METHODOLOGY FOR THE JOINT ASSESSMENT OF THE NET TRANSFER CAPACITY AT THE NORTHERN ITALIAN INTERCONNECTION

Adopted within the activities of the Technical Task Force among the Transmission System Operators Eles, swissgrid, RTE, Terna and Verbund-APG

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FOREWORD

This document aims to provide the methodology adopted since 2004 for the assessment of the Net Transfer Capacity (NTC) of the Italian northern interconnection, both in import direction to Italy and in export. In particular, this document describes:

- how the NTC values are currently evaluated and what scenarios are considered as reference for this assessment.
- the methodology adopted to evaluate the TRM margins.

The methodology is harmonised between **Terna** and the Transmission System Operators **ELES**, **RTE**, **swissgrid** and **Verbund-APG** (later on called *the involved TSOs*), neighbouring with the Italian northern border. The delegations of each TSO take part to a Working Table that carry out all the activities needed to check NTC consistency and reliability as well as to ensure transparency towards supervisory bodies.

The Working Table is set up yearly and meets periodically.

The methodology adopted for the NTC assessment of northern Italian interconnection, both in import direction to Italy (later on called **Import NTCs)** and in export from Italy (later on called **Export NTCs)** is in line with the ETSO rules [1, 2] for the transfer capacity assessment and with the UCTE technical guidelines [3].

Each delegation takes its own responsibility on:

a) the data provided for the calculations;

b) the sustainability of the agreed NTC values, including all information behind;

c) the procedures adopted in operation.

The principles given in par 2.7 are integral part of the process.

1. NOTATIONS

The notations, commonly used in applying the method for the NTC assessment, are those included in the ETSO guidelines [1] and in the UCTE Operational Handbook [3].

The NTC values, evaluated in the year Y, come into force in the target year Y+1. All the analyses are based on the historical data of the physical power flows recorded in the year Y-1 and the forecasted changes (grid development and generation pattern) within the responsible region.

2. METHODOLOGY OF THE NTC ASSESSMENT

The assessment of the transmission capacity on the northern Italian border is jointly performed by the involved TSOs within the activities of the technical working table.

The security analyses are performed adopting the N-1 security criterion on the grids under the control of the involved TSOs. An Alternate Current (AC) load-flow algorithm is used. The NTC assessment is carried out on the basis of network datasets, called "*base cases*" (see par.2.2), processed in order to represent the forecast reference status of the interconnected network at the time frames considered (see par. 2.1). These cases are built on real and complete UCTE data sets properly selected. The NTC is assessed on a yearly basis during the year Y with reference to the year Y + 1,

2.1. TIME FRAMES

The NTC assessment takes into account reference situations of the power system, in four time frames:

- peak and off-peak hours expected in Winter period,
- peak and off-peak hours expected in Summer period.

All the TSOs accepted to apply the following definition for the mentioned seasonal periods:

- Winter period, 1st January to 30th April and 1st October to 31st December,
- Summer period, 1st May to 30th September, excluding August.

For each seasonal period, two different typical hours of operation are defined as follows:

- 10h30 as typical for peak hours (7h-23h),
- 3h30 as typical for off-peak hours (23h-7h).

A period throughout the year in which NTC reductions are allowed is agreed among the involved TSOs due to:

- Maintenance activities on interconnectors or internal lines affecting the operation of the interconnection, scheduled out of the month of August.
- Peculiar conditions of the Italian power system that can lead to congestions at the interconnection or within the close grid portions belonging to the involved TSOs.

The analyses concerning the NTC values, both for import to Italy and for export, in periods usually dedicated to the main activities of lines maintenance which can affect the operational security of the network, are performed by the involved TSOs. The relevant NTC values updating are developed by involved TSOs once the program of maintenance activities on network elements is harmonized. In case of extraordinary maintenance, if needed, the maintenance activities can be carried out in a time period different from August, bilaterally agreed by the involved TSOs without affecting the security of the power system.

2.2. BASE CASES CONSTRUCTION

As outlined in the ETSO general guidelines [1], cross-border power flow calculations are based on snapshots of the UCTE network. Such simulations give the possibility of taking into account the influence of the neighboring networks on the Italian northern interconnection. The involved TSOs share the base cases, chosen as reference for the aforementioned time frames, and use them to assess both the import and export NTC values.

All the base cases are modified to take into account the forecast operational conditions of the interconnected system, such as the grid topology and the generation patterns.

All the security analyses are based on the complete datasets of UCTE interconnected grid in order to reach a sufficient level of consistency and harmonization and to guarantee that each NTC value is feasible without compromising the security of the interconnected electrical systems.

Each time frame is evaluated in two different scenarios with the aim of simulating the occurrence of possible unbalances at the Northern Italian Border due to changes on power flows patterns in Europe. The base case of each scenario is selected on the basis of a statistical analysis of the yearly historical data of the physical power flows at the interconnection towards Italy .

Such analysis can enable to choose the aforementioned two different scenarios (*base cases*) for each time frame with an expected occurrence of:

- About 70% of times, called "*balanced base case*",
- About 30% of times, called "*unbalanced base case*".

The *balanced base case* are supposed to reproduce a balanced distribution of physical flows at the northern Italian interconnection. The NTC values, that are assessed through steady-state simulations performed on this base case, can be considered as the maximum reference ones for the time frame. In fact the power flows approach roughly a statistically optimal distribution on the tie-lines.

