Counter Measures for Congestion Management

Definitions and Basic Concepts

June 2003

1. Introduction

The objective of this short note is to give an overview and to provide a simple definition of different operational counter measures taken by TSOs for congestion management. The focus of this note is on the counter measures that can be performed by the operator in the control centre during real-time operation in order to solve congestion caused by incidents which reduce transfer capacity. Longer term or 'market-driven' mechanisms like allocations of network capacity by capacity auctioning are not considered.

The main goal of such measures is to solve congestion arising from variations in the scenario assumed to compute the Net Transfer Capacity (NTC) value. These variations might include generation or network outages, unforeseen levels of demand/renewable generation, etc. Congestion Management measures become necessary when the physical capacity is no longer sufficient to accept the allocation based on the published NTC value.

Together with this main objective, these measures can also be applied in some cases for increasing transfer capacity at a quite low cost (e.g. topological measures such as radial operation of interconnection lines).

All counter measures can roughly be classified according to different characteristics:

- Time needed for realisation or time horizon of activation:
  - During the day of operation (d) performed by the network operator in reaction to an unexpected congestion and due to variations of the scenario leading to a reduction of allocated transfer capacity. Congestion management during operational planning and in real time is sometimes also called congestion and security management (CSM).
  - Preventive measures that are performed day ahead (d-1) or even further in the past during the planning process in order to increase transfer capacity or to avoid/prevent expected congestion (e.g. outage of tie lines)
- Modification of power flows:
  - Network changes to redistribute power flows on the tie-lines
  - Adaptation of the generation or load pattern
- Exchange program between control areas:
  - Measures without change of the exchange program
  - Measures with change of the exchange program:
    - Without change of the previously established cross-border schedules
    - With change of the previously established cross-border schedules

2. Basic Types of Counter Measures

According to the nature of the adopted mechanism the counter measures can be classified as follows:

- **Topology actions**: particular examples of this category are switching of bus couplers and lines, adjustment of phase shifter tap positions, or radial operation of interconnection lines (single feeding). The TSO determines in case of congestion the optimal combination of topology actions.
- Counter measures based on changes of the **generation or load pattern** are called **redispatch**.

The table below provides a short definition and a simplified example of the basic types of counter measures. Combinations of these basic measures are possible, too.

Topology actions

Topology actions in the grid can normally be performed by operators in the control centre during real-time operation (d) within some minutes or previously (e.g. during maintenance planning according to the network elements planned to be out of operation). Of course they can also be carried out in advance. The measures comprise switching of bus couplers and lines and the adjustment of phase shifter tap settings, if installed, or even the radial operation of a tie-line with single feeding at one end. Switching actions can further be subdivided into:

1) Actions performed by only one TSO,
2) Actions performed by two or more TSOs in a co-ordinated way. The TSOs inform each other about the actions. The whole set of actions solves the congestion problem.
3) Actions performed by both (or more involved) TSOs jointly. In this case the TSOs make a common optimisation of the measures to be taken.

Any topology action mainly affects the distribution of the power flow of the internal and tie-lines, but does not usually affect the total power exchange between the control areas (excluded extreme cases of topology changes, e.g. disconnection of all tie-lines between two control areas). Therefore the costs of these measures are only caused by higher network losses due to the deviation from the loss-minimal “natural” power flow. In case of the installation of a phase shifter the increase of losses can be significantly high.

These measures might require a certain degree of co-ordination between TSOs, at least for information exchange (day-ahead and real-time).

Redispatch

Redispatch measures can be further subdivided into

- Redispatch without change of the exchange program
- Redispatch with change of the exchange program

a) Redispatch without change of the exchange program

The power flow is affected by a displacement of the power injections. The simplest case is the **internal redispatch** within one control area in order to redistribute the power flow on the tie-lines without changing the exchange program between control areas. A variant of this measure is when two TSOs inform each other about the necessary redispatch and agree to solve the congestion problem in a co-ordinated way by an internal redispatch of each of them in its control area. This could be called a **co-ordinated redispatch**. It is in general not based on a common optimization. The exchange programs remain unchanged so that the total power exchange between control areas remains unchanged. The internal redispatch can be performed by the grid operators in the control centre up to real-time operation.

b) Redispatch with change of the exchange program

In contrast to the above mentioned measures, following redispatch measures do affect the exchange program between the two concerned control areas by increasing the total generation in one control area and decreasing the generation in the other control area by the same amount (load change can also be taken under consideration in some cases).

