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| Joint operation between the Eastern Danish and Swedish subsystems on the AC links across Öresund and to Bornholm |
| Appendix 6 to SOA Annex OS (DK2 and SE) |
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# Background

The subsystems of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The subsystem of Western Denmark is connected to Norway, Sweden and Eastern Denmark using DC links. This Appendix describes the operation of the AC links across Öresund and to Bornholm.

# Transmission facilities linking the subsystems of Eastern Denmark and Sweden

## Transmission facilities owned/held by system operators at both ends

|  |  |  |
| --- | --- | --- |
| **Facility** | **Voltage level** | **Settlement point** |
| Hovegaard-Söderåsen (FL25) | 400 kV | Söderåsen |
| Görlöse-Söderåsen (FL23) | 400 kV | Görlöse |

The ownership structure of the facilities is set out in ”Anlægsaftalen for 400 kV forbindelserna” between Svenska kraftnät and Elkraft Transmission (merged with Energinet as of 1 January 2005), dated 12 December 2001.

Svenska kraftnät owns three single phase 400 kV cables included in FL23, cables K4001, K4002 and K4003, between Kristinelund and Ellekilde Hage, including the corresponding share belonging to the oil equipment at Kristinelund and Ellekilde Hage. The ownership boundary between wholly-owned Danish and Swedish facilities is constituted by the splicing points between the land lines and submarine cables on the Danish side. The cable joints belong to the Swedish-owned facilities.

A single phase 400 kV cable K4004 between Kristinelund and Ellekilde Hage, including the corresponding share belonging to oil equipment at Kristinelund and Ellekilde Hage, is owned to 50 % by Svenska kraftnät and to 50 % by Energinet. The boundary between K4004 and surrounding facilities is composed of the splicing points between the land lines and submarine cables on both the Danish and Swedish sides. The cable joints are part of K4004.

Energinet owns three single phase 400 kV cables which are included in FL25, cables K4005, K4006 and K4007, between the Swedish shore and Ellekilde Hage, with associated oil equipment at Kristinelund and Skibstrupgaard. The ownership boundary between the Danish and Swedish-owned facilities is constituted by the splicing points between the submarine cables and land lines on the Swedish side. The cable joints belong to the Danish-owned facilities.

## Other transmission facilities

|  |  |  |
| --- | --- | --- |
| **Facility** | **Voltage level** | **Settlement point** |
| Teglstrupgaard 1-Mörarp | 130 kV | Mörarp |
| Teglstrupgaard 2-Mörarp | 130 kV | Teglstrupgaard |
| Hasle, Bornholm-Borrby | 60 kV | Borrby |

The ownership structure of the 130 kV links is set out in ”Anlægsaftalen for 132 kV forbindelserna” between Sydkraft and Elkraft Transmission (merged with Energinet as of 1 January 2005), dated 13 May 2002.

The ownership structure of the 60 kV facility is set out in ”Anlægsaftale for 60 kV forbindelsen” between E.ON Elnät Sverige AB and Energinet.

# Electrical safety for facilities under 2.1

## General

The common ground for the electrical safety work of the system operator companies within the Nordic countries is constituted by the European standard for managing electrical high-voltage facilities EN 50 110 - which governs the organisation and working methods.

In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the system operators as regards dealing with operational issues from an electrical safety point of view.

## Responsibility for electrical operation/Operational management

Responsibility for electrical operation of the 400 kV Öresund links on the Swedish side is held by Svenska kraftnät, and operational management on the Danish side is carried out by Energinet.

The power operation responsibility boundaries for electrical operation/operational management are the same as the ownership boundaries, see under 2.1.

The power operation manager of K4004 is Svenska kraftnät.

## Switching responsible operator/Switching leader

|  |  |  |
| --- | --- | --- |
| **Facility** | **Swedish side** | **Danish side** |
| Söderåsen – Kristinelund – Görlöse (FL23) | Operations Centre at Sundbyberg (DCSY) | Energinet’s Control Centre at Erritsø |
| Söderåsen – Kristinelund Hovegaard (FL25) | Operations Centre at Sundbyberg (DCSY) | Energinet’s Control Centre at Erritsø |

The power operation manager for the 400 kV Öresund links on the Swedish side is Svenska kraftnät’s Operations Centre at Sundbyberg (DCSY), and on the Danish side Energinet’s Control Centre at Erritsø.