It should be noted that, in case the physical power flows are not balanced in real time operation, the balanced NTC values can be guaranteed provided that an operational procedure for congestions management (*Pentalateral procedure*, see Chapter 2.7) is in place. Such a procedure can ensure the ability to cope with congestions that can arise at the interconnection in real time operation and that can jeopardize their power systems security

The *unbalanced base case* reproduces the maximum expected unbalanced distribution of power flows on the Italian border. Such an assessment provides the lowest global NTC value: in fact the violation appears earlier in the process of NTC assessment due to the structural unbalance of power flows on the border under analysis with respect to the interconnector thermal capacities. The NTC value assessed in these conditions can be viewed as a reference minimum value for the studied time frame, and more in general as a secure and robust NTC value guaranteed almost under each network condition.

The following figure depicts the range of 16 cases available at the end of the process.

➢ IMPORT	❖ BALANCED	❑ WINTER	• **Peak** • Off - peak
		❑ SUMMER	• Peak • Off - peak
	❖ UNBALANCED	❑ WINTER	• Peak • Off - peak
		❑ SUMMER	• Peak • Off - peak
➢ EXPORT	❖ BALANCED	❑ WINTER	• Peak • Off - peak
		❑ SUMMER	• Peak • Off - peak
	❖ UNBALANCED	❑ WINTER	• Peak • Off - peak
		❑ SUMMER	• Peak • Off - peak

2.3. NETWORK MODEL

Starting from the selected base cases the network models are set up by restoring the normal operation conditions and by adding new elements for the power systems belonging to the involved TSOs, such as power plants or internal line, expected by the target year (Y+1).

2.4. INPUT DATA, GENERATION SHIFT AND LOAD PATTERNS

The input data (thermal ratings of network elements, maximum and minimum power output values of generators, priority list of generating units, etc.), used to perform load-flow calculations, are provided by each involved TSO in the reference base cases, under their responsibility.

In order to determine the cross-border transmission limits among the power systems of the involved TSOs, both in import to Italy and in export, starting from the common base cases the generation is shifted according to the following agreed rules:

- An increase of generation on the exporting side and an equivalent decrease on the importing side.
- The total amount of the generation decrease on the importing side is split among the involved TSOs' borders, according to the pro-rata criterion of NTC values of the year Y-1, for each time frame of the study.
- The generation shift of each TSO, needed to perform the previous step, is performed according to the priority list of the units operated in its control block or by using one of the other methods described in [4].
- The two items above are performed stepwise until a network limit is reached and performed taking into account its technical limits (maximum/minimum power) and additionally also the technical operation constraints of each generator (optimal use of pumping units, hydro reservoirs limits).

The Italian and other involved TSOs' load demands are changed according to the demand forecasts for the target year.

This process leads to the *shifted base cases* used to perform the load-flow simulations in order to check the security rules.

2.5. CROSS-BORDER EXCHANGES SIMULATIONS

The load-flow simulations are carried out through AC steady-state tools

Each TSO delegation performs its own load-flow calculations and shares the findings with the other involved TSOs in order to finalize the joint assessment of the values of total transmission capacities at the northern Italian border.

Afterwards each TSO reports the findings of its analyses to the others, summarized as follows:

- the values of Total Transfer Capacity (TTC) for each time frame, as a result of its own analyses;
- the most relevant overloads of the network elements, located in the control area of each TSO or at the interconnection, detected through load-flow simulations according to the N-1 criterion and to its internal operational rules.

Once the involved TSOs have shared their findings from the technical point of view, a report is submitted to a Steering Committee which endorses the results and their subsequent commercial implications.

2.6. TRANSMISSION RELIABILITY MARGIN

The TRM value is a security margin necessary to take into account a series of uncertainties possibly affecting the computed NTC values. These deviations can be caused by two main factors:

- the unintended deviations occurring in the real operation state with respect to the simulated network operation
- Unintended deviations of physical functioning of the primary and secondary control

Once the TRM value has been commonly defined, the value of NTC is determined by deducting the TRM value from the TTC value.

2.7. OTHER IMPORTANT PRINCIPLES

In developing such analyses the method applied is based on the following aspects:

- The N-1 security criterion is applied to all interconnectors and internal grid elements operated within the control area of the involved TSOs included in a belt which is considered influencing the security of the border.
- The security calculations are performed on the TTC. That is the network has to be secure even in time interval in which unintended deviations are present. The allocated NTC is the TTC – TRM.

- The thermal ratings of the interconnection lines between Italy and neighboring countries are exchanged and applied during the TTC assessment.
- Simultaneous trips of the 380kV double circuit lines at the interconnection.
- The Automatic Tripping Device (ATD) installed (e.g at 380kV Redipuglia substation) are simulated.
- Part of the security concept is the ability to cope with congestions that can arise at the interconnection in real time operation and that can jeopardize their power systems security. This is regulated by the so called Pent lateral Procedure which gives the right to each involved TSO to invoke a reduction of NTC when a congestion is detected in its own system. The amount of NTC curtailment is roughly the difference between the balanced and unbalanced NTC, previously calculated. The reduction is implemented according to a pro quota criterion, i.e. each TSO reduces an amount directly proportional to the NTC quota assigned.
- The Phase Shifter Transformers are operated to guarantee the security of the system.
- The Italian generation is considered at the maximum available output according to the internal limits of the system.
- The Transmission Reliability Margin (TRM) is assumed 500 MW, following the operational experience, and is assigned to the complete northern interconnection.

3. BIBLIOGRAPHY

[1] “Definitions of Transfer Capacities in liberalized Electricity Markets”, ETSO, April 2001

[2] “Procedures for cross-border transmission capacity assessments”, ETSO, October 2001

[3] “Operational Handbook”, UCTE, http://www.ucte.org/publications/ophandbook/

[4] ”Technical guidelines for Net Transfer Capacity determination”, UCTE March 2004

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