A4 – Appendix 4: Coordinated Operational Planning

Chapters

A. Capacity Assessment

B. UCTE network calculations

History of Changes

v0.4 final appendix approved by the UCTE Steering Committee on 03.05.2006

Current status

This document summarises technical descriptions and backgrounds of a subset of current UCTE rules and recommendations related to coordinated operational planning, with additional items. *This version of the document (version 0.4, level E, dated 03.05.2006) has "final" status.*

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A. Capacity Assessment

Guideline for NTC determination.

Definitions

NTC (net transfer capacity)

NTC = BCE + ΔE – TRM

where:

BCE: Base Case Exchange (scheduled exchange)

ΔE: Maximum Shift of generation that can be assigned to control areas involved in the interconnection preventing any violation from appearing with n or (n-1) criterion.

TRM: Transmission Reliability Margin

ATC (available transfer capacity)

ATC = NTC – AAC

where:

AAC: already allocated capacity

Reference Base Case Preparation

The input data sets (Winter, Summer) are the UCTE reference cases based on the UCTE snapshot that have to follow the following rules:

- For all generation nodes that are to be considered for the NTC determination, the minimal and maximal output power must be indicated. Generators out of operation in the base case must also be included, with their corresponding limits, so that they could be switched on if necessary during NTC determination.
- In cases where a node of the transmission network is linked by a transformer to a lower voltage radial network with load and generation, the load and the generation can be summed up separately and indicated in the node of the transmission network (thus the aggregated generation of the lower voltage network can be used for the NTC determination). In this case the summed minimum and the maximum of the generation power must be indicated. In the case of meshed underlying networks, that procedure is not admissible; such networks have to be explicitly modelled.
- Pump storage stations that also have to be considered for the NTC determination can be defined by the indication of the minimal and maximal power limits.

Definition of Generation Shift Method

Generators that take part in the NTC determination must be characterized by their minimal and maximal power limits. It is possible to choose a limited number of generators to perform NTC calculation manually, especially when there are many generators.

Generation shift method deals with the way the global exchange shift is shared between the different generation units.

The chosen generators are used for the NTC determination in the following way: in the area of one TSO (generators i=1,n) the generators' active power is increased and in the area of the other TSO (generators j=1,m) the generators' active power is decreased by the same value simultaneously.

That shift can be accomplished as follows:

Method A:

All chosen injections are modified proportionally to the remaining available capacity.

$$P_{new}^{inc} = P_i + \Delta E \cdot \frac{P_i^{max} - P_i}{\sum_n (P_i^{max} - P_i)}$$

$$P_{new}^{dec} = P_i + \Delta E \cdot \frac{P_i^{min} - P_i}{\sum_n (P_i^{min} - P_i)}$$

additional condition : $|\Delta E| \leq |\sum (Pmax - Pi)|$

additional condition : $|\Delta E| \leq |\sum (Pmin - Pi)|$

Advantage: generation over-utilization is impossible and generation capacities are reached simultaneously. It is also ensured that the evacuating lines are not overloaded because their capacity was based on the maximal power evacuation.

That method should be used by TSOs in the normal case, because it respects the physical limits while operating a transmission grid. The last value of ΔE^{max} is determined when all generators or any network element reached its operation limits.

Method B:

This method can be used in emergency cases if the indication of the generation limits are missing or as a further calculation after the capacities used in method A have all been reached.

All chosen injections are modified proportionally to the current generation:

$$P_{new}^{inc} = P_i + \Delta E \cdot \frac{P_i}{\sum_n (P_i)}$$

$$P_{new}^{dec} = P_i + \Delta E \cdot \frac{P_i}{\sum_n (P_i)}$$

In this method, the generation limits are not considered; this can lead to an over-utilization and thus to unrealistic NTC results. The method B indicates a theoretical NTC value of the transmission grid without taking the physical limits of production into consideration.

Method C:

The chosen injections are modified proportionally according to a merit order with indications of the ranking after each injection taking the maximal and minimal production into account.

where:

P_i : Actual active power generation (MW)

P_{new}^{inc} : New increased injection, in next iteration it will be P_i

P_{new}^{dec} : New decreased injection, in next iteration it will be P_i

ΔE : Shift generation, negative for increasing and positive for decreasing

P_i^{max} : Maximum permissible generation (MW)

P_i^{min} : Minimum permissible generation (MW)

Generation Shift Computation (ΔEmax)

After the generations and the shift method for the NTC determination have been chosen, ΔE is increased iteratively until a relevant constraint is violated.

