Ad hoc Group

"Geographical Distribution of Reserves"

Document 4:

Border – Crossing Exchange of

Secondary Control Reserve

Limits and Constraints

Version 1.0 – July 2005

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0. Goal of the Document

This document gives an overview of the possibilities and the limitations on the cross-border exchange of SECONDARY CONTROL RESERVE. It also discusses the organisational aspects and requirements of such exchanges. Furthermore the operational risks associated with cross-border exchange of SECONDARY CONTROL RESERVE are analysed in detail. The document does not however take into account local regulations or provide an economical analysis of the subject, nor does it provide any market solutions, subjects which are out of scope of the document. Terms printed in CAPITAL FORMAT are defined within the separated document "Glossary of Terms".

1. Definition

Analysing the border – crossing exchange of reserves it is essential to distinguish the activation details for the different reserve types. Figure 1 gives an overview of the different reserve types – according to the definitions in the document "Basic Framework and Current State". This is an example how reserves will be activated and interact after an outage of generation.

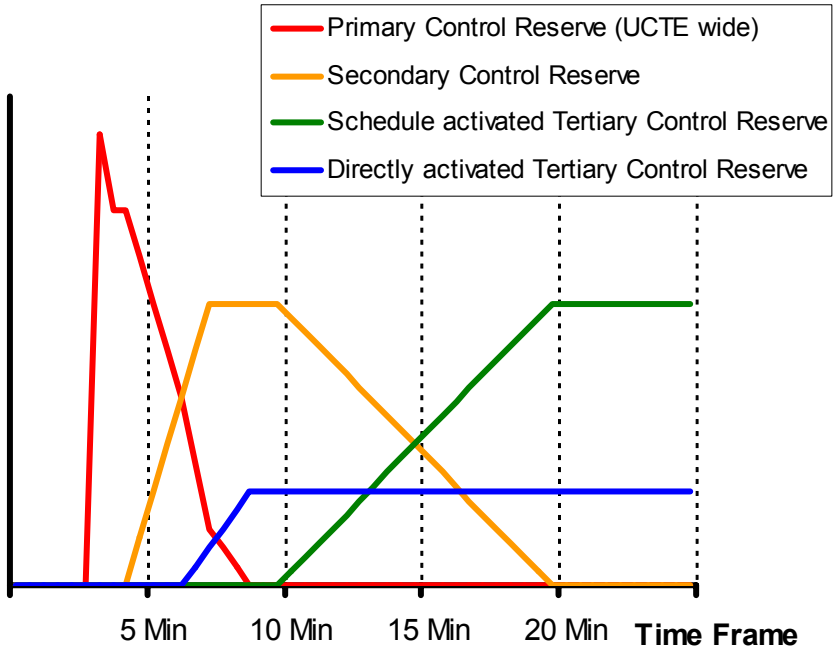

Fig. 1: Activation of different reserve types

The scope of this document is the analysis of limits for distribution of the SECONDARY CONTROL RESERVE.

Concerning the rules for geographical distribution the reserve types SECONDARY CONTROL RESERVE and DIRECTLY ACTIVATED TERTIARY CONTROL RESERVE have to be treated in the same way. This is explained in more detail in Chapter 2.

2. Physical Limits

2.1 Geographical Distribution of Secondary Control Reserves

The goal of SECONDARY CONTROL RESERVE is to restore frequency and cross – border exchange to the set values and therefore also to free up the PRIMARY RESERVE within 15 minutes after the occurrence of an imbalance. The SECONDARY CONTROL RESERVE is activated within the automatic process of the Load Frequency Control

Analysing the geographical distribution of SECONDARY CONTROL RESERVES the following aspects have to be taken into account:

- Transmission Capacity must be available between RESERVE RECEIVING TSO and RESERVE CONNECTING TSO – taking into account all RESERVE TRANSITING TSOS affected
- The provision of SECONDARY CONTROL RESERVES outside the CONTROL AREA results in missing observation (incomplete grid and generator information), control and thus an increasing dependency on third parties with respect to the grid infrastructure needed
- The border crossing exchange of SECONDARY CONTROL RESERVES bears additional operational risks, e.g. due to the virtual Tie- lines needed
- In case of grid problems at the RESERVE CONNECTING TSO or the RESERVE TRANSITING TSO the taking of corrective actions is more complex.
- In case of a UCTE network splitting both network portions should still meet internally the UCTE criterion to restore the frequency within 15 minutes.
- A minimum amount of SECONDARY CONTROL RESERVE allows the straightforward operation of two separated network portions and facilitates their reconnection.