Switchings on the links take place after agreement between Svenska kraftnät’s Operations Centre at Sundbyberg (DCSY) and Energinet’s Control Centre at Erritsø.

The party which initiates a planned outage is the switching responsible operator/switching leader for the switchings and other operational measures carried out (leading switching leader) if not otherwise agreed upon.

In the event of faults which require switchings that have an impact on the 400 kV Öresund links, that party whose facility suffers from the fault is the switching responsible operator/switching leader for the switchings and other operational measures carried out (leading switching leader). If the fault cannot be located, the switchings shall take place on the basis of mutual consultation.

If a party needs switchings by the other party because of electrical safety reasons, the other party shall carry out such switchings without delay.

## Operation monitoring and control in respect of electrical safety

Operation monitoring and control of the 400 kV Öresund links is managed on the Danish side by Energinet’s Control Centre at Erritsø and on the Swedish side by Svenska kraftnät’s Operations Centre at Sundbyberg (DCSY).

Both parties’ switching responsible operators/switching leaders have access to status indications and electronic measured values via remote control from each other’s facilities and from those stations where the 400 kV Öresund links are connected to the respective parties’ grids.

## Operational orders/Switching schedule

Switchings on the links are carried out in accordance with operational orders drawn up by Svenska kraftnät. Energinet’s Control Centre at Erritsø shall acknowledge the receipt of order. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations. After the work is finished, switching confirmations shall be exchanged.

## Disturbance management

### Cross-border link trips – management

In the event of operational disturbances, measures in accordance with issued instructions shall, as soon as possible, restore the link to operation within defined security limits.

### Switching schedule/Operational orders

In the event of faults requiring switchings which have an impact on the 400 kV Öresund links, Energinet’s Control Centre at Erritsø and Svenska kraftnät’s Operations Centre at Sundbyberg (DCSY) are informed prior to any switchings are made.

For switchings in the Swedish grid, a switching schedule/operational order is drawn up by Svenska kraftnät’s Operations Centre at Sundbyberg (DCSY).

For switchings in the Danish grid, a switching programme is drawn up by Energinet’s Control Centre at Erritsø.

### Fault finding

Initial fault finding is carried out differently from case to case. Generally, it is the respective facility owner who is responsible for fault finding.

### Fault clearance, remaining faults

Once the fault has been localized, the respective facility owner will look after fault clearance. For fault clearance, a special preparedness plan for submarine cables has been drawn up.

# System operation for facilities under 2.1 and 2.2

## Total Transmission capacity (TTC)

### Transmission capacity in MW per cable bundle

|  |  |  |  |
| --- | --- | --- | --- |
| Line | 5 °C | 15-20 °C | 30 °C |
| Hovegaard – Söderåsen | 830 | 830 | 830 |
| Görlöse – Söderåsen | 830 | 830 | 830 |
| Teglstrupgaard 1 – Mörarp | 182 | 182 | 154 |
| Teglstrupgaard 2 – Mörarp | 173 | 173 | 157 |
| Hasle, Bornholm - Borrby,  | 60 | 60 | 60 |

### Transmission capacity in MW per link

* To Eastern Denmark

|  |  |
| --- | --- |
| Link | Capacity (MW) |
| Öresund (Zealand) | 1,350 |
| Bornholm | 60 |

* To Sweden

|  |  |
| --- | --- |
| Link | Capacity (MW) |
| Öresund (Zealand) | 1,750 |
| Bornholm | 60 |

The transmission capacities (TTC) of the links are technically dependent and can be affected by the current operational situation in Zealand.

## Routines for determining the transmission capacity

The transmission capacity between Eastern Denmark and Sweden shall be set on a daily basis by the Parties.

## Trading capacity (Net Transmission Capacity – NTC)

Determination of the capacity is based on the combined transmission capacity of the 400, 130, and 60 kV transmission facilities. When determining the trading capacity (NTC) of the links, the applicable regulation margin of 50 MW is taken into account. A weekly forecast for the trading capacity shall be established for the coming week.

If a country can guarantee *counter trading* and the existence of sufficient *fast active disturbance reserve,* the *trading capacity* may be increased.

## Operation monitoring and control in respect of system operation

*Operation monitoring* of borders and transmission constraints, which can affect exchanges, is managed on the Danish side by Energinet’s Control Centre at Erritsø and on the Swedish side by Svenska kraftnät’s Operations Centre at Sundbyberg (Svk-vhi).