Joint cross-border redispatch is performed by the grid operators in the control centres during real-time operation. The grid operators of the concerned control areas determine jointly which producers or big consumers should modify their power injected into or taken out of the transmission system. The determination of which generators/loads should be affected can be supported by an optimisation tool in order to obtain an optimal solution regarding physical power flow and costs. The resources for the redispatch are normally acquired via a bidding process where generators offer to the TSOs their possibilities for generation increase or decrease, and where loads offer their possibilities for load reductions. Joint cross-border redispatch leads to an optimal solution of the congestion problem for both TSOs because the offers take into account the geographic location of generators and load in the grid (bids related to specific nodes).

A particular solution is the so-called **counter trade**. The concerned TSOs use offers from producers or traders at power exchanges (PXs) to increase or decrease the generation in their areas. The exchange program of the two control areas is changed but the previously established cross-border transactions are fulfilled. The resulting change of the generation pattern is not necessarily optimal regarding physical power flow and costs, due to the fact that the trade at PXs is not defined geographically per electrical node. This definition of counter trade differs slightly from the one used today in some European areas but is necessary in order to properly distinguish between redispatch based on located bids and based on non-located bids.

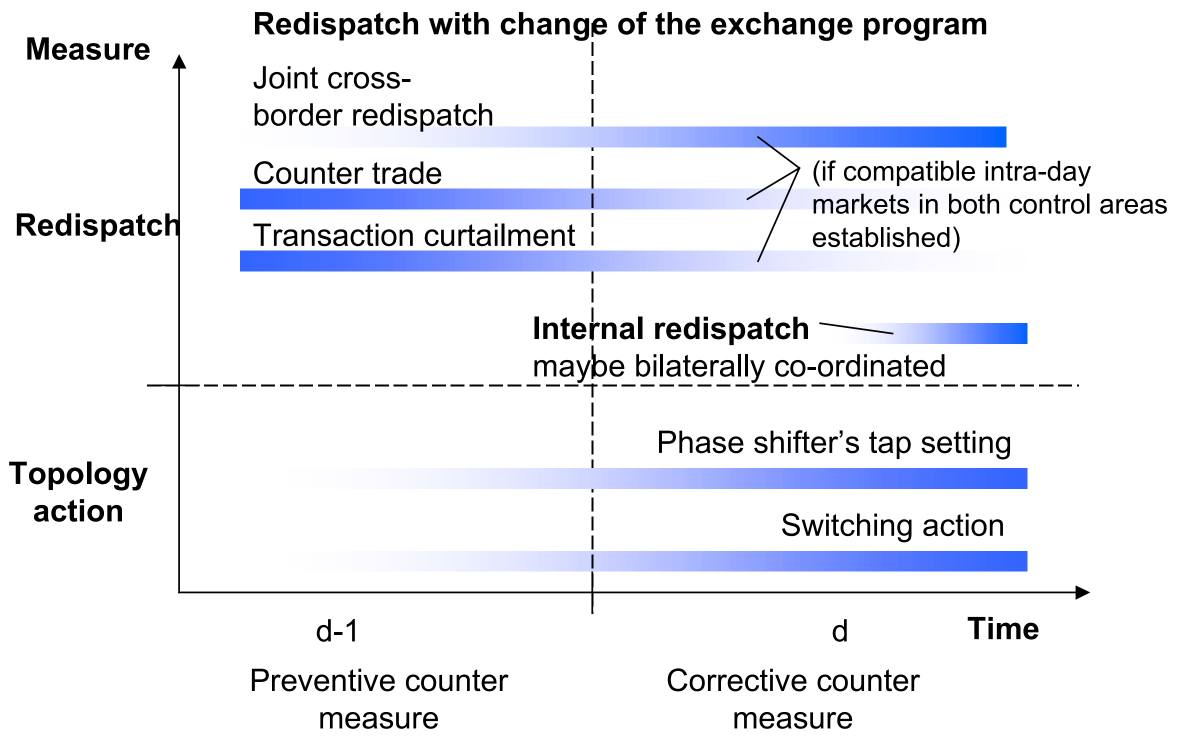
Another particular solution of redispatch with change of the exchange program is **transaction curtailment**. The cross-border schedules of the transaction holders affecting the congestion are reduced according to predefined criteria (e.g. pro rata or other criteria). The exchange program of the two control areas is changed. Transaction curtailment may be achieved by an optimal joint cross-border redispatch with financial liability being sent back to those market participants having commercial cross-border contracts. For example, a particular case of "transaction curtailment" between 2 countries may be implemented by a physical process of joint cross-border redispatch, associated to a pro-rata reduction of allocated capacities that induces imbalances for those market actors engaged in cross-border exchanges between the 2 countries. Transaction curtailment may also be implemented by asking the holders of cross-border capacity to manage themselves the subsequent change of generation, which is not necessarily optimal because there is no direct link between the change of generation by the curtailed traders on the one hand, and the optimal de-/increase of generation based on locational defined bids on the other.