On the basis of these aspects the following rules for geographical distribution are proposed:

- The transmission capacity needed has to be available.
- To gain experience with the monitoring and the reliability it is proposed to keep a fixed share of 2/3 of the SECONDARY CONTROL RESERVES needed inside the CONTROL AREA (in case of a statistic based dimensioning of reserves this corresponds with the amount of reserves that is sufficient in 95% of the time). In addition a share of 1/2 of the total SECONDARY CONTROL RESERVES / TERTIARY CONTROL RESERVE needed should be kept inside the CONTROL AREA.
- Exchange between neighbouring CONTROL AREAS recommended as a starting point to gain experience.
- Each TSO (both in the role as RESERVE CONNECTING TSO and RESERVE RECEIVING TSO) decides about the number of Virtual Tie – Lines allowed according to the resulting accuracy of the ACE measurement. In general the measurements of virtual tie – lines should meet the same requirements as the physical tie – lines (see OpHb: resolution, accuracy, redundancy, etc.). The TSO judges the accuracy of the ACE, taking into account these requirements and the number of physical / virtual tie – lines.

2.2 Cross-Border Transfer Capacities

In general, in case of SECONDARY CONTROL RESERVE exchanges between two CONTROL AREAS there is a necessity of having enough available transfer capacity. This applies not only for the RESERVE CONNECTING TSO and RESERVE RECEIVING TSO but also for all RESERVE TRANSITING TSO involved. According to the analysis made in the document "Border – Crossing Exchange of Reserves – Use of Transmission Capacity" it can be concluded that a power flow resulting from SECONDARY CONTROL activation should use a part of NTC.

3. Technical Realisation of border – crossing exchange of Secondary Control Reserve

3.1 Concepts for Technical Realisation

According to the document "Basic Framework and Current State" the following three scenarios exist for the technical realisation of border – crossing exchange of SECONDARY CONTROL RESERVES:

1. Direct control of the external generation by the RESERVE RECEIVING TSO
    a) Adaptation of the LFC by the measurement value from the external generation
    b) Adaptation of the LFC by the requested power from the RESERVE RECEIVING TSO
2. Power request by the RESERVE RECEIVING TSO through the RESERVE CONNECTING TSO

3.1.1 Direct control of the external generation by the Reserve Receiving TSO

In case of direct control of the generation unit the LFC of the RESERVE RECEIVING TSO sends its request for power directly to the generation. In the case of DIRECTLY ACTIVATED TERTIARY CONTROL RESERVE this corresponds to the manual activation of an exchange schedule – independent of an accounting time frame. The LFCs of both the RESERVE RECEIVING and the RESERVE CONNECTING TSO have to be adapted in order to shift the generation unit "virtually" from the area of the RESERVE CONNECTING TSO to that of the RESERVE RECEIVING TSO. For this purpose the generation unit information (on – line measurement value of active power for scenario a) or request for power for scenario b)) has to be added to the LFC of the RESERVE RECEIVING TSO and subtracted from the LFC of the RESERVE CONNECTING TSO. The direct control of the generation unit by the RESERVE RECEIVING TSO fits to the contractual relation of border – crossing exchanging of SECONDARY CONTROL RESERVE from a GenCo.

<u>a) Adaptation of the LFC by the measurement value from the generation unit</u>

The on – line measurement value of active power is sent from the generation unit back to the LFCs of both the RESERVE RECEIVING and the RESERVE CONNECTING TSO. If the generation unit produces according to an underlying schedule in addition to providing for SECONDARY CONTROL RESERVE the schedule has to be subtracted from the measurement value accordingly. This introduces the concept of virtual tie - lines which connects the generation unit in the CONTROL AREA of the RESERVE CONNECTING TSO directly to the CONTROL AREA of the RESERVE RECEIVING TSO.