## Voltage regulation

The basic principle for voltage regulation is governed by section 7 point 7.5 in the agreement.

### Voltage regulation on the Swedish side

The Operations Centre in Sundbyberg (DCSY) is responsible for voltage regulation in the southern parts of the grid.

The following voltage levels are applied:

|  |  |  |  |
| --- | --- | --- | --- |
| Substation | Minvoltage (kV) | Normal operation range (kV) | Maxvoltage (kV) |
| Söderåsen | 395 | 400-410 | 420 |

### Voltage regulation on the Danish side

The Control Centre at Erritsø is responsible for voltage control in Zealand.

The following voltage levels are applied:

|  |  |  |  |
| --- | --- | --- | --- |
| Substation | Minvoltage (kV) | Normal operation range (kV) | Maxvoltage (kV) |
| Hovegaard | 380 | 390-410 | 420 |
| Görlöse | 380 | 390-410 | 420 |
| Teglstrupgaard 1 | 130 | 130-137 | 137 |
| Teglstrupgaard 2 | 130 | 130-137 | 137 |

### Co-ordination of voltage regulation

Mvar contribution from the cables is distributed between Svenska kraftnät and Energinet in the same proportion as their ownership.

At a voltage of 400 kV, the facilities FL23 and FL25 each will generate 150 – 170 Mvar. The reactors at Hovegaard and Söderåsen compensate this generation by 110 Mvar per line.

The 400 kV voltage at Hovegaard and Söderåsen shall be regulated so that the given Mvar distribution is achieved as well as possible. Minor deviations in the region of 25 Mvar are accepted in normal operation. Short-term deviations from this Mvar range can occur for example in conjunction with the connection of capacitor batteries or reactors. There can be deviations in the Mvar distribution in conjunction with disturbances.

## Outage planning

The Parties shall, in consultation, plan outages on the links and on their own networks if the transmission capacity of the links is affected.

Operational planning and maintenance are co-ordinated in consultation between Energinet’s Operational Planning at Erritsø and Svenska kraftnät’s Outage Planning at Sundbyberg.

Operational planning and maintenance which affects the entire Nordic system shall, whenever possible, be co-ordinated in consultation with all system operators.

## Disturbance management

The term disturbance situation here means that the operational security limits have been violated due to, for instance, long-term line faults or the loss of production. If the transmission capacities are not exceeded during the faults, the situation will be deemed to be normal.

In the event of operational disturbances, measures in accordance with the issued instructions shall, as soon as possible, restore the link to operation within defined security limits.

# Miscellaneous

## Parallel operation 130 kV

Power transmitted via the 130 kV network does not entail any liability to render payment or any other reimbursement of expenses from Svenska kraftnät or Energinet.

## Transmissions to Bornholm

As regards balance, Bornholm is managed as a part of the Eastern Danish subsystem. Energinet shall be responsible for the production resources on Bornholm being capable of being utilized for general system operation requirements in the same way as the production resources in the rest of Eastern Denmark.

## Co-ordination of fast active disturbance reserve south of constraint 4

Svenska kraftnät and Energinet shall ensure that there is sufficient fast active disturbance reserve to cope with dimensioning faults based upon each subsystem’s responsibility for its own reserves. Svenska kraftnät and Energinet’s Control Centre at Erritsø shall exchange information regarding how much fast active disturbance reserve there is which can restore the operational situation to normal state following a fault.

During normal state, Svenska kraftnät and Energinet’s Control Centre at Erritsø co-ordinate the fast active disturbance reserve in Southern Sweden and Eastern Denmark by summing up all available reserves in SE4 and DK2. If the total amount of reserves is not enough, the requirements should be distributed in accordance with the following distribution rules:

(Dimensioning fault) x (own fault) / (own fault + counterparty fault)

Dimensioning fault = largest fault in area south of constraint 4

Own fault = largest fault in own area south of constraint 4

Counterparty fault = largest fault in counterparty’s area south of constraint 4

In Sweden, south of constraint 4, the largest fault is typically the result of:

* Network part of constraint 4
* Baltic Cable
* SwePol Link
* NordBalt

In Eastern Denmark, the largest fault is typically the result of:

* Unit at the Avedöre plant
* Kontek
* Great Belt