132-400 kV AC substation

Outdoor AIS-AC Substations
Common conditions and technical requirements for high voltage apparatus

ETS-50-00 Rev. 3
# REVISION VIEW

<table>
<thead>
<tr>
<th>Document no.:</th>
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<td>Version</td>
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<td>3</td>
<td>JLY</td>
</tr>
</tbody>
</table>
# Table of contents

1. Introduction .................................................. 4
2. Standards and regulations .................................. 4
3. Functional requirements .................................. 4
   3.1 General .................................................. 4
4. Technical requirements .................................. 4
   4.1 Grid .................................................... 4
   4.2 Short-circuit currents ................................ 4
   4.3 Installation environment ............................. 4
   4.4 Insulator materials .................................. 4
   4.5 Grid data and insulation requirements .............. 5
   4.6 Insulators pollution withstand levels .............. 5
   4.7 Position indicators .................................. 5
   4.8 Mechanical loads .................................... 5
   4.9 Equipment containing oil ............................ 6
   4.10 Washability of HV equipment ....................... 6
   4.11 Treatment of iron parts and supports ............. 6
   4.12 Earthing .............................................. 6
   4.13 Terminal boxes and connection of measuring/control cables 6
   4.14 Plates and tags ..................................... 7
5. Documentation ............................................... 7
   5.1 General ................................................. 7
   5.2 Documentation to be included ....................... 8
1. **Introduction**
This standard specifies the general requirements for outdoor AIS AC substations. The general requirements apply to all AIS high voltage equipment. Furthermore for each type of equipment an additional technical specification applies.

The requirements stated in the technical specification for specific equipment take precedence over the requirements stated in these common conditions and technical requirements.

2. **Standards and regulations**
The construction, production and testing of units and equipment shall comply with the relevant standards and regulations.

Applicable standards: DS/SB/EN/IEC.
- **DS**: Dansk standard
- **SB**: Stærkstrøms bekendtgørelsen
- **EN**: European standard
- **IEC**: International Electrotechnical Commission

3. **Functional requirements**

3.1 **General**
Units and equipment shall function as intended in the local condition and environment. The construction shall also comply with all relevant regulations to guarantee the safety of staff during operation and maintenance.

4. **Technical requirements**

4.1 **Grid**
The nominal grid frequency is 50 Hz. If the frequency affects the properties of the unit and the equipment, the rated frequency shall correspond to the nominal grid frequency.

4.2 **Short-circuit currents**
The rated symmetrical 50 Hz short circuit withstand level shall be 40 kA for 1s, with a dynamic short circuit level of 100 kA.

4.3 **Installation environment**

<table>
<thead>
<tr>
<th>Installation:</th>
<th>Outdoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum ambient air temperature:</td>
<td>40°C</td>
</tr>
<tr>
<td>Maximum average daily temperature:</td>
<td>30°C</td>
</tr>
<tr>
<td>Minimum ambient air temperature:</td>
<td>-30°C</td>
</tr>
<tr>
<td>Atmosphere:</td>
<td>Humid and salty</td>
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</tbody>
</table>

4.4 **Insulator materials**
Post insulators can be made from brown or grey glazed porcelain. All insulators containing electrical parts shall be composite insulators with soft sheds, i.e. with silicone rubber sheds.
4.5 Grid data and insulation requirements

<table>
<thead>
<tr>
<th>Nominal voltage (kV)</th>
<th>Maximum operating voltage [kV]</th>
<th>Test voltage Rated short-time withstand voltage (RMS) [kV]</th>
<th>Surge voltage Rated lightning impulse withstand voltage LIWL (1.2/50)µs [kV]</th>
<th>Surge voltage Rated switching impulse withstand voltage SIWL 250/2,500µs [kV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>132</td>
<td>145</td>
<td>275</td>
<td>650</td>
<td>Non-dimensioning</td>
</tr>
<tr>
<td>150</td>
<td>170</td>
<td>325</td>
<td>750</td>
<td>Non-dimensioning</td>
</tr>
<tr>
<td>220</td>
<td>245</td>
<td>395</td>
<td>950</td>
<td>750</td>
</tr>
<tr>
<td>400</td>
<td>420</td>
<td>520</td>
<td>1425</td>
<td>1050/1575</td>
</tr>
</tbody>
</table>

For all voltage levels the system earthing is grids with low-impedance neutral earthing (effectively earthed grid).

4.6 Insulators pollution withstand levels
Specific requirements for the minimum pollution withstand levels unless otherwise specified:

<table>
<thead>
<tr>
<th>Nominal voltage (kV)</th>
<th>Pollution level</th>
</tr>
</thead>
<tbody>
<tr>
<td>132</td>
<td>Heavy</td>
</tr>
<tr>
<td>150</td>
<td>Very Heavy</td>
</tr>
<tr>
<td>220</td>
<td>Very Heavy</td>
</tr>
<tr>
<td>400</td>
<td>Heavy</td>
</tr>
</tbody>
</table>

4.7 Position indicators
The following switchgears shall have a visible mechanical position indicator:

- Circuit breakers
- Disconnectors
- Earthing switches

OUT indication should be with green background collar. Can display ‘O’ or ‘OUT’
IN indication should be with red background collar. Can display ‘I’ or ‘IN’.