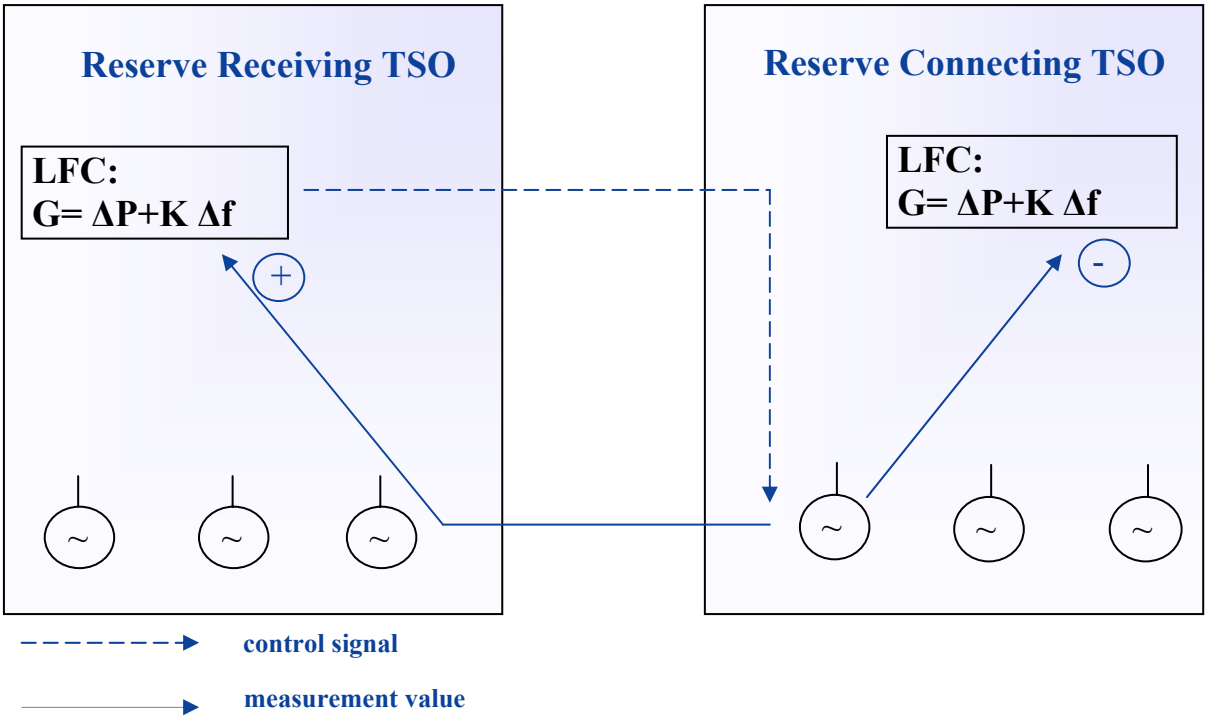

Fig. 2: Technical Realisation of SECONDARY CONTROL RESERVE across the Border: Scenario 1. a)

b) Adaptation of the LFC by the requested power from the RESERVE RECEIVING TSO

The request for power from the RESERVE RECEIVING TSO to the generation unit is sent to the RESERVE CONNECTING TSO. This request for power is used for an adaptation of the LFCs of both the RESERVE RECEIVING and the RESERVE CONNECTING TSO. Delegation of the responsibility of the SECONDARY CONTROL for this part of the reserve to the RESERVE CONNECTING TSO is supposed. This responsibility may be stopped in case of an outage of the generation by manually adapting the requested power to zero.

