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METHODOLOGY FOR THE JOINT ASSESSMENT OF THE GLOBAL VALUE OF TRANSMISSION CAPACITY ON THE NORTHERN ITALIAN BORDER

Adopted within the activities of the technical Task Force
"Transmission Capacity of the Italian interconnection on the year 2005"

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1. INTRODUCTION AND CONTENT

The definition of a basic procedure for the determination of cross-border transmission capacities harmonised between neighbouring TSOs is of great importance for defining concrete and comparable values of capacities, checking their consistency and reliability as well as ensuring transparency towards supervisory bodies and has been more than once called for by the organisation of European Transmission System Operators (ETSO). Transfer capacities values represent in fact important indicators for market participants, to access the electricity market as well as to plan properly cross-border commercial transactions, and for TSOs, to manage the associated international electricity physical exchanges.

The document is structured as follows. In chapter 2, the technical definitions related to the transfer capacities, as adopted into the document, are recalled. In chapter 3, a detailed description of the sequential steps to achieve the determination of transmission capacities is provided. The following main steps are covered: the identification and processing of the network base cases, the TSOs info exchange on the network security rules, including the verification of countermeasures to restore the operational security, the implementation of the security analyses and the joint assessment of the transfer capacity values. Further verifications are also performed in order to check the consistency of the calculated transfer capacities with some operational criteria. At chapter 4, the ETSO and UCTE papers are listed as references.

The content of this document starts from the outstanding experience gained within the activities of the multilateral TF for the joint assessment of 2001-2004 TTC/NTC. A series of new concepts matured from the knowledge of the interconnection behaviour are also introduced into the procedures in order to further improve the operational consistency of the cross-border capacities. The methodologies are based on the definitions and procedures currently recommended and discussed by ETSO for the cross-border exchanges of electricity within the EU Internal Energy Market (IEM) and the technical guidelines for NTC determination, approved by UCTE.

In particular, the present document describes the methodologies of calculations applied for the joint assessment of NTC global values for the year 2005 within the ad-hoc pent lateral TF. The document, instead, does not deal with the subsequent phase of the process concerning the splitting per border of the global value of transmission capacity on the northern Italian border, which remains therefore out of the topics treated within the present document.

2. DEFINITIONS

The definitions of transmission capacities used into the present document are in line with the ones provided by ETSO in [2]. To the extent of the present document, such capacities must be intended as values assessed one year-ahead and particularly referring to a peninsular system such as the Italian network with respect to the neighbouring countries ones. The definitions of transmission capacities are recalled hereafter:

Total Transmission Capacity (TTC): maximum exchange programme between two areas compatible with operational security standards applicable in both areas, if future network conditions, generation and load patterns in these areas (and, whether applicable, in other areas strongly interconnected) were perfectly known at the time of the capacity assessment.

Transmission Reliability Margin (TRM): security margin coping with uncertainties on the computed TTC values, consisting of unintended deviations of physical flows during operation due to the physical functioning of load-frequency regulation, emergency exchanges between TSOs to handle unexpected unbalanced situations in real time, various numerical inaccuracies on used data TRM is jointly determined by TSOs according to the real-time operational experience of their power systems and interconnected networks.

Net Transmission Capacity (NTC): maximum exchange programme between two areas compatible with operational security standards applicable in both areas and taking into account the technical uncertainties on future network conditions.

The following relationship binds the previously defined parameters:

NTC = TTC – TRM

Base Case Exchange (BCE): magnitude of the global exchange programme between two areas associated to the base case

ΔE_{max}^{+} and ΔE_{max}^{-}: Maximum shift of generation without breaching security rules in the two control areas, respectively in the control area where to increase and in the one where to decrease

The following relationship binds the previously defined parameters:

$TTC = BCE + \Delta E_{max}$ [1]

The defined values of TTC, NTC, BCE and ΔE_{max} have a meaning of commercial programme values, used for the planning of commercial transactions. Such values must not be confused with the physical flows subsequent to the implementation of the commercial programmes.

3. PROCEDURES FOR TRANSMISSION CAPACITIES ASSESSMENTS

The assessment of the transmission capacity on the northern Italian border is jointly performed by GRTN and all the neighbouring TSOs usually within the activities of an ad-hoc Task Force, convened by GRTN.

The security analyses are generally carried out on a yearly basis during the year Y-1[2] with reference to the year Y, by means of Alternate Current (AC) load-flow calculations performed adopting the N-1 security criterions on the grids under the control of the involved TSOs. The transmission capacity assessment is carried out on the basis of identified network datasets, called "base cases", properly processed with the view to reasonably represent the forecasted status of the interconnected network at the time frames considered.

The security analyses are used to determine the values of total transmission capacity across the northern Italian border on a seasonal basis. Since the behaviour of the interconnected network

[1] In the base case selected, the value of global exchange programme between the two control areas (BCE) can be significantly different from the physical flows associated to the transactions (let's call Base Case Flows-BCF); this is can be due to the deviations of the functioning of primary and secondary control in real-state operation and registered within the chosen base case. In these situations, GRTN considers that using the relationship: : $TTC=BCE+\Delta E_{max}$ could bring to wrong TTC results, as the TTC value can depend on the difference between BCE and BCF. Therefore, to avoid such dependence and since for the Italian peninsular system it is normally: BCE=BCF apart from the grid losses, GRTN prefers to calculate the global TTC with the following relationship: $TTC=BCF+\Delta E_{max}$. In case that BCE=BCF, as in the normal situation, this relationship is basically equivalent to the $TTC=BCE+\Delta E_{max}$.

[2] Usually the meetings of the joint technical TF for TTC/NTC assessment on the Northern Italian border for the year Y is convened on the month of September and October of the year Y-1.

at the northern Italian border can significantly differ during the peak load hours with respect to the off peak-load hours, the calculations are performed with reference to two different time frames, daytime and night time, for each seasonal period.

On the whole, the following time frames are considered into the security analyses:

- Winter period, peak and off-peak hours
- Summer period, peak and off-peak hours
- Maintenance periods, peak and off-peak hours: during programmed outages regarding tie lines and internal lines affecting the interconnection, i.e. having a significant impact on the physical flows on the border[3]. The base cases for the analyses of the maintenance periods are built starting from the basic winter and summer cases, by properly modifying the initial dataset to reproduce network scenarios expected during the realisation of the activities of lines maintenance.

The security analyses will be performed taking into account the characteristics of balance or unbalance of the physical power flows statistically occurring on the northern Italian border. On this respect, for each time frame of study, two specific base cases will be analysed, reproducing two different cross-border grid situations with respect to the statistical distribution of the physical flows with the aim to characterise the behaviour of the interconnected grid.

- First, a grid scenario is analysed reproducing a balanced distribution of physical flows on the whole Italian border with respect to the thermal capacities of the tie-lines ("balanced base case"). The NTC so assessed can be considered as the maximum reference value for the studied time frame, as the power flows location approaches roughly the optimal distribution on the tie lines. A statistical estimation of the operational risk while applying the "balanced NTC" as firmly allocated capacity is also performed.
- Secondly, a grid scenario is analysed reproducing almost the maximum unbalanced distribution of power flows on the Italian border, specifically on the national border considered as the most congested ("unbalanced base case"). Such an assessment provides a lower 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. For building-up realistic conditions of unbalanced power flows on the Italian border, an analysis of the generation patterns and so of the exchange scenarios between the major European countries being not Italian neighbouring, will be performed, with the view to reproduce and study the causes and solutions of the levels of unbalance detectable at operational level on the border.

The single steps to be undertaken for the transmission capacities assessment are detailed in the following. All the considerations provided in the following must be intended as referring to each of the targeted base cases.

[3] The period for performing network maintenance works generally includes three weeks during the month of August: in this period the main activities for the maintenance of cross-border network and of the internal lines affecting the transits on the cross-border grid are planned. In addition a period of up to 30 days of import reduction is also identified, in order to face further periods of extraordinary maintenance and of national holydays and special events.

3.1 Base case identification

The first step of the procedure consists of the identification of the base case for the proper simulation of the whole European interconnected system operation in the targeted time frame. At this stage, a base case consists of a network model, taken from the network data recently exchanged, containing information on the network topology and on load and generation patterns of all the UCTE countries referred to the original time frame.

Each base case should simulate as best as possible the real functioning of the European synchronously interconnected network at the targeted time frame. The characteristics to be taken into account for identifying the base case can be summarised as follows:

- The base case should be available in the format commonly adopted for exchanging data among countries of Continental Europe, the "UCTE format"
- The base case should include the description of most of the countries constituting the Continental Europe synchronous interconnected system The area of study has to be as large as possible to allow an optimal simulation of the physical flows on the tie lines resulting from international exchanges, including the part of power flows circulating between the countries involved through networks of third countries
- The base case should contain at least[4] a complete modelling of all the network elements at 400 kV and 220 kV voltage levels operated within the countries of the studied area. The effect of DC links operation is taken into account by introducing elements of injection or sinks on the relevant nodes.
- The base case should provide a network situation likely to be representative of the transits in the targeted time frame, according to the operational experience of the involved TSOs. A statistical analysis of the historical transits data is implemented to support the selection of a proper base case. On this basis, a characterisation of the statistical behaviour of the northern Italian border in terms of balance of distribution of the physical flows with respect to the thermal capacities of the tie lines is pursued.

As far as applicable, the TSOs adopt one of the following options, in hierarchical order, for choosing the base cases for transfer capacities calculations:

- UCTE seasonal snapshots models: these base cases contain a complete representation of the recorded status of the whole UCTE interconnected network, validated by all the UCTE partners. Such models are provided at least twice a year with reference to Winter and Summer peak and off-peak periods, by the UCTE "Network Models and Forecasting Tools" Sub-Group (NM&FT SG).
- UCTE seasonal reference models: these base cases contain a complete representation of the forecasted status of the whole UCTE interconnected network, validated by all the UCTE partners; such models are again provided at least twice a year with reference to Winter and Summer peak- and off-peak-periods, by the UCTE NM&FT SG.
- UCTE forecast models exchanged within the Day Ahead Congestion Forecast (DACF) procedures. These network models are made available on a daily or weekly basis at the UCTE files transfer protocol (ftp) server by the single European TSOs participating in the data exchange within DACF procedures. For most of the countries, the forecast models are created with reference to one situation at peak-load (10h30) and one at off-peak load (3h30). In case of adoption of such models, the description of the interconnected network must be

[4] The introduction of grid portions operated at voltage levels lower than 220 kV into the dataset can be allowed, in case that they are expected to strongly affect the electrical behaviour of the interconnection.

large enough to allow the proper interpretation of physical flows resulting from international exchanges. Also, after the merging of the forecast models provided by single TSOs the load-flow calculation results must reasonably reproduce the total exchange program on the borders scheduled on the original DACF models.

The involved TSOs provide a table summarising the base cases commonly identified for performing the transfer capacities assessment at the different targeted time frames.

3.2 Base case processing

The second step of the procedure consists of the processing of the network model data sets constituting the identified base cases, with the aim to work out a description of the power systems optimally reproducing the conditions of the interconnected system operation at the targeted time frame.

In this phase, each TSO modifies the input data regarding the network under its control reported in the original base case and introduces updated forecasted data consistent with the targeted time frame. Each TSO provides the best estimated available input data for its own control area, by introducing the most reasonable scenarios and assumptions, according to their knowledge and operational experience of the behaviour of the grid under its control.

Such modifications to the original base case concern basically three kinds of data: the network, the generation and the load patterns in each control area.

- **Network consistency and topology**

  Each TSO, as far as the network of its control area is concerned and with reference to the targeted time frame:

  - Introduces into the dataset the description of all the new network elements (lines, transformers, substations, ..) expected to be into operation, properly modelled in UCTE format[5]. In case of a new tie-line, the relevant data of the network element are agreed between the two concerned TSOs, in order to carry out a harmonised modelling
  - Introduces into the dataset the description of all the devices for controlling power flows (e.g. Phase Shifter Transformers-PSTs, other Flexible Alternate Current Transmission Systems-FACTS) expected to be into operation, modelled in UCTE format. Further detailed information on the electrical characteristics of the devices and their modality of operation are provided, on request.
  - Checks the consistency of the electrical parameters of all the network elements and updates them, in case of upgrading of network devices.
  - Checks the seasonal thermal ratings (in Ampere) of all the network elements included into the processed dataset and notably the seasonal thermal capacities of the tie lines operated with the other involved TSOs, harmonising them if needed. In case of different values of thermal capacities detected for the same tie line, the lower value is adopted for security reasons. In case of modified thermal capacities, a list of the network elements into the processed dataset at the different timeframes is provided to the other TSOs.

[5] The description of the network elements should include at least all the electrical parameters and the set of seasonal thermal ratings values in Ampere

- Sets into operation all the network elements of the dataset reasonably expected to be operated[6], including those occasionally out of operation into the original dataset due to maintenance or tripping, lines made available after periods of outage for various reasons (EMC, long-term activities), and the new grid elements introduced into the dataset, while excluding network elements expected to be not completed or forcedly not operated for legal issues or voluntarily switched-off to relieve local congestion
- Determines the proper network topology to be adopted into the processed base case, by implementing the network conditions expected to determine the most severe grid congestion; notably, the status of the multiple bus bar circuit breakers as well as the subsequent arrangement of the network elements and power units should be set
- Informs the other involved TSOs on the sets of permanent and transitory operational limits[7] to be considered for treating the overloads of the network elements during the NTC calculations and provides, on request, the operational configuration of the protection devices installed, such as the maximum difference between the phase angles of voltages measured at the lines extremes able to allow the successful lines re-closure after tripping.

- **Generation and load patterns**

  Each TSO, as far as the generation and load operated in its control area are concerned and with reference to the targeted time frame:

  - Checks the consistency of the values of generation assigned within the original base case to the units of the network, with respect to the minimum and maximum value of the active (and reactive, if applicable) power available in each power plant
  - Checks the consistency of the load patterns assigned within the original base case
  - Updates the generation patterns within the original dataset, taking into account the new units expected to be available and the planned outages of units for various reasons (long-term maintenance, rehabilitation, re-powering, dismissing)
  - Updates the load patterns within the original dataset, taking into account the forecasted demand and information on the location of further sinks

At the end of the phase of base case processing, each TSO provides a report on the processing and on the nature and extent of all the modifications brought on the original base case.

All the modifications brought must be consistent with the operational reality both at control area level (e.g. respecting limits of units generation) and at control block level (e.g. respecting cross-border exchange programs into the base case, also after a harmonisation with the neighbouring TSOs, if needed).

All the single modifications proposed by each TSO are integrated into the original base case in order to produce the commonly adopted base case (from now on "common base case").

[6] The network topology of the processed dataset must be intended in principle as completely meshed, except the special cases mentioned

[7] Such values usually represent the maximum current sustainable by the grid element without exceeding its thermal limit starting from assigned standard environmental conditions. Generally, two values are declared:

1) Permanent value: current sustainable for any length of time
2) Temporary value: current sustainable for at least 20 minutes provided that the value of current previously operated on the grid element be lower than the permanent value

The common base case so defined is made available to all the involved TSOs and is used as starting point for the joint assessment of the transfer capacity.

The load-flow calculation performed on the common base case (from now on "base case load flow") determines the starting conditions of the interconnected networks. The exchange programs between the involved TSOs, as from the common base case, represents the Base Case Exchange (BCE) used for the transfer capacities assessment.

3.3 Rules for operation and measures for relieving congestion

The third step of the procedure consists of the mutual exchange of information regarding the operational rules to be applied by each TSO for guaranteeing the network security and the actions expected to be undertaken for facing cross-border and internal network congestion, in normal operation and N-1 security conditions:

On this respect, each TSO, with reference to the targeted common base case:

- Provides exhaustive information on the criteria adopted for operating the elements constituting its own network within its own security rules.

  The mentioned operational security criteria shall describe at least the general rules currently used for managing the possible overloads of all the grid elements, in terms of:

  - Maximum permanent and transitory values of overloads of the grid elements considered acceptable as well as the relevant period of time requested for relieving them, in further accordance with the type and configuration of the protection devices installed in its own network
  - Maximum and minimum values of voltages considered acceptable at all the nodes of its own network
  - Further operational limits due to possible phenomena of transient or dynamic stability of its own network, whereas applicable.

  The operational network rules for managing possible congestion have to comply with the Grid Code in force within its own country and shall be in full accordance with the UCTE recommendations for N and N-1 network security criteria.

  The rules as described by each TSO are used for running the security analyses for the NTC assessment.

- Declares the operational countermeasures planned to be adopted on its side during emergency situation in order to face the consequences of the most severe contingencies known during the minutes immediately after the tripping

  The countermeasures for relieving congestion should include at least the real-time actions usually undertaken by TSOs at operational level to bring all the network elements back to the N and N-1 security operational conditions, once a congestion occurs. The contingencies determining the major congestions, both on the cross-border and the internal grid, will be examined by TSOs. In case of internal congestions, only the ones directly impacted by cross-border exchanges will be treated.

The operational measures for reducing or relieving possible congestion, in normal operation and following specific network elements tripping, can include:

- Automatic or manual opening of bus bar couplers, located on multiple bus bars substations
- Automatic or manual insertion of devices for power flows control, such as Phase Shifter Transformers (PSTs) or autotransformers equipped with tap changer and normally used in operation for managing power flows, if they are remote-controlled from the concerned TSO control room. Specifically, in case of PSTs, beside the modelling provided what prescribed at 3.2, the full information on the modalities of operation, both under meshed network conditions and following contingencies, shall be provided, in terms of lines tripping and operational conditions expected to cause the PSTs operation
- Automatic or manual opening of 220 kV (or lower voltage) internal lines for lightening local overloads or for redirecting power flows over different network areas
- Automatic or manual disconnection/insertion of key generation or pumping units to solve local congestion, in case of tripping of specific lines and, whereas applicable, in presence of power transits on network elements/area over a defined threshold
- Automatic or manual disconnection/insertion/modulation of key generation or pumping units with the aim to reduce/increase the physical flows in import/export from/to TSO control block
- Modulation of units constituting the generation operational reserve located in the country, following the rescheduling of the cross-border exchanges

For each of the contingencies examined, a list of actions to be undertaken by TSOs as well as their scheduled timing for implementation will be defined; such countermeasures identify and quantify the means to fully restore the new network conditions of N and N-1 security within certain and prescribed time.[8][9]

At the end of this step, the involved TSOs formally agree and validate a detailed protocol of action for the implementation of the operational countermeasures available to the TSO involved for restoring the N and N-1 security in due time, after the targeted contingencies occur. Each TSO commits itself to implementthe protocol during emergency situations.

3.4 Generation shifting and security analyses

The fourth step of the procedure consists of the determination of the cross-border transmission limitations between the Italian and the neighbouring countries networks. On this respect, starting from the BCE above identified, the cross-border exchanges are gradually increased, while modifying the generation patterns in the network of the TSOs and maintaining loads in the whole system unchanged, till security limits are reached.

The following actions are carried out on the common base case referring to the targeted time frame:

- The direction of the transmission capacities values is determined by identifying the exporting and the importing side[10]

[8] The period of time for restoring the new N and N-1 security conditions must anyway not to exceed 20 minutes from the time of the first grid element tripping.

[9] The security analyses and the subsequent protocol of actions to guarantee the operational security of the Slovenian border will be also a subject of investigation of a dedicated Working Group (WG) involving GRTN, ELES and APG-Verbund experts..

[10] Till the TF convened in 2003 for TTC 2004 values the importing side has always been the Italian network and no calculations have been performed for Italian network as exporting side

- Each TSO acting as importing side provides a merit order list of units, to be used hierarchically for decreasing generation on its network.
- Each TSO acting as exporting side provides a merit order list of units, to be used hierarchically for increasing generation on its network.
- Each TSO can also provide a list of generation units, whose injections are to be modified proportionally to the remaining available capacity (method A ref.[4]) or alternatively whose injections are to be modified proportionally to the currently operated generation (method B ref.[4]) .

The list of generators should at least contain:

- UCTE code of identification for the generation nodes (real or equivalent, as modelled within the identified common base case) and the name of the relevant power plant and units
- Maximum and minimum technical values of power available on the reported units and the value of their generation operated on the common base case
- Type of the power units and their possible technical constraints in operation

At this stage, each TSO, in accordance with the list of generators and the units technical limits provided, individually performs the generation shifting and the network security analyses[11].

The generation shifting is performed by an increase of generation on the exporting side and an equivalent decrease of generation on the importing side. The generation shifting, and the subsequent increase of cross-border exchanges, is made stepwise by using a minimum step of 50 MW. After the implementation of each generation step, all the needed network security analyses are performed again.

The security analyses consist of the simulation of the forecasted behaviour of the interconnected network, as defined and processed at steps 3.1 and 3.2, by applying the N and N-1 security criteria in accordance with the ETSO and UCTE recommendations, taking into account the operational parameters and rules for relieving congestion, as defined by all the involved TSOs at step 3.3.

As far as the implementation of the N-1 security criterion concerns, all the double-circuit tie-lines are computed as a single circuit while simulating the network elements tripping, therefore the contemporary tripping of both the circuits is considered. Instead, concerning the internal lines operated in each TSO block, the double-circuit lines will be computed in accordance with the security criteria declared by the relevant TSO. Also, on TSOs' request and in case of exceptional network conditions, more severe security criteria for network analyses could be implemented (N-2 or even N-k, with k>2) instead of the N-1 one, in order to cope with special criticalities of the network system.

The process of generation shifting proceeds till the security rules are breached for the first time on whatever network element pertaining either to the cross-border network or to the internal network of the countries involved in the calculations. Once it has happened, the generation shifting is stopped and the relevant base case represents the so said "shift base case".

[11] As from reference [3]: "...The party who is making the calculations is responsible at least for the contingency analysis in its transmission system and cross-border tie line including some well known contingencies in the neighbouring system, which influence the security of its own system.

The violation of the network security rules can be determined by constraints in terms of thermal capacities of network elements, voltage levels, network stability, excessive difference of phase angles voltages at the line extremes with respect to the installed protection devices, maximum or minimum generation available in one of the control area.

If the violation is detected within the control area of the TSO running the calculations, it has to be evaluated by the TSO itself whether the violation can be considered effective in real-operation or whether further unilateral corrective measures on its side (i.e. re-dispatching, network topology changes) can be implemented to restore the security conditions on its own electric system[12]. In case the violation is operationally effective, it is considered as actually limiting the value of transfer capacity.

If the detected violation does not occur in the control area of the TSO running the calculations, its effectiveness has to be confirmed by the TSO whose network the congestion takes place, before the limit is considered as effective. Once a violation is recognised by both the TSOs, it can be considered as an actual network constraint.

The load flow associated to the shifted base case represents the final network conditions of the study for the targeted time frame. It identifies the total maximum shift of generation ΔE_{max} between the Italian and the neighbouring countries networks, implemented starting from the common base case to the shift base case, as well as the values of the relevant physical flows induced on the interconnected border for the exchange programs of magnitude BCE+ ΔE_{max}.

3.5 Total Transfer Capacity assessment

The fifth step of the procedure consists of the joint assessment of the values of total transmission capacities on the northern Italian border, on the basis of the results individually carried out by each TSO delegation.

On this respect, with reference to the targeted common and shift base case:

- Each TSO notifies the others of the results of the calculations individually performed, by providing a relevant exhaustive report. The minimum standard of information is represented by the full completion of the ad-hoc spreadsheet proposed by ETSO. It contains the basic outcomes of the transmission capacities assessment, notably the values of the exchange programs on each border both on the common and shift base case (BCE, ΔE_{max}, TTC, NTC), the values of the related physical flows (NTF, ΔFmax, TTF) and information on the most significant overloads of the network elements detected, under meshed network conditions and following the most severe contingencies occurring.
- Each TSO takes note of the unilateral results produced by the other delegations and asks, if needed, further specific information on the calculations performed by them. A focused attention is devoted to check those security constraints identified by each TSO on the network elements located in different control areas, in order to evaluate their consistence from the operational point of view and bridge possible gaps or misunderstandings occurring during the elaborations. The constraint is considered actually effective once it is explicitly recognised by the TSO responsible for the network within which it occurs.

[12] If the congestion cannot be relieved through internal countermeasures, further coordinated actions can also be proposed and agreed among the involved TSOs.

- The value of total transmission capacity on the northern Italian border is defined by selecting the minimum values among the ones unilaterally evaluated by each delegation[13].
- The TSOs delegations produce a common table reporting the final values of the transmission capacities determined together with the information on the network constraints identified. The TTC value so defined is validated by the technical experts of all the TSOs involved and submitted to the decisional level.

3.6 Transmission Reliability Margin and Net Transfer Capacity assessment

The sixth and final step of the procedure consists of the joint evaluation of the values of the Transmission Reliability Margin (TRM) and, subsequently, of the Net Transfer Capacity (NTC).

The TRM value represents a security margin necessary to take into consideration a series of uncertainties possibly affecting the computed TTC values. These deviations can be reported to two main factors: the unintended deviations occurring in the real operation state with respect to the simulated network operation and the possible inaccuracies affecting the process of capacity assessment.

The deviations of the transmission capacities are mainly due to the following factors:

- Unintended deviations of physical functioning of the primary and secondary control
- Emergency exchanges between TSOs

The TRM value is determined by the TSOs according to the real-time operational experience of their power systems and interconnected networks and refers to a particular direction of transmission.

On this respect, with reference to the targeted time frame:

- Each TSO notifies the others a proposed TRM expected to ensure the operational security of its own system and the interconnected network
- The delegations, on the basis of the common operational experience, endeavour to carry out a unique harmonised TRM value for a given direction of transmission. In case of disagreement on a unique TRM value, each TSO will maintain its final value of TRM while operating its own network, whilst the higher value will be considered as the TRM value for the capacity assessment.

Once the TRM value has been commonly defined, the value of NTC is determined by deducting the TRM value from the TTC value determined at step 3.5.

The NTC value is provided with reference to the whole northern Italian border, without referring to the single country borders The definition of the NTC values on the single national borders is out of the objectives of the present document.

3.7 Verification of consistency of NTC values at operational level

The values of transfer capacities assessed during the previous steps are submitted to a process of verification with respect to operational criteria, with the view to check the

[13] Discrepancies between calculations, even starting from a well-harmonised common base case, are normally detectable. Their possible effects are anyway taken into account within the TRM assessment phase.

consistency of their application in the phase of cross-border network operation. On this respect and based on the security analyses carried out for the NTC assessment, the following additional analyses are performed:

- **Analysis of consistency of the minimum operational reserve installed**

  The analysis aims to assess the minimum reserve of generation that should be available within the importing country to face the consequences of the most severe network contingencies identified. In particular, after simulating the network conditions subsequent to a contingency and considering those tripping as permanent, the interconnected system (without the network element tripped) will be brought back to restored full conditions of N and N-1 security by simulating a co-ordinated re-dispatching to relieve the congestion. The verification will be accepted if a corresponding amount of reserve of generation will be reduced by the neighbouring TSOs in the most efficient way[14].

- **Analysis of consistency of the thermal units nightly regulation**

  The analysis aims to assess the existence of a satisfactory margin of regulations for all the units during the night period, when operating the new calculated NTC values. The level of generation operated by all the units in the study case will be first compared with their own technical limitations in producing the minimum levels of generation. Then, it will be assessed whether all those units, supposed to be necessary to cover the peak-load demand during the daily hours, can manage a satisfactory margin of regulation during the night hours. The availability of a proper margin of such an operational reserve is important to cope with emergency situations and increases the level of system security[15].

- **Analysis of system transient stability and voltage stability**

  Whereas considered needed, the involved TSOs commit their selves to exchange data for performing analyses of system transient stability and voltage stability, following identified contingencies and ender specific scenarios.

If the verifications above point out the incompatibility of the calculated transfer capacities with the main operational requirements mentioned, the values of TTC/NTC will be further decreased to guarantee their consistency with the network system operational security.

The present procedure provides the global seasonal NTC values. These values are submitted to the Steering Committee (SC) level for the decisions on the modalities of capacity allocation.

4. REFERENCES

[1] Procedures for cross-border Transmission Capacity Assessments, ETSO, October 2001

[2] Definitions of Transfer Capacities in liberalised Electricity Markets, ETSO, April 2001

[3] NTC and ATC in the Internal Electricity Market in Europe, ETSO, March 2000

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

[14] At this level, the co-ordinated re-dispatching is intended to be operated among the importing country and the TSOs responsible for the control of the tripped tie-line or, alternatively, a TSO expected to be efficient in relieving congestion due to the influence if its actions on the bottleneck

[15] UCTE has indicatively quantified such a margin as about 600 MW for each border.

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APPENDIX A: LOGICAL SCHEME UNDER THE PROCEDURE