Alternatively:
OUT indication can be white with black text. Can display ‘O’ or ‘OUT’
IN indication can be white with black text. Can display ‘I’ or ‘IN’.

Single pole operated equipment shall have individual mechanical position indicator.
The position indicator shall be easily readable from ground level.

4.8 Mechanical loads
All high-voltage apparatus shall, at the primary connection terminal(s), be able to withstand a static load of at least 2,000 N (200 kp) in any direction, with an additional wind pressure of 1,000 Pa (100 kp/m²).
4.9 Equipment containing oil
All equipment containing oil shall be completely oil tight and fitted with oil-resistant, high-quality sealings. Taps and valves shall be completely oil tight.

Equipment containing oil shall have an oil level indicator. The oil level indicator shall have markings clearly indicating the normal oil level. It shall be possible to read the oil level from ground level.

Any drain valves shall be placed at the lowest point in the oil-filled chamber and shall be easy to operate for taking oil samples.

4.10 Washability of HV equipment
It shall be possible to wash down the high voltage equipment and any penetrating water shall drain off. The water shall not in any way impair the functionality of the high voltage equipment.

4.11 Treatment of iron parts and supports
All iron parts shall be hot-dip galvanised. The pre-treatment and hot-dip galvanising shall – in so far as these can be adapted – be carried out in accordance with the latest version of the DS/EN ISO 1461 standard.

The hot-dip galvanising shall at least be class A, while supports shall be at least class B.

4.12 Earthing
All equipment shall be prepared for connection to the substation's earthing system. All equipment shall include all internal earthing conductors and connection materials etc. for connection of all equipment, steel structures and metal parts to the substation earthing system.

The design of the earth connection shall:

- Have sufficient mechanical strength and corrosion-resistance
- Withstand thermal impact from the largest fault current
- Avoid damage to property and equipment
- Ensure the safety of persons with regard to touch voltage at the largest occurring earth fault current

Earth electrodes shall be made from a corrosion-resistant material (chemical or biological impact, oxidation, formation of an electrolytic element, electrolysis, etc.). They shall be able to withstand the mechanical impact occurring during installation and normal operation.

4.13 Terminal boxes and connection of measuring/control cables
Terminal boxes shall have an IP54 protection rating. There shall be ample space for connecting cables and for installing the necessary cable glands which shall be downward facing.

Upward facing cable glands are not accepted.

At the bottom of the boxes there shall be a vent hole, with a wire mesh preventing ingress of insects etc.
The terminal boxes shall have space for a heating unit, if needed and 10% spare free space in the terminal blocks, for expansion.

The terminals shall be easily accessible with at least 25 cm free space between terminal blocks, i.e. if the terminals are arranged in horizontal blocks then the vertical distance between each block shall be minimum 25 cm.

The terminals shall be non-tracking and for minimum 6 mm² wires/cables. The specific terminal type shall be approved by Energinet.dk.

Screws, terminal blocks, terminals, etc., shall be made from corrosion-resistant materials.

### 4.14 Plates and tags

All equipment shall be fitted with a permanent plate/tag. Plates and tags shall state the serial number, name and address of the manufacturer, nominal capacity, electrical properties and other relevant information.

For equipment containing pressurized gas shall the pressure be stated in absolute value in the SI unit MPa on the permanent plate/tag.

All text on plates and tags shall be in Danish.

Drawings of plates and tags shall be forwarded for review and subsequent approval.

Plates and tags shall be weather and corrosion resistant. Plates made from plastic or Silumin are not accepted.

Plates and tags shall be sufficiently secured, gluing will not be accepted.

### 5. Documentation

#### 5.1 General

All deliveries of units and equipment shall include all documentation necessary for erection, commissioning, operation, repair, maintenance, storage and disposal.

The documentation can be in Danish or English, however all safety related documents shall be in Danish.

The documentation shall always be forwarded for inspection and subsequent approval.

The documentation shall generally meet the requirements defined in the EDS-50-01 standard.

The standard EDS-50-01 does not relieve the supplier of his responsibility for the documentation.
5.2 **Documentation to be included**
Upon delivery, units and equipment shall be accompanied by the following documentation:

- Data sheets for units and equipment stating the manufacturer, type, output data, preconditions, description, drawings, etc.
- Instructions for transport, storage, handling, service, testing, control and adjustment
- Instructions for testing of any safety equipment
- Instructions for regular maintenance and inspection
- Safety instructions and operational manuals in Danish
- Instructions for regular lubrication and lubrication sheet with relevant lubricants, and other chemical products combined in a separate document
- Instructions concerning special tools and accessories for installation, operation and maintenance
- Instructions concerning spare parts
- Routine test report.
- Environmental information such as:
  - Information about the main content of units and equipment (type of material as a percentage of the weight). Information about the content of hazardous substances (e.g. heavy metals, carcinogenic substances, other substances that are not easily degradable, substances not occurring in the natural environment)
  - Handling and treatment of the equipment for scrapping.