In summary, these three measures of dispatch differ in the way that generators are selected to increase or decrease their power injection.

Joint cross-border redispatch can be performed by the grid operator in the control centre <u>during real-time</u> operation, whereas a redispatch caused by transaction curtailment or counter trade is generally carried out through modifications in the programs during the <u>day ahead</u> (d-1). However, in principle counter trade and transaction curtailment could also be carried out in a shorter time frame, on condition that compatible short-term markets are established in both concerned control areas. At present, this is not yet always the case.

Finally, it is important to point out that these solutions are not mutually exclusive and can of course be used in combination.

Counter Measures for Congestion Management and indicative times of application

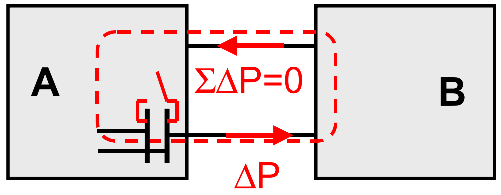
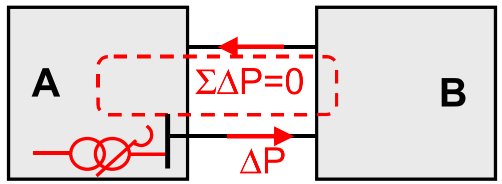
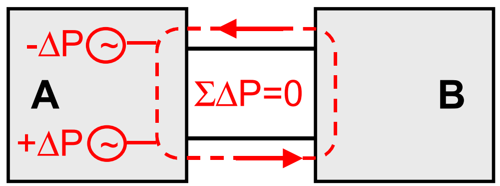
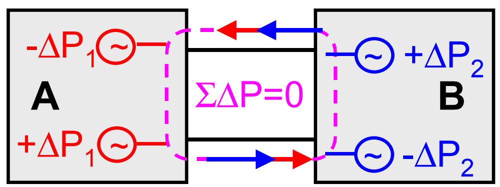


3. Definition of Counter Measures for Congestion Management

Redistribution of Power Flow

Topology Actions

Redispatch

Counter Measure	Definition	Example
Switching action 1. unilateral (A only) 2. co-ordinated (A and B) 3. "joint cross-border" (A and B, common optimisation)	Switching of a bus coupler or an internal line in order to redistribute the power flow in the tie-lines. The exchange program between control areas remains unchanged. Minor extra costs in operation due to higher losses.	
Readjustment of phase shifter's tap setting 1. unilateral (A only) 2. co-ordinated (A and B) 3. "joint cross-border" (A and B, common optimisation)	Readjustment of one or more phase shifters tap settings in order to redistribute the power flow in the tie-lines. The exchange program remains unchanged. The installation of a phase shifter causes significantly higher losses in the network.	
Redispatch without change of the exchange program 1. Internal redispatch (A only) 2. Co-ordinated redispatch (Co-ordination between A and B but no joint determination of redispatch measures)	Redispatch of the generators (or load) in <u>one</u> control area (A) or in both (A and B) <u>without</u> change of the exchange program between control areas in order to redistribute the power flow of the tie-lines. Redispatch costs to be shared between both systems in any case.	 

Redispatch

Change of Exchange Program

Redispatch with change of the exchange program 1. Joint cross-border redis-patch (joint determination of redispatch measures, performed by TSOs during real-time operation) 2. Counter trade (usually day ahead) 3. Transaction curtailment (usually day ahead)