancy as pure aluminum. The alloys sensitive for season cracking, layer corrosion or intercrystalline corrosion shall not be used.

Terminals for *surge arresters* may also be manufactured of galvanized steel.

Terminals with cylindrical shape may also be manufactured of copper. Terminals of copper or a copper alloy shall be Silver-plated to a thickness of minimum 10 µm. Nickel-plating is also acceptable, to a thickness of minimum 10 µm. A copper alloy which is sensitive for season cracking may not be used.

## 3.2 Terminals with rectangular shape

### 3.2.1 Current rating between 2500A and 3000 A

Terminals shall have 9 bolts with 14mm and distance between holes (center to center) shall be 40 mm

Thickness shall be between 15 and 30 mm.

Bolt Size shall be M12.

To reduce eddy-currents, terminal thickness on air cooled reactors may be reduced to minimum 10 mm.

### 3.2.2 Current rating < 2500A

Terminals with rectangular shape shall have hole diameters of 14 mm. Distance between holes (center to center) shall be 40 mm.

Bolt size shall be M12.

To avoid high temperature in the high-current connection the quantity of bolts shall be sufficient. The current must not exceed 500 A/bolt.

Terminal thickness shall be between 15 and 30 mm.

To reduce eddy-currents, terminal thickness on air cooled reactors may be reduced to minimum 10 mm.

For equipment with low current rating (< 400 A) terminal thickness may be reduced to minimum 10 mm.

## 3.3 Terminals with cylindrical shape

Terminals for *Converter transformer indoor bushings and wall bushings* with cylindrical shape shall have a diameter of 130 mm and a minimum length of 160 mm.

Terminals of aluminum alloy is allowed up to 2500 A.

For currents above 2500 A copper must be used.

Cylindrical terminals with current ratings between 2500A and 3000A, Tap diameter 80mm with length 150 mm shall be used.

*Capacitor banks* shall have aluminum tubes as terminals. The high voltage terminal shall have a diameter of 356mm and the low voltage terminal shall have a diameter of 60 mm.

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Diameter tolerance is +/- 0,5 mm.

## 4. Earthing Connections

The terminal shall be of rectangular shape with two holes.

Hole diameter shall be 14 mm.

Distance between holes shall be 40 mm.

Bolt size shall be M12.

If clamp is provided with the apparatus it must be possible to connect a conductor with cylindrical shape and an area of maximum 120 mm<sup>2</sup>.

Earthing conductors shall withstand 63 kA, 1 sec for Raigarh and 50kA, 1 sec for Pugalur on the line side of the HVDC converter transformers, minimum conductor size shall than be

- 240 mm<sup>2</sup> for copper conductors
- 720 mm<sup>2</sup> for zinc coated steel core conductors
- 1180 mm<sup>2</sup> for stainless steel 304 conductors.

## 5. Mechanical Terminal Loads

Terminals for apparatus in HVDC-stations must withstand different types of mechanical loads such as:

- Static load from conductor.
- Dynamic loads due to equipment vibrations.
- Dynamic loads in conductor due to wind, short circuit forces etc.

Minimum required mechanical strength of a terminal is to withstand a force of 2 kN in any direction.

An exception to this requirement is AC- and DC-filter equipment with a current rating less than 750 A and for an operating voltage less than 145 kV, which shall minimum withstand a terminal force of 750 N in any direction.

Additional requirements of terminal loads, if any, on 800 kV DC-apparatuses shall be informed by ABB AB, HVDC separately.

## 6. References

- [ 1 ] IEC TR62271-301 High-voltage switchgear and control gear  
Part 301: Dimensional Standardization of terminals

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## 7. Revision History

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|----------------------------------------------------|-----------------------|-------------------------|
| Rev.<br>B                                          | Prepared<br>Sheeba PT | Approved<br>Ashish Naik |
| Revision text<br>Section 3.3 and Section 4 updated |                       |                         |

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|---------------|-------------------------------|-------------------------------|
| Rev.<br>A     | Prepared<br>Sreejith Govindan | Approved<br>Sommarsjo Kamilla |
| Revision text |                               |                               |