Shift Limitation due to Security Constraints

After each iteration step, the n-1 security must be checked in the one's own transmission network; each TSO must decide which elements are to be considered in the n-1 security analysis. It is advisable to take into account some elements in neighbouring systems as well as in one's own grid.

At any rate, the detailed security aspects must be exchanged between the neighbouring TSOs.

Handling of transformer taps, reactive power and losses

During the NTC determination, the transformer taps and the reactive injections of PQ nodes are not changed. The change of losses caused by the load flow shift is compensated in the slack node.

B. UCTE network calculations

UCTE Network Data Sets

The need to compute the behaviour of the meshed European electric network requires that each TSO provides a network data set that describes the model of each network including the generation and load data. This data set is given in the UCTE format.

There are three types of data sets:

- Forecast – used in the DACF procedure,
- Snapshot – information retrieved from the real-time system, describing the real situation,
- Reference – full description of the network for future winter and summer situations.

These data sets provide a useful data base that enables various types of studies, such as:

- expansion of the UCTE network,
- computation of the NTC values,

Forecast data sets. These so called DACF data sets are used to forecast possible congestion. The detailed description of these data sets can be found further in this document.

Snapshot data sets. Each TSO retrieves from the Energy Management System (EMS) the real time data needed for this task. Normally the network data is obtained from the State Estimator. Since this application is a statistical tool, in order to facilitate the convergence of the full European network, it is recommended to provide the snapshot after a power flow computation. The network equipment that is out for maintenance is marked as out of operation. In order to enable merging of the data TSOs have to use the same timestamp for the snapshot data sets. The timestamps used are normally 03:30 and 10:30 CET. These timestamp aim to coincide with the minimum and maximum load of the UCTE network, but due to the big solar gap and the difference in load behaviour between Iberia and Greece, the data sets do not always describe the extreme load situation of each TSO

Reference data sets. These data sets are forecasted not for the day after (used in the DACF), but for the medium or the long term The medium term forecast is made for the next summer or winter to provide a good base to compute the NTC. The long term forecast is made to enable studies related to the expansion of the synchronous UCTE network. For the reference data sets all the network and generation data must be provided, including the minimum and maximum limits of active and reactive power (MW, Mvar) for each generator/plant. All the network elements are considered to be in operation.

DACF procedure:

The different steps of the modular short-term load flow forecast and security analysis are the following:

- Based on a data set of its own network each TSO collects the forecast data for the agreed timestamps (production schedules from the 750-/380-/220-kV-power plant operators, topology, etc.) and adjusts a suitable selected load flow data set in the following way:
    i. Extract the part of the data set representing the own network by cutting all TIE-LINES in their electrical center (half the line parameters) and adding a fictitious node (starting with the character "X" in its name).
    ii. Replace the injections (generation) in the own network by the node-based aggregated production schedules (considering the export/import situation) and adapt the network topology, tap position, etc., according to the expected state of the forecast time of the following day.
    iii. Adjust the loads in the own region based on a convenient estimated load distribution, taking into account the production in the distribution system, so that the sum of the productions minus the losses minus the sum of the loads equals the control program (i.e. the sum of the scheduled power exchanges including generation of power plants operating in VIRTUAL TIE-LINE mode).
    iv. Determine enough possibilities of realistic Mvar production in his network to allow the load flow to reach a suitable voltage level.
    v. Adjust the injection (load or generation) in the fictitious X-nodes to match the control program according to roughly estimated TIE-LINE flows. These adjusted flows have no influence on the results obtained after the composition of the total interconnected system, because their sole purpose is to allow a stand-alone plausibility check of the TSO's network.
    vi. Carry out a stand-alone load flow calculation of the TSO load flow data set to check the proper participation of the slack bus (only used for compensating the network losses) and the plausibility of the result (MW, Mvar, voltage).
- To exchange the control programs, the VULCANUS system is used, once its flaws (e.g. VIRTUAL TIE-LINES of jointly owned power plants) are corrected. Each TSO takes the last available and convenient load flow DACF data set.
- After having collected the complete load flow data sets of all other TSOs all these data sets have to be merged (reference will be given) by connecting the "X-nodes" and setting the X-node injections to zero.
- Adjust the production or even load in TSOs for which the time stamp is not available (or even group of TSOs) linearly or using other information so that the sum of the production minus the losses minus the sum of the loads equals the control program.

- Perform a security analysis for all TIE-LINES on the merged DACF data sets.

DACF visualization.

The defined DACF procedure is visualized in the following figure.