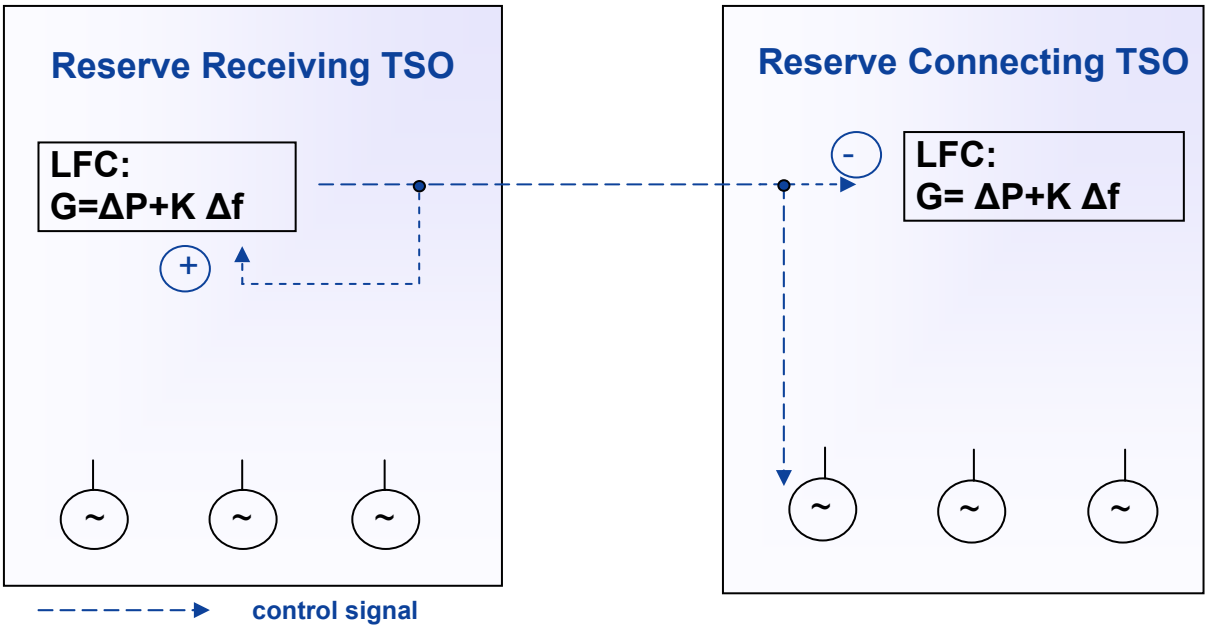

Fig. 3: Technical Realisation of SECONDARY CONTROL RESERVE across the Border: Scenario 1. b)

3.1.2 Request for power by the Reserve Receiving TSO through the Reserve Connecting TSO

The principle of this solution is that the RESERVE RECEIVING TSO does not send its request for power directly to the generation unit but to the RESERVE CONNECTING TSO. The RESERVE CONNECTING TSO adjusts either the power of the plants which the RESERVE RECEIVING TSO has contracted with or the power plants the RESERVE CONNECTING TSO has contracted with. A full delegation of the responsibility of the SECONDARY CONTROL for this part of the reserve to the RESERVE CONNECTING TSO is supposed. The block diagram is presented in figure 4.

3.2 Operational risks resulting from fault scenarios

To evaluate the different scenarios for technical realisation the operational risks resulting from fault scenarios are analysed. The following fault scenarios were taken into account:

1. Outage of the generation unit used for cross – border SECONDARY CONTROL
2. Tripping of tie lines and potential drop of interchange capacity on tie lines for SECONDARY CONTROL,
3. Data acquisition and transmission problems concerning:
   - a power request to « outer » generation plants and
   - the data exchange necessary for correct reaction of the load frequency control of the RESERVE CONNECTING TSO and the RESERVE RECEIVING TSO,
4. Wrong response of « outer » generation units to the load-frequency control of a RESERVE RECEIVING TSO (no respect of technical terms enclosed in the contract)

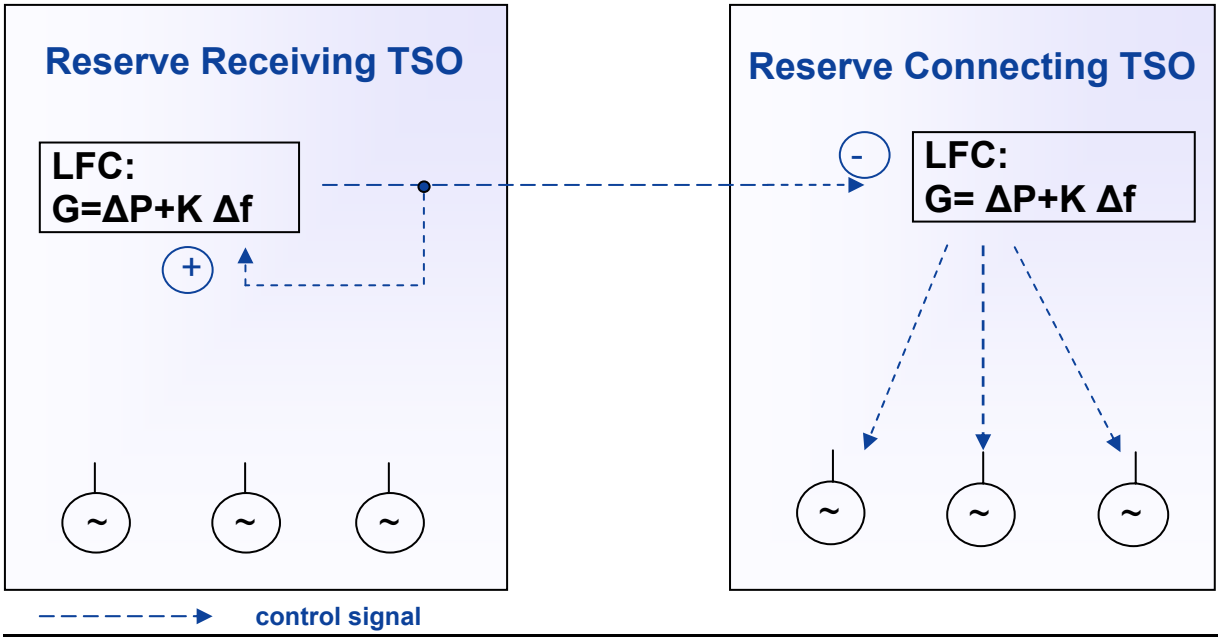

Fig. 4: Technical Realisation of SECONDARY CONTROL RESERVE across the Border: Scenario 2.

Analysis of the different scenarios:

Analysis of Fault Scenario 1 (the outage of a generation unit):
Depending on the technical realisation the results differ:

- Adaptation of the LFC by the measurement value from the generator: In case of an outage of a generation unit, the measurement value decreases to zero and consequently the adaptation of the LFCs of RESERVE RECEIVING and RESERVE CONNECTING TSO also decreases to zero.; → the RESERVE RECEIVING TSO has to compensate for the missing power;
- Adaptation of the LFC by the request for secondary power reserve from THE RESERVE RECEIVING TSO: this request (control signal) from the RESERVE RECEIVING TSO does not change in case of an outage of the generation unit (unless it is stipulated in the contract that the availability of the generator must be communicated to the RESERVE RECEIVING TSO in which case the RESERVE RECEIVING TSO shall adapt the control to take this into account); thus from the point of view of the RESERVE RECEIVING TSO the generation unit is still available for SECONDARY CONTROL; unless the request (control signal) is not changed accordingly, the adaptation of the LFC of RESERVE RECEIVING and RESERVE CONNECTING TSO still remains. → As a result, for this scenario the risk of an outage of a generation unit for SECONDARY CONTROL RESERVE is shifted from the RESERVE RECEIVING TSO to the RESERVE CONNECTING TSO if the availability of the generator is not taken into account by the control mechanism.
- Indirect control of the generator by the RESERVE RECEIVING TSO via the RESERVE CONNECTING TSO: In this case the RESERVE CONNECTING TSO has to care to replace the generation unit with the outage by another unit. Also in this case the RESERVE CONNECTING TSO has to compensate unless the request (control signal) is not changed accordingly.

As a result only in the first case (and in the second case providing the availability stipulations) the RESERVE CONNECTING TSO has not to bear the risk

Analysis of Fault Scenario 2 (drop of interchange capacity):
This scenario may occur everywhere on European network (and inside any national transmission grid), but in the scope of SECONDARY CONTROL RESERVE distribution, it deals with tie lines OF RESERVE TRANSITING TSO with RESERVE CONNECTING and RESERVE RECEIVING TSO. A RESERVE TRANSITING TSO must study any N-1 scenario to check if it can transmit secondary energy between TSO, whatever commercial transit due to long term contracts or spot sales on its tie lines, without congestion problems and line tripping for overload. It has to be pointed out that transmission of SECONDARY CONTROL RESERVE must not use Transmission Reserve Margin (see document "Use of Transmission Capacity").

Analysis of Fault Scenario 3 (data transmission problems):
This fault scenario may obviously happen for SECONDARY CONTROL of any TSO. Nevertheless, the matter is more critical as several TSOs are involved, as well transits on tie lines. Thus, it is necessary for the RESERVE CONNECTING TSO to monitor regularly the response of the generation units and facing a problem, enter into the engagement of warning without delay, both the RESERVE RECEIVING TSO and the RESERVE TRANSITING TSO. The operational risk is limited when it affects a limited number of generation units. In the case of concentrated « pack » of generation plants for SECONDARY CONTROL RESERVES, even the loss of a few data transmission links may jeopardise European system frequency, this is one reason for spreading SECONDARY CONTROL RESERVES over many locations. In the case of 1a) it must be stressed that the transmission of the measurements is critical which should be reflected in the recommendations for back-up procedures

Analysis of Fault Scenario 4 (response quality):
The last fault scenario is a contractual problem. Reliable monitoring should show that the generation plants do not comply with their commitments, although this is more complex than internal monitoring as the units are not directly connected to the RESERVE RECEIVING TSO network.

Conclusion:
Specific rules for different fault scenarios have to be established to avoid longer periods of unbalance as well as "unfair" bearing of risks of the involved partners. It must be kept in mind for scenario 1 a) and 1b), that a RESERVE RECEIVING TSO has to conclude a contract with a GenCo including direct contact concerning connection / measuring points for a probably limited contracted time which makes problems of data transmission and responsibility more complex. In addition the rules for handling problems of power transmission have to be determined carefully.

3.3 Technical Requirements

In the case of scenario 1 a), the adaptation of the LFC by the measurement value from the generator, a data exchange of the measurement value of the generation units to both the RESERVE RECEIVING TSO and the RESERVE CONNECTING TSO has to be set up. If border – crossing exchange between CONTROL AREAS / BLOCKS occurs the data exchange of the measurement value of the generation units has to be set up for all CONTROL AREAS / BLOCKS affected. This requires a reliable communication system. The measurement values are used for the adaptation of all LFC involved (virtual tie – lines). In case of the scenarios 1 b) and 2, no data exchange of the measurement values of the generation units is needed. The LFC involved are adapted on the basis of the control signal from the RESERVE RECEIVING TSO. In all cases described a data exchange of this control signal from the RESERVE RECEIVING TSO to all other TSOs affected has to be set up.

3.4 Recommended Technical Realisation

Taking into account the operational risks resulting from fault scenarios and the technical requirements mentioned above the technical realisation of scenario 1 a) is recommended. Its advantage is that it guarantees the full responsibility for the reserve to the RESERVE RECEIVING TSO. However there is the disadvantage of set – up of additional data exchange for every bidder. Especially in case of an outage of a generation unit, the measurement value decreases to zero and consequently the adaptation of the LFCs of RESERVE RECEIVING and RESERVE CONNECTING TSO also decreases to zero. With that the RESERVE RECEIVING TSO has to compensate for the missing power.

In the case of the concept of full delegation of the responsibility for the reserve from the RESERVE RECEIVING TSO to the RESERVE CONNECTING TSO scenario 2 is recommended. This is the most consequent solution for this concept which gives the necessary means to the RESERVE CONNECTING TSO keeps the situation independently under control.

Scenario 1 b) is not recommended since it mixes up the responsibilities for the reserve between RESERVE RECEIVING TSO and RESERVE CONNECTING TSO.

4. Organisational Constraints

4.1 Allocation of Transfer Capacity

As mentioned in Chapter 2 for the border – crossing exchange of SECONDARY CONTROL RESERVES the transfer capacity has to be available accordingly. With this the exchange of SECONDARY CONTROL RESERVES has to be taken into account in the process of transfer capacity assessment, allocation and nomination. If the SECONDARY CONTROL RESERVES are contracted on a daily basis, the transfer capacity has to be allocated short term (ST); in case of longer contracting periods for SECONDARY CONTROL RESERVES the capacity allocation has to be long term (LT) accordingly. The process needed for this purpose is described in detail in the document "Border – Crossing Exchange of Reserves – Use of Transmission Capacity".

4.2 Data Exchange of the Control Signal

For the activation of SECONDARY CONTROL RESERVE the control signal has to be transmitted from the RESERVE RECEIVING TSO to the RESERVE CONNECTING TSO. This control signal has to be taken into account in the load frequency control as "Virtual tie – line" without delay.

The operational risk of the TSOs involved increases with the number of virtual tie – lines. To cope with this the following restrictions are recommended (see section 2.1):

- Each TSO decides about the number of Virtual Tie – Lines allowed according to the resulting accuracy of the ACE measurement.
- Exchange between neighbouring CONTROL AREAS / BLOCKS recommended as a starting point to gain experience.

TSOs have to agree on the responsibility for the corresponding necessary cross - border telecommunication links and the required quality of the data (availability, reliability, accuracy, protocol) for the involved LFC 's.

4.3 Risk of Unavailability

In the case of a cross - border exchange for SECONDARY CONTROL RESERVE there is the risk that a TSO is not in the position to cover its needs, although enough reserve is available in its CONTROL AREA / BLOCK. This could occur when SECONDARY CONTROL RESERVE is sold to other TSOs and no more reserve is available in its CONTROL AREA / BLOCK block. For this case local market rules are a possibility to assure that every TSO is in the position to cover its needs of SECONDARY CONTROL RESERVE. As an example reciprocity of access to SECONDARY CONTROL RESERVE among CONTROL AREAS / BLOCKS could be a prerequisite.

In addition, with increasing border –crossing exchange of SECONDARY CONTROL RESERVES the need is growing to verify that the market participants can ensure the supply. One risk is double selling of reserves by suppliers. To cope with this risk rules for monitoring will be necessary including complete information exchange among TSOs involved. The monitoring is a specific task of the Connecting TSO.

4.4 Data Exchange Bidder / TSO

A daily information process between Bidders and TSOs involved has to be set up. The RESERVE RECEIVING TSO has to inform the RESERVE CONNECTING TSO about the day – ahead share of each bidder in the area of the RESERVE CONNECTING TSO. The bidder has to inform the RESERVE CONNECTING TSO about the generation units planned for the next day provision of SECONDARY CONTROL RESERVES. Based on this information the RESERVE CONNECTING TSO has to check that the bidder is in the position to fulfil his contractual duties. For example misuse by multiple bids of one share of reserve to different TSOs has to be excluded. In addition the RESERVE CONNECTING TSO has to be in the position to monitor the delivery of SECONDARY CONTROL RESERVE per generation unit. This leads to additional efforts for the RESERVE CONNECTING TSO.

4.5 Accounting

The accounting of the SECONDARY CONTROL RESERVES including any kind of penalty is up to the bilateral contract between the RESERVE RECEIVING TSO / RESERVE CONNECTING and the Bidder. In addition the following aspects have to be taken into account:

- The **physical or requested delivery** for SECONDARY CONTROL RESERVES exchanged among TSOs has to be taken into account in the procedure for the UCTE accounting of unintentional deviations
    - In case of the recommended realisation scenario 1 a) the measurements of the RESERVE RECEIVING TSO have to be stored and integrated for each accounting period to calculate the **physical delivery**.
    - In case of all scenarios the accounting of the **requested delivery** for SECONDARY CONTROL RESERVES can be based upon the control signal - integrated for each accounting period. In this case any deviation between the physical delivery and the requested delivery of SECONDARY CONTROL RESERVES is treated according to the local rules of the balancing mechanism of the RESERVE CONNECTING TSO (scenario 1b) and 2) resp. the RESERVE RECEIVING TSO (scenario 1a)

5. Implementation Issues

Before the implementation of border – crossing exchange of SECONDARY CONTROL RESERVES the following topics have to be treated:

a) Adaptation of UCTE Operation Handbook Policy 1
b) Contractual Issues
c) Technical Issues
d) Availability of Transmission Capacity
e) Related Market Rules

The main issues to be taken into account are given in the check lists below.

a) Adaptation of UCTE Operation Handbook Policy 1

The border – Crossing Exchange of SECONDARY CONTROL RESERVES is not allowed since only multiples of ¼ h schedules are specified in the current version of UCTE Operation Handbook. Thus before the implementation of border – crossing exchange of SECONDARY CONTROL RESERVES the Policies 1 / 2 has to be adapted accordingly.

b) Contractual Issues:

Scenario1

- Contractual Agreement among TSO necessary:
  - Responsibility of TSO involved
  - Pre – Qualification of generation units
  - Accounting of Reserves
  - Information exchange for the monitoring of reserves
  - Treatment of error scenarios
- Contractual Agreement between each Receiving TSO and Supplier

Scenario 2

- Contractual Agreement among TSO necessary:
  - Responsibility of TSO involved
  - Pre – Qualification of generation units
  - Accounting of Reserves
  - Development of Pricing Models if needed (e.g. based on the price of Connecting TSO)
- Contractual Agreement between Connecting TSO and Supplier

c) Technical Issues

- Realisation of data exchange for measurement values (Scenario 1a)
- Adaptation of the LFC System
- Monitoring of the supply of reserves

d) Availability of Transmission Capacity

- development of a system for allocation of the available capacity over all transactions and reserves (methods, procedures and tools)

e) Related Market Rules

- adaptation of rules, laws or existing contracts in each country if needed (example: expansion of the bidding rules)

6. Summary

The SECONDARY CONTROL RESERVE can be exchanged border – crossing taking into account a number of constraints in the UCTE system. The following rules are developed in this document:

- The transmission capacity needed has to be available. In case of limited transfer capacity it has to be decided how to share the transfer capacity between the market transactions and the TSO for SECONDARY CONTROL RESERVE. In any case the allocation of transfer capacity to the different kinds of transactions has to be organised accordingly.
- To gain experience with the monitoring and the reliability it is proposed to keep a fixed share of 2/3 of the SECONDARY CONTROL RESERVES needed inside the CONTROL AREA. In addition it is proposed to keep a fixed share of 1/2 of the total SECONDARY CONTROL RESERVES plus TERTIARY CONTROL RESERVE that is needed inside the CONTROL AREA.
- Each TSO decides about the number of Virtual Tie – Lines allowed according to the resulting accuracy of the ACE measurement.
- Exchange between neighbouring CONTROL AREA / BLOCKS recommended as a starting point to gain experience.

The document recommends two technical solutions for border-crossing exchange of SECONDARY CONTROL RESERVES, points out the operational risks resulting from fault scenarios and summarises the implementation issues to be taken into account. The major question is whether the RESERVE RECEIVING TSO keeps the full responsibility for the reserve or delegates this responsibility completely to the RESERVE CONNECTING TSO.

The border – Crossing Exchange of SECONDARY CONTROL RESERVES is not allowed since only multiples of ¼ h schedules are specified in the current version of UCTE Operation Handbook. Thus before the implementation of border – crossing exchange of SECONDARY CONTROL RESERVES the Policies 1 / 2 have to be adapted accordingly.

As ETSO transfer capacity definitions are currently only available for adjacent CONTROL AREAS / BLOCKS it is recommended to allow only applications between neighbouring CONTROL AREA / BLOCKS to gain additional experience on the implementation issues as a first phase. On the basis of this experience as a second phase the complete opening of the border – crossing exchange of SECONDARY CONTROL RESERVES can be decided.