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| Joint operation between the Finnish and Swedish subsystems on the AC links and Fenno-Skan | | | | |
| Appendix 2 to SOA Annex OS (FI 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 400 kV AC links and the Fenno-Skan 1 and 2 DC links.

# Transmission facilities linking the subsystems Sweden – Finland

## Transmission facilities which are owned/held by system operators

Northern connections between Finland and Swedish bidding area SE1

|  |  |  |
| --- | --- | --- |
| **Facility** | **Voltage level** | **Settlement point** |
| Petäjäskoski – Letsi | 400 kV AC | Petäjäskoski 400 kV |
| Keminmaa – Djuptjärn | 400 kV AC | Keminmaa 400 kV |

Southern connections between Finland and Swedish bidding area SE3

|  |  |  |
| --- | --- | --- |
| **Facility** | **Voltage level** | **Settlement point** |
| Fenno-Skan 1, Rauma-Dannebo | 400 kV DC \*) | Rauma 400 kV AC |
| Fenno-Skan 2, Rauma-Finnböle | 500 kV DC | Rauma 400 kV AC |

\*) Fenno-Skan 1 installed DC voltage level is 400 kV, but due to cable conditions the operational voltage is permanently reduced to 80 % in order to avoid possible cable failure.

# Electrical safety for facilities under 2.1

## General

The common ground for the electrical safety work of the system operator companies within ENTSO-E Regional Group Nordic 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

The responsibility for electrical operation for the transmission facilities is held in Finland by Fingrid. In Sweden, Svenska kraftnät holds the responsibility for electrical operation.

The power operation responsibility boundary concerning the 400 kV links lies at the border between Finland and Sweden. The power operation responsibility boundary regarding Fenno-Skan 1 and 2 lies at the ownership boundaries of the cables.

## Switching responsible operator

|  |  |  |
| --- | --- | --- |
| **Facility** | **Swedish side** | **Finnish side** |
| Petäjäskoski – Letsi | Operations Centre at Sollefteå (DCNO) | Main Grid Control Centre in Helsinki |
| Keminmaa - Djuptjärn | Operations Centre at Sollefteå (DCNO) | Main Grid Control Centre in Helsinki |
| Fenno-Skan 1 and 2 | Operations Centre at Sundbyberg (DCSY) | Main Grid Control Centre in Helsinki |

## Operations monitoring and control in respect of electrical safety

Same parties as under section 3.3.

## Switching schedule

Switchings on the 400 kV links are carried out in accordance with a switching schedule drawn up by Svenska kraftnät. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.

Switching concerning Fenno-Skan 1 and 2 takes place as follows:

* The necessary switching required to switch off, earth and issue switching confirmations for the polar cables is implemented in accordance with switching schedules drawn up by Svenska kraftnät. Templates for these switching schedules have been drawn up jointly between Fingrid and Svenska kraftnät.
* Switching in Rauma alone takes place in accordance with a switching plan drawn up by Fingrid.
* Switching in Dannebo or Finnböle alone takes place in accordance with a switching schedule drawn up by Svenska kraftnät.

## Disturbance management

When a cross-border link is taken out of operation, the control rooms will contact each other immediately.

As and when required, the switching responsible operators issue the necessary switching schedules in order to carry out fault finding and clearance.

The switching responsible operators conduct fault finding in consultation.

Clearance of remaining faults is organised by the switching responsible operators in consultation.

For Fenno-Skan 1 and 2, the Preparedness plan for fault clearance is used.

# System operation for facilities under section 2.1

## Total Transmission Capacity (TTC)

### 400 kV AC links

The transmission capacity (TTC) to Finland is dependent upon the temperature in northern Sweden and Finland, as follows:

|  |  |  |
| --- | --- | --- |
| Temperature | ≤ 20 °C | > 20 °C |
| Capacity | 1,650 MW | 1,600 MW |

The transmission capacity to Sweden is limited because of dynamic reasons as follows:

|  |  |
| --- | --- |
| Constraint 1 | Max. transmission to Sweden |
| 3,000 MW | 1,200 MW |
| 3,100 MW | 1,100 MW |
| 3,300 MW | 1,000 MW |

The transmission capacity of only one 400 kV link in the north is a maximum of:

|  |  |  |
| --- | --- | --- |
|  | Planned outage in the other link | Disturbance in the other link |
| To Finland | 500 MW | 500 MW |
| From Finland | 400 MW | 400 MW |

### Fenno-Skan

The installed transmission capacity of Fenno-Skan 1 is 500 MW. Due to submarine cable conditions Fenno-Skan 1 is permanently operated with reduced DC voltage (80 % level) causing reduction of the transmission capacity down to 400 MW. The temperature dependent transmission capacity of Fenno-Skan 1 is not used during the voltage reduction.

The transmission capacity on Fenno-Skan 2 is normally 800 MW. Fenno-Skan 2 also has a thermal overload capacity which can be used in accordance with valid instructions.

## Routines for determining the transmission capacity

The transmission capacity between the subsystems is set on a daily basis in consultation between the Main Grid Control Centre in Helsinki and Svenska kraftnät’s Grid Supervisor at Network Control at Sundbyberg.

Both parties shall inform the other party in good time before the day of operation of the transmission capacity on Fenno-Skan and on the northern links. The minimum values will be the transmission capacity.

## Trading capacity (Net Transmission Capacity - NTC)

When determining the trading capacity of the AC links, the transmission capacity is reduced by a regulation margin of 100 MW. The trading capacity of Fenno-Skan 1 is equal to its transmission capacity, normally with reduced voltage 400 MW. The trading capacity of Fenno-Skan 2 is equal to its transmission capacity, normally 800 MW.

## Operations monitoring and control in respect of system operation

Operations monitoring and control in Finland are carried out from:

* The Main Grid Control Centre in Helsinki as regards AC links and Fenno-Skan 1 and 2.

Operations monitoring and control in Sweden are carried out from:

* Svenska kraftnät’s Grid Supervisor at Network Control at Sundbyberg concerning 400 kV AC links and Fenno-Skan 1 and 2.

Regulation of Fenno-Skan 1 and 2 is carried out on an alternating basis per half calendar year: the first half by Svenska kraftnät’s Operations Centre at Sundbyberg and the second half by the Main Grid Control Centre in Helsinki.

## 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 Sollefteå (DCNO) is responsible for voltage regulation in the northern parts of the grid.

The following voltage levels are applied:

|  |  |  |  |
| --- | --- | --- | --- |
| Substation | Min voltage (kV) | Normal operation range (kV) | Max voltage (kV) |
| Letsi | 395 | 400-410 | 415 |
| Djuptjärn | 395 | 400-415 | 420 |

The minimum voltage is a voltage which the power system can withstand with a certain margin against a voltage collapse. The maximum voltage is the design voltage of the equipment. The target value for voltage lies within the normal operation range.

### Voltage regulation on the Finnish side

For voltage regulation, there are reactors on the tertiary windings of transformers and capacitors in the 110 kV system.

At Keminmaa, the capacitor is connected for reactive energy on the 110 kV side of transformers. The reactors are connected by means of automation for 400 kV voltages. The automation has three windows of ±4 kV and it can be adjusted upwards and downwards from the Main Grid Control Centre.

At Petäjäskoski, the reactors are connected manually.

The following voltage levels are applied:

|  |  |  |  |
| --- | --- | --- | --- |
| Substation | Min voltage (kV) | Normal operation range (kV) | Max voltage (kV) |
| Petäjäskoski | 380 | 400-417 | 420 |
| Keminmaa | 380 | 399-417 | 420 |

### Co-ordination of voltage regulation

Problems can arise on the Djuptjärn - Keminmaa line if the Swedish side does not pay attention to the Finnish voltage regulation principle. There can be consequential impacts between reactor connections at Svartbyn and corresponding connections at Keminmaa on account of the size of the reactor at Svartbyn, 150 Mvar. The voltage at Svartbyn shall be held within 406 - 414 kV. If problems occur, the relevant control centres shall contact each other.

## Outage planning

The Parties shall plan, in consultation with each other, outages on the links and on their own networks when such outages will impact upon the transmission capacities of the links.

Planned outages on Fenno-Skan 1 and 2 are to be co-ordinated with the other HVDC links of the Nordic area.

## 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.

When a cross-border link is disconnected, the control rooms will immediately contact each other and jointly reduce the transmission level to permissible values.

During hours when a disturbance situation is in force, loss minimization is not employed.

During disturbance situations, both Fingrid and Svenska kraftnät have the right to regulate Fenno-Skan 1 and 2 to support their networks. Fenno-Skan 1 and 2 can be used as much as possible facility-wise and to an extent not entailing any difficulties in the other Party’s network.

During a disturbance situation, the Fingrid and Svenska kraftnät shall immediately contact each other and agree that it is a disturbance situation. In conjunction with this, it must also be agreed how much Fenno-Skan is to be regulated and who will regulate. If the situation is very serious and the situation in the other Party’s network can be assumed to be normal, then Fenno-Skan can be regulated by the Party affected by the disturbance without any previous contact. Such unilateral regulation may not, however, exceed 300 MW counted from the current setting.

If Fenno-Skan 1 and 2’s emergency power regulation has been activated, this will also be deemed to be a disturbance situation. If the emergency power intervention entails counter trading requirements for a Party not being affected by a disturbance, then Fenno-Skan 1 and 2 shall be regulated within 15 minutes to such a value that the counter trading requirement